

# National Cooperative Highway Research Program FY 2022 Program



## **PART I – Candidates for Continuation Funding**

## **PART II – New Problems**

(Statements with Evaluations and Submitter Responses)

February 2021

## INTRODUCTION

In formulating the fiscal year 2022 program for the National Cooperative Highway Research Program, the Special Committee on Research and Innovation will consider candidate studies in two broad categories: (1) continuations of projects initiated in earlier years and (2) new projects. Corresponding to these categories, this report is in two parts.

Part I contains write-ups for 13 continuation candidates. These write-ups were prepared by the NCHRP staff and project panels and provide the specifics of project objectives, funding, accomplishments, and recommendations for needed additional research. The continuations have been further subdivided as follows: Annual Projects (e.g., Project 20-05) and Research Projects (recommended extensions to individual objective-specific projects). You will find ‘Accountability Reports’ attached to continuation requests under the Annual Projects category.

Part II contains 111 problem statements for consideration as new projects, and the 2 problem statements that were withdrawn. For each candidate problem, the problem statement write-up, which was to be submitted in a format specified by NCHRP, is presented first. The problem statement is then followed by evaluations that may be from among 3 sources: FHWA staff, NCHRP staff, and/or AASHTO committee or council. Lastly, there may be a response from the original submitter to the evaluation comments. Submitters were given the opportunity to support or rebut the evaluations or to withdraw the statement. In 3 instances (C-13, F-01 and SP-01), the submitter submitted a revised problem statement. These revisions have not been provided because they could not be reviewed by AASHTO, FHWA and NCHRP. Two problem statements (A-03 and D-07) were withdrawn by the submitter.

## ACTIONS REQUIRED

This report is accompanied by a ballot for assigning priorities to both the continuation problems and the new problems. The questions to be considered in completing the ballot are:

- a. Does the proposed study represent a current problem that needs researching?
- b. Is the proposed study appropriate for NCHRP or should it be performed elsewhere?
- c. Is the problem of interest to a majority of states?
- d. Are similar efforts already underway elsewhere? If so, will this unnecessarily duplicate the efforts of others?
- e. What is the probability of this research being successful?
- f. If the research is successful, what is the anticipated return with respect to its cost?

By whatever means research committee members choose to employ, the evaluation of each problem by these questions is to be translated into a single rating number from 0 (no need) to 5 (absolute need) that will be used to rank the problem according to ballots returned by R&I and RAC.

**The ballot is due on April 2, 2021,** and a summary of the results will be distributed early in April. When R&I meets on April 14 and 15, the order in which continuation candidates and new problems will be considered will be based on the composite rankings by R&I and RAC.

# **Part I**

## **CANDIDATES FOR CONTINUATION FUNDING**

## FY 2022 CANDIDATES FOR CONTINUATION FUNDING

### Table of Contents

| <u>Project No.</u> | <u>Title</u>                                                                                                                                         | <u>Funding Request</u> | <u>Page</u> |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------|
|                    | <b>Annual Project</b>                                                                                                                                |                        |             |
| 20-05              | Synthesis of Information Related to Highway Problems                                                                                                 | \$810,000              | 7           |
| 20-24              | Administration of Highway and Transportation Agencies                                                                                                | \$1,000,000            | 14          |
| 20-30              | NCHRP-IDEA Program                                                                                                                                   | \$950,000              | 22          |
| 20-44              | Accelerating the Application of NCHRP Research Results                                                                                               | \$2,000,000            | 37          |
| 20-68              | U. S. Domestic Scan Program                                                                                                                          | \$600,000              | 46          |
| 20-123             | Support for AASHTO Committees and Councils                                                                                                           | \$833,000              | 50          |
|                    | <b>Research Projects</b>                                                                                                                             |                        |             |
| 01-57A             | Developing Standard Definitions for Comparable Pavement Cracking Data                                                                                | \$500,000              | 56          |
| 03-119             | Application of MASH Test Criteria to Breakaway Sign and Luminaire Supports and Crashworthy Work-Zone Traffic Control Devices                         | \$280,000              | 58          |
| 09-60              | Addressing Impacts of Changes in Asphalt Binder Formulation and Manufacture on Pavement Performance through Changes in Asphalt Binder Specifications | \$500,000              | 62          |
| 12-102             | Recommended AASHTO Guide Specification for ABC Design and Construction                                                                               | \$150,000              | 66          |
| 15-67              | Wind Drag Coefficients for Highway Signs and Support Structures                                                                                      | \$75,000               | 68          |
| 20-50(20)          | LTPP Data Analysis: Develop Practical Tools and Procedures to Improve WIM Data Quality                                                               | \$118,460              | 70          |
| 22-29B             | Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Off-Ramps                                                               | \$75,000               | 73          |

# **Part 1.1**

## ANNUAL PROJECTS

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board, The National Academies of Sciences,**  
**Engineering and Medicine**

**Continuation Request**  
**Project 20-05, FY 1968 & Continuing**  
*Synthesis of Information Related to Highway Problems*

**Present Expiration Date:** Continuing  
**Recommended Allocation:** \$810,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The purpose of NCHRP Project 20-05 is to synthesize the useful knowledge and practice on particular subjects and prepare well documented state-of-knowledge and - practice reports. This is a systematic way to bring such useful information together and to make it available to the entire highway community.

With the rapid advancements that are taking place in highway and transportation planning, location, design, construction, maintenance, and operations, and as result of the broad spectrum of information input to these fields from a multitude of sources, it is imperative that a means of synthesizing this information into usable form be maintained and augmented. This service has been provided since 1967 through NCHRP Project 20-05 under the guidance of Project Panel SP20-05 and has been highly responsive to the needs of highway and transportation organizations. The synthesis program continues to be highly rated by R&I and RAC and has consistently been ranked as a very high priority.

The substantial interest that the program has generated is evidenced by the number of subjects that are proposed for synthesis each year—typically between 120 and 150. As of November 30, 2019, 540 syntheses had been published, seven reports are in the final editorial and publication process, and 27 others are in the research stage. A review of TRB's web page shows that 11 NCHRP synthesis studies were published in 2019.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

For the FY2020 series, the NCHRP 20-05 project committee requested and AASHTO R&I approved a budget of \$765,000 to execute 17 topics. The R&I also funded two additional topics, for a total FY2020 budget of \$855,000. The budget recommended by the NCHRP 20-05 project committee for FY2021 is \$810,000 to support 18 topics.

### 3. Funds (in thousands)

|                          | FY 1968<br>– 2015* | FY 2016      | FY 2017      | FY 2018      | FY 2019      | FY 2020    | FY2021 |
|--------------------------|--------------------|--------------|--------------|--------------|--------------|------------|--------|
| Continuation allocation  | 35,610             | 1,750        | 1,830        | 1,830        | 1,830        | 765***     | 810    |
| Transfers to proj. 20-05 | 1,720**            | 120**        | -0-          | -0-          | -0-          | 90         |        |
| Less obligation          | <u>37,330</u>      | <u>1,870</u> | <u>1,830</u> | <u>1,830</u> | <u>1,830</u> | <u>855</u> |        |
| Balance (earmarked)      | -0-                | -0-          | -0-          | -0-          | -0-          | -0-        |        |
| Reallocation             | <u>-0-</u>         | <u>-0-</u>   | <u>-0-</u>   | <u>-0-</u>   | <u>-0-</u>   | -0-        |        |
| Total available          | -0-                | -0-          | -0-          | -0-          | -0-          | -0-        |        |
| Recommended addition     | -0-                | -0-          | -0-          | -0-          | -0-          | -0-        | 810    |

\* Annual funding allocations ranged from \$1.0M to \$1.5M.

\*\* These transfers were for additional synthesis projects funded by R&I from among their regular NCHRP problem statement submissions.

\*\*\* Beginning in FY 2020, funds reflect the amount for research contracts only.

### 4. Interpretation of AASHTO Problem Statement by Panel

Administrators, practicing engineers, and researchers are continually faced with highway problems on which much information already exists, either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and unevaluated. Often it is unknown to the persons normally responsible for initiating changes related to the topic (changes in specifications, procedures, etc.). As a consequence, full information on what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

Another type of waste occurs if a number of people who have similar problems make independent efforts to assemble the appropriate information, especially if the assemblies are incomplete and not made available to others.

Textbooks, monographs, and state-of-the-art papers represent conventional methods for maximizing the use of existing information and for minimizing the total effort expended in bringing together useful information. All such documents involve the synthesis of information from various sources and can, therefore, be looked upon as information syntheses.

In this project, particular highway problems, or sets of closely related problems will be designated as topics for information syntheses. For each topic, the project objectives are: (1) To locate and assemble all documented information on the topic; (2) To learn what the practice has been for solving or alleviating problems within the topic; (3) To identify all ongoing research on the topic; (4) To learn what problems remain largely



unsolved; (5) To organize, evaluate, synthesize, and document the useful information that is acquired; and (6) To evaluate the effectiveness of the synthesis after it has been in the hands of its users for a period of time.

The document produced by attainment of the foregoing objectives will be called a synthesis of existing information on the topic. The first and third objectives imply full use of the Transportation Research Database (TRID) and other information systems for documented information. It is expected that information obtained for the second and fourth objectives will be largely undocumented and will, therefore, be obtained through interviews in federal, state, and local agencies that have had first-hand experience with problems within the topic.

#### **5. Original AASHTO Problem Statement Number**

Problem Statement is on file.

#### **6. Research Assignment to Date**

NCHRP Project 20-05, "Synthesis of Information Related to Highway Problems"

#### **7. Review Dates**

May 1 – May 2, 2019 (Panel/staff),

**Accountability Report for NCHRP Project 20-05  
“Synthesis of Information Related to Highway Problems”**

|                                       |                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose:</b>                       | To provide summaries of the state of highway practice and knowledge.                                                                                                                                                                                                                                                                                                                          |
| <b>Started:</b>                       | Project 20-05 began in 1968.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Funding:</b>                       | Allocated for FY 2020: \$855,000<br>Requested for FY 2021: \$810,000                                                                                                                                                                                                                                                                                                                          |
| <b>Problem Solicitation:</b>          | Once each year, NCHRP specifically solicits topics from state DOTs, AASHTO and TRB committees, and FHWA. TRB staff also encourages submittals by TRB committees during the TRB annual meeting. Topics for FY 2021 are due by February 17, 2020.                                                                                                                                               |
| <b>Process for Selecting Studies:</b> | Requests are considered at an annual meeting of the 20-05 panel, and a list of topics and alternates are selected.                                                                                                                                                                                                                                                                            |
| <b>Consultant Selection:</b>          | The synthesis program is managed by staff in TRB's National Cooperative Highway Research Program. Each year's new studies are announced publicly (NCHRP email list and the TRB E-Newsletter) to solicit interest in being a topic panel member or an author. Staff then forms a topic panel for each selected synthesis. The topic panel reviews expressions of interest and selects authors. |
| <b>Studies Requested Last Year:</b>   | 126 topics were proposed for the FY2020 program.                                                                                                                                                                                                                                                                                                                                              |
| <b>Studies Funded Last Year:</b>      | 19 studies, totaling \$855,000, were funded for the FY2020 program (see attachment A).                                                                                                                                                                                                                                                                                                        |
| <b>Studies Completed Last Year:</b>   | 19 NCHRP Syntheses will be completed in calendar year 2019.                                                                                                                                                                                                                                                                                                                                   |
| <b>Distribution of Findings:</b>      | NCHRP syntheses are distributed widely by TRB to sponsors, subscribers, and affiliates. All NCHRP synthesis reports are posted on the TRB website as well.                                                                                                                                                                                                                                    |
| <b>Use of Findings:</b>               | By all indications, the NCHRP Synthesis Series is one of the most popular of the NCHRP activities. Recent syntheses that have been downloaded most often from TRB's website include: <i>402, Construction Manager-at-Risk Project Delivery</i>                                                                                                                                                |

*for Highway Programs; 488, Roundabout Practices, 516 Tack Coat Specifications, Materials, and Construction Practices; 521, Investment Prioritization Methods for Low-volume Roads; 527, Resilience in transportation Planning, Engineering, Management, Policy, and Administration; and 529, Construction and Rehabilitation of Concrete Pavements Under Traffic.*

**Next Year's Studies:**

FY2021 studies will be selected in May 2020 from topics submitted to the panel by February 17, 2020.

## **ATTACHMENT A**

### NCHRP SYNTHESIS TOPICS INITIATED in 2019

|                                                   |                                                                                                                                                                  |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">NCHRP Synthesis 20-05/Topic 51-01</a> | Practices for Construction-Ready Digital Terrain Models                                                                                                          |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-02</a> | Practices for Bridge Approach Pavement Details and Bridge Approach Pavement Support Details for Durability, Ride and Water Management                            |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-03</a> | Pavement Markings Placement and Removal Practices and Its Effect on Work Zone Safety                                                                             |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-04</a> | Practices for Selecting Pedestrian and Bicycle Projects                                                                                                          |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-05</a> | Practices for Coordinating Asset Management Performance Measurement and Monitoring between State Transportation Agencies and Metropolitan Planning Organizations |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-06</a> | State DOT Use of Vehicle Probe and Cellular GPS Data for Monitoring and Planning                                                                                 |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-07</a> | Practices for Assessing and Mitigating the Moisture Susceptibility of Asphalt Pavements                                                                          |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-08</a> | Practice and Performance of Cold In-Place Recycling and Cold Central Plant Recycling                                                                             |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-09</a> | Concrete Pavements Joint Sealant Practices and Performance                                                                                                       |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-10</a> | Flood Resiliency and Adaptation Through Integrated Storm Prediction and Response Systems                                                                         |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-11</a> | Design Practices and Solutions for Rural Intersection Lighting                                                                                                   |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-12</a> | Night Movement of Oversize/Overweight Loads                                                                                                                      |
| <a href="#">NCHRP Synthesis 20-05/Topic 51-13</a> | Load Rating of Bridges with Missing As-Built Plans                                                                                                               |

|                                                                   |                                                                                                  |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-14</u></a> | Repair and Maintenance of Post-Tensioned Concrete Bridges                                        |
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-15</u></a> | State DOT Practice for Developing and Implementing TSMO Plans                                    |
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-16</u></a> | Proper Maintenance Before Pavement Infrastructure Preservation                                   |
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-17</u></a> | Practices for Closing Out Highway Projects from Substantial Completion to Final Document Receipt |
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-18</u></a> | Practices for Project-Level Analyses for Air Quality                                             |
| <a href="#"><u>NCHRP<br/>Synthesis 20-<br/>05/Topic 51-19</u></a> | Performance Metrics for Public-Private Partnership                                               |

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project 20-24, FY 1988 & Continuing**  
*Administration of Highway and Transportation Agencies*

**Present Expiration Date:** Continuing  
**Recommended Allocation:** \$1,000,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The objectives of NCHRP Project 20-24 are to (1) identify critical problems facing top management officials in state highway and transportation agencies and AASHTO and (2) design and conduct research projects to address those problems. Fiscal year allocations are used to fund projects selected by NCHRP Panel SP20-24 in response to initiatives of interest to state DOT and AASHTO leadership.

The NCHRP Panel currently meets at least twice a year, typically in conjunction with the AASHTO Annual and Spring meetings, with teleconferences as needed to address specific matters. At the two regularly scheduled meetings, the panel considers new topics for research, reviews progress on individual studies and the 20-24 project series as a whole, and discusses current issues facing DOTs and top AASHTO leadership. Recent funding has been used to address state DOT strategic management issues, system performance measurement and management, agency capabilities and workforce, transportation funding mechanisms. Section 6 presents a comprehensive listing of project titles.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

Interest in the "20-24 series" concept remains high among top management of state DOTs and the leadership of AASHTO. State transportation agency leadership generally as well as the AASHTO Board of Directors and staff have a continuing need for research to produce factual information and analysis in support of their strategic planning, capacity building, and current decision making to address an evolving set of such critical issues as change and uncertainty in revenues and financing mechanisms, travel demand, workforce development, and the balance among governments' roles in transportation system management. The project panel requests \$1,000,000 to maintain their efforts to address these continuing research needs. As in previous years, the NCHRP 20-24 panel is expected to convene in association with the AASHTO Spring and Annual Meetings and on other occasions as needed to consider pressing funding requests, new initiatives, and the status of the 20-24 series and ongoing and recently completed projects in the series.

**3. Funds (in thousands)**

|                         | <b>FY<br/>1989–<br/>1990</b> | <b>FY<br/>1991–<br/>1995</b> | <b>FY<br/>1999</b> | <b>FY<br/>2000</b> | <b>FY<br/>2002–<br/>2010<sup>a</sup></b> | <b>FY<br/>2011–<br/>2021<sup>a</sup></b> | <b>FY<br/>2022</b> |
|-------------------------|------------------------------|------------------------------|--------------------|--------------------|------------------------------------------|------------------------------------------|--------------------|
| Initial allocation      | 125                          |                              |                    |                    |                                          |                                          | 1,000              |
| Continuation allocation | 600                          | 1,825                        | 500                | 400                | 9,500                                    | 13,750                                   |                    |
| Less obligation         | <u>725</u>                   | <u>1,750</u>                 | <u>500</u>         | <u>400</u>         | <u>9,500</u>                             | <u>12,201<sup>b</sup></u>                |                    |
| Balance (earmarked)     | -0-                          | 75                           | -0-                | -0-                | -0-                                      | <b>1,549<sup>b</sup></b>                 |                    |
| Reallocation            | <u>-0-</u>                   | <u>75</u>                    | <u>-0-</u>         | <u>-0-</u>         | <u>-0-</u>                               | <u>-0-</u>                               |                    |
| Total available         | -0-                          | -0-                          | -0-                | -0-                | -0-                                      | -0-                                      |                    |
| Recommendation          |                              |                              |                    |                    |                                          |                                          | 1,000              |

<sup>a</sup> \$1M per year for FY 2002-2009, \$1.5M for FY 2010; \$1.25M per year for FY 2011-2021.

<sup>b</sup> Obligation of funds based on panel's 10/14/2020 meeting; other commitments pending.

#### **4. Interpretation of AASHTO Problem Statement by Panel**

At a special session held during the 1986 Annual Meeting of the Transportation Research Board (TRB) a number of Chief Administrative Officers (CAOs) from state departments of transportation identified areas of concern in the management of transportation agencies. Economic considerations and management of financial resources were judged to be the most important areas. Others included the management of people, information systems, public affairs, and technology transfer. In each area discussed, problems were identified that are in need of research. At the same meeting, members of the academic community reported the findings of the NSF seminar on "Transportation Research: The State of the Art and Research Opportunities." Although their recommendations called for more fundamental research, some of the problems identified were very similar to those listed by the CAOs.

As a consequence, a need was recognized for a research program specifically directed to the management, administration, and policy planning needs of senior management of state transportation agencies. Accordingly, the AASHTO Standing Committee on Research directed that a study be undertaken under the NCHRP to develop a plan for research focused on these needs.

#### **5. Original AASHTO Problem Statement Number**

Problem No. 1988-A-08

#### **6. Research Assignments to Date**

NCHRP Project 20-24 "Research Program Design -- Administration of Highway and Transportation Agencies"

NCHRP Project 20-24(01) "Using Market Research to Improve Management of Transportation Systems"

NCHRP Project 20-24(02) "Executive Management Information Systems for State Departments of Transportation"

NCHRP Project 20-24(03) "Expanding the Civil Engineering Pool"

NCHRP Project 20-24(03)A "Civil Engineering Careers in Transportation -- Outreach Program"

NCHRP Project 20-24(04) "Senior Executive Service Participant's Manual"

NCHRP Project 20-24(05) "Public Outreach in Transportation Management"

NCHRP Project 20-24(06)A "Performance Measures Used by State Highway and Transportation Agencies"

NCHRP Project 20-24(06)B "Business Systems Plan for Highway Engineering Information"

NCHRP Project 20-24(06)C "Information Systems for Transportation Agencies"

NCHRP Project 20-24(07) "Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements"

NCHRP Project 20-24(07)A "Alternative Approaches to Taxation of Heavy Vehicles"

NCHRP Project 20-24(08) "Project 20-24 Series -- Revisited" (Completed -- Agency report)

NCHRP Project 20-24(09) "State Departments of Transportation: Strategies for Change"

NCHRP Project 20-24(10) "Customer-Based Quality in Transportation"

NCHRP Project 20-24(11) "AASHTO Guide for Asset Management"

NCHRP Project 20-24(12) "Issues Involving Delays in Completing Federal-aid Highway and Bridge Projects"

NCHRP Project 20-24(13) "Innovative Financing Clearinghouse"

NCHRP Project 20-24(14) "Managing Change in State Departments of Transportation: Topic Scans"

NCHRP Project 20-24(15) "AASHTO Support Activities for Reauthorization"

NCHRP Project 20-24(16) "AASHTO Experience in Transportation Enhancements"

NCHRP Project 20-24(17) "National Conference on Historic Preservation"

NCHRP Project 20-24(18) "Outsourcing of State DOT Delivery of Capitol Programs"

NCHRP Project 20-24(19) "How State DOTs Can Learn to Thrive in an E-Business Environment"

NCHRP Project 20-24(20) "Transportation Outcomes and Other Strategic Performance Impact Measures: A Framework for State Departments of Transportation"

NCHRP Project 20-24(21) "Characteristics of the 21st Century Operations-Oriented State DOT"

NCHRP Project 20-24(22) "Best Practices in Partnering with Public Resource Agencies"

NCHRP Project 20-24(23) "Assessing the Importance of Transportation for Major Industries and Sectors of the U.S. Economy" -- A. Agriculture; B. International Trade; C. Congestion; D. Travel, Tourism, and Recreation

NCHRP Project 20-24(24) "Transportation Mobility, Access, and Safety for an Aging Population"

NCHRP Project 20-24(25) "Improving Project Costing and Incorporation of New Attributes -- Highways and Transit"

NCHRP Project 20-24(26) "Finance Trends in Non-Federal Funding and Debt"

NCHRP Project 20-24(27) "Expanded State and National Investment Analysis Capability -- Highway"

NCHRP Project 20-24(28) "Rate of Return from Highway Investment" (Final report overdue)

NCHRP Project 20-24(29) "CEO Peer Exchange Workshop for Strategic Leadership"

NCHRP Project 20-24(30) "Performance Measurement in Context Sensitive Design"



NCHRP Project 20-24(31) "Financial Management for Effective Program Management"  
 NCHRP Project 20-24(32) "New CEO Briefings"  
 NCHRP Project 20-24(33)A "21st Century Freight Mobility"  
 NCHRP Project 20-24(33)B "Transportation, Technology, and the 21st Century Vehicle"  
 NCHRP Project 20-24(33)C "Transportation Vision 2010" (Active)  
 NCHRP Project 20-24(34) "Commuting-in-America Reporting Base"  
 NCHRP Project 20-24(35) "Communicating Urban Congestion Information"  
 NCHRP Project 20-24(36) "Updating AASHTO's Strategic Plan in CY 2004"  
 NCHRP Project 20-24(37) "Five Workshop Sessions to Discuss Strategic Measures for  
 State DOTs" Strategic Performance Measures for State DOTs)  
 NCHRP Project 20-24(37)A "Construction Project Cost and Schedule Performance"  
 NCHRP Project 20-24(37)B "Pavement Smoothness"  
 NCHRP Project 20-24(37)C "Safety "  
 NCHRP Project 20-24(37)D "Operations Performance Using Incident Response Time"  
 NCHRP Project 20-24(37)E "Bridge Conditions"  
 NCHRP Project 20-24(37)F "Establishment of Comparative Performance Measures  
 program infrastructure to support national system performance data collection and  
 analysis"  
 NCHRP Project 20-24(37)G "Standards and guidance for national level performance  
 measurements"  
 NCHRP Project 20-24(37)H "Workshop on transportation-system performance measures  
 suitable for national use"  
 NCHRP Project 20-24(37)I "Congestion (speed-based measures)"  
 NCHRP Project 20-24(37)J "Pavement health (composite/structural measures)"  
 NCHRP Project 20-24(37)K "Safety - Serious Injuries"  
 NCHRP Project 20-24(37)L "State DOT Comparative Performance Measurement: A  
 Progress Report"  
 NCHRP Project 20-24(38) "CEO Engagement Options for Discussing Strategic Issues and  
 Sharing Best Practices"  
 NCHRP Project 20-24(39) "Alternative Organizational Designs for State Transportation  
 Departments"  
 NCHRP Project 20-24(40) "Analysis and Benchmarking of State DOT Human Resource  
 Activities" NCHRP  
 NCHRP Project 20-24(41) "Project Summaries for state DOT CEOs"  
 NCHRP Project 20-24(42) "Comparison of State DOT Quality Management Systems"  
 NCHRP Project 20-24(43) "Innovative Contracting for Major Transportation Projects"  
 NCHRP Project 20-24(44) "Highway Safety Leadership Organizational Issues: A Survey of  
 States and Recommendations for Sustaining Progress"  
 NCHRP Project 20-24(45) "Executive Seminar, Coordinating Transportation and Land  
 Development: Outlook, Challenges, Success"  
 NCHRP Project 20-24(46) "Freight Transportation: New Roles for State DOTs"  
 NCHRP Project 20-24(47) "Benchmarking Diversity in the Transportation Industry: A  
 Scoping Study"  
 NCHRP Project 20-24(48) "Analysis and Benchmarking of State DOT Human Resource  
 Activities (Ph. 2)"  
 NCHRP Project 20-24(49) "Future Financing to Meet Highway and Transit Needs"

NCHRP Project 20-24(50) "In-Service Training Needs for State DOTs"

NCHRP Project 20-24(51) "State DOT Leadership Forum – 2006"

NCHRP Project 20-24(52) "Future of the National System of Interstate and Defense Highways"

NCHRP Project 20-24(53) "Twenty-first Century Leadership and Management Techniques for State DOTs"

NCHRP Project 20-24(54) "2006 Bottom Line Report, State and National Investment Analysis: Highways"

NCHRP Project 20-24(55) "National Summit for Funding and Finance Strategies"

NCHRP Project 20-24(56) "State and Local Officials: To Advance a Vision for the Transportation System Required to Meet Future Needs"

NCHRP Project 20-24(57) "Management and Leadership Information for a Dialogue with New State DOT CEOs"

NCHRP Project 20-24(58) "Toward Developing Performance Based Federal-Aid Highway Programs"

NCHRP Project 20-24(59) "Strategies for Reducing the Impacts of Surface Transportation on Global Climate Change"

NCHRP Project 20-24(60) "Updating AASHTO's Strategic Plan in CY 2008"

NCHRP Project 20-24(61) "Executive Forum on Performance Based Maintenance and Operations Practices"

NCHRP Project 20-24(62) "The Identification of Marketing Tools that Resonate with Lawmakers and Key Stakeholders to Support and Increase Funding and Revenue for the Nation's Transportation System"

NCHRP Project 20-24(63) "Partnership Approaches to Identify, Promote, and Implement Congestion Management Strategies"

NCHRP Project 20-24(64) "Implications for Transportation of a Conformity-Style Approach to Reduce Greenhouse Gases, and Assessment of Alternative Policies to Integrate GHG Objectives into Transportation Decisions"

NCHRP Project 20-24(67) "State DOT CEO Leadership Forum- Spring/Summer 2009; Pilot Study of State Driven Performance Based Management Reporting"

NCHRP Project 20-24(68) "Estimating the Costs to State Governments due to Highway Related Debilitating Injury and Fatal Crashes"

NCHRP Project 20-24(69) "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding"

NCHRP Project 20-24(70) "Update the 2003 Report Reducing Greenhouse Gas Emissions from U.S. Transportation"

NCHRP Project 20-24(71) "Expediting NEPA: Practitioner Strategies for Early Identification of and Response to High Risk Issues"

NCHRP Project 20-24(72) "Maximizing Highway Operational Strategies to Reduce Greenhouse Gas (GHG) Emissions"

NCHRP Project 20-24(73) "Economic and Employment Benefits of Highway Investments in Response to Economic Downturns: A Scoping Study"

NCHRP Project 20-24(74) "Risk Management Practices in State Departments of Transportation"

NCHRP Project 20-24(75) "Development of a Performance Management Roadmap"

NCHRP Project 20-24(77) "Support for a TRB-sponsored conference on Strategies for Meeting Critical Data Needs for State and Metropolitan Transportation Agencies"

NCHRP Project 20-24(78) "Integrating Performance Measures into a Performance-Based Planning and Programming Process"

NCHRP Project 20-24(79) "Specifications for a national study of the future 3R, 4R, and capacity needs of the Interstate System"

NCHRP Project 20-24(80) "Assessing the Economic Benefit of Transportation Infrastructure Investment in a Mature Surface Transportation System"

NCHRP Project 20-24(81) "Leading in Lean Times: Maximizing Resources in a Constrained Environment"

NCHRP Project 20-24(82) "Increasing Consistency in the Highway Performance Monitoring System for Pavement Reporting"

NCHRP Project 20-24(83) "Alternative State DOT Organizational Models for Delivering Services"

NCHRP Project 20-24(84) "State DOT CEO Leadership Forum- Summer/Fall 2012, a Focus on State DOT Current Organizational and Management Issues"

NCHRP Project 20-24(85) "Scoping support for new NCHRP 20-24 projects"

NCHRP Project 20-24(86) "Critical Assessment for Future Surface Transportation Needs Analyses"

NCHRP Project 20-24(87) "State DOT Administration of Local Road Safety Aid"

NCHRP Project 20-24(88) "Performance Measure Coordination, Engagement and Reporting"

NCHRP Project 20-24(89) "Role and Value of Transportation for U.S. Industries and Sectors"

NCHRP Project 20-24(90) "Defining and Communicating a National Vision for Transportation"

NCHRP Project 20-24(91) "State DOT CEO Safety Leadership Forum -- May 2013 (Support)"

NCHRP Project 20-24(92) "Evaluation of State-of-the-Art Transportation Funding and Finance Methods"

NCHRP Project 20-24(93)A "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Public Outreach"

NCHRP Project 20-24(93)B(01) "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Management Planning"

NCHRP Project 20-24(93)B(02) "Improving Public Communication Influence and Effectiveness Through Better Understanding of Transportation Users' Expectations and Language – Management Outreach"

NCHRP Project 20-24(94) "Support for Development of AASHTO'S 2013-2018 Strategic Plan"

NCHRP Project 20-24(95) "Next Generation Workforce Management"

NCHRP Project 20-24(96) "Improving Organizational Traffic Safety Culture in DOTs"

NCHRP Project 20-24(97) "Advancing Performance Management Under a National Framework"

NCHRP Project 20-24(98) "Connected and Automated Vehicle Research Roadmap"

NCHRP Project 20-24(99) "New CEO Orientation and Peer Exchange on Teamwork Between an Agency CEO and a Transportation Board or Commission"

NCHRP Project 20-24(100) "State DOT CEO Leadership Forum – a Focus on Transportation Futures"

NCHRP Project 20-24(101) "An Introduction to Knowledge Management and Workforce Issues for CEOs: A CEO Leadership Workshop"

NCHRP Project 20-24(102) "Executive Strategies to Deliver Practical Design"

NCHRP Project 20-24(103) "Peer Exchange on Issues and Communication to Support Economic Competitiveness through Transportation Investments"

NCHRP Project 20-24(104) "State DOT Implementation of MAP21 Performance Measure Rules"

NCHRP Project 20-24(105) "Launching U.S. Transportation Enterprise Risk Management Programs"

NCHRP Project 20-24(106) "Evaluation Guidance for Automated Vehicle Pilot and Demonstration Projects"

NCHRP Project 20-24(107) "Update to Transportation Governance: A 50-State Review of State Legislatures and Departments of Transportation"

NCHRP Project 20-24(108) "CEO Leadership Peer Exchange"

NCHRP Project 20-24(109) "Research on Enhancing Transportation System Resilience"

NCHRP Project 20-24(110) "Development of Resources to Support State DOT Communications on Safety"

NCHRP Project 20-24(111) "State DOT CEO Leadership Forum on "Connected & Autonomous Vehicles and Transportation Infrastructure Readiness" in conjunction with 2017 ITSWC, Montreal, Canada"

NCHRP Project 20-24(112) "Connected Road Classification System (CRCS) Concept Development"

NCHRP Project 20-24(113) "CEO Peer Exchange 2017"

NCHRP Project 20-24(114) "Supplement to NCHRP 20-07 New project on "flexible" or "urban" design, "Green Book" update"

NCHRP Project 20-24(115) "Development of Strategic Plan for Transportation Workforce Planning and Development"

NCHRP Project 20-24(116) "Guidance on Roles and Responsibilities in Operation of Automated Vehicles"

NCHRP Project 20-24(117) "TSMO Workforce Development"

NCHRP Project 20-24(118) "Strategic Planning Support for AASHTO Committees"

NCHRP Project 20-24(119) "Strategic Research in Support of the Connected and Automated Vehicle Executive Leadership Team"

NCHRP Project 20-24(120) "Building a Bridge: A Guide to Communicating Revenue Needs "

NCHRP Project 20-24(121) "Road Usage Charge: Applying Lessons Learned in New Zealand to the United States"

NCHRP Project 20-24(122) "A Comprehensive Study of Future Competencies for Transportation Planners"

NCHRP Project 20-24(123) "Roadmap for Supporting Specialty Personnel Recruitment, Development, and Retention in the DOT Workforce"

NCHRP Project 20-24(124) "Performance Management Messaging Peer Exchange"

NCHRP Project 20-24(125) "Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis"

NCHRP Project 20-24(126) "National Automation Readiness Framework: Coast-to-Coast Automated Mobility by 2025"

NCHRP Project 20-24(127) "Performance Management Implementation Concerns, Issues and Challenges"

NCHRP Project 20-24(128) "State DOT Executive Leadership Review of State-of-the-Art of Cooperative Automated Transportation (CAT) Systems"

NCHRP Project 20-24(129) "CEO Peer Exchange 2019 and Strategy Planning"

NCHRP Project 20-24(130) "Support for AASHTO Strategic Planning 2019-2024"

NCHRP Project 20-24(131) "Mapping the Common Interests of AASHTO Committees"

NCHRP Project 20-24(132) "Understanding Knowledge Management in Context with Other Organizational Practices"

NCHRP Project 20-24(133) "Update to 'Transportation Governance: A 50-State Review of State Legislatures and Departments of Transportation'"

NCHRP Project 20-24(134) "Deployment of Unmanned Aerial System Equipment Within Highway Rights of Way"

NCHRP Project 20-24(135) "Practices for Transportation Agency Procurement and Management of Advanced Technologies"

## **7. Review Date**

14 October 2020

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board,**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project SP 20-30, FY 1992 & Continuing**  
*NCHRP-IDEA Program*

**Present Expiration Date:** Continuing  
**Recommended Allocation:** \$950,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The DEA (Innovations Deserving Exploratory Analysis) program explores the feasibility of unproven technical concepts, novel applications of proven concepts, or advances that have not yet been tried or tested for application in transportation practice. The focus is on high-payoff concepts, products, systems, tools, or techniques that accelerate the development and deployment of advanced technologies, methods, or processes for highway and intermodal transportation systems.

The IDEA is a unique concept to traditional transportation research programs. Unlike most transportation research solicitations where competitive proposals are requested on a specific topic and objective, IDEA makes a general solicitation, seeking out proposals from entrepreneurs, inventors, forward thinkers, and problem solvers -- anybody who has a possible solution to a vexing transportation problem.

Two types of IDEA projects, designated Type 1 and 2, are funded. Type 1 projects address technical feasibility of the proposed concepts and Type 2 projects deal with prototyping and evaluation. The maximum funding for a Type 1 project is \$150,000 and for a Type 2 \$100,000. Additional funding from other sources as cost sharing is encouraged, not mandatory for Type 1 projects but required (at least a 25% match) for Type 2 projects.

The NCHRP Project SP 20-30 Panel provides oversight to the NCHRP-IDEA Program. The Panel also evaluates proposals and, based on available funding, selects those with most merit. The selected proposals are then funded, recognizing the high degree of risk but also the potential for scientifically-founded solutions that have high value to transportation practice. The Project Panel meets twice a year to make new IDEA selections and review follow-on requests. The meeting is held in June and December every year. To date, the NCHRP-IDEA Program has awarded 225 contracts, out of which 200 have been completed or closed out, 22 are currently active, and 3 are in the contracting process. Ongoing activity for the NCHRP-IDEA Program can be found on the NCHRP website under the Project SP 20-30.

The NCHRP-IDEA Program's annual report, *New IDEAs for Highway Systems*, is published every January for the preceding fiscal year. The report summarizes research performed on NCHRP-IDEA projects active or completed during a particular fiscal year along with one-page summaries of all previously completed projects. The report for FY 2020 is currently under preparation and will be available by early January 2021. The report is now being published electronically.

#### Proposals Received and Selected for Funding during FY 2020

During FY 2020, a total of 78 proposals were received by the NCHRP IDEA Program for its 51st and 52nd review cycles. The NCHRP Project SP 20-30 Panel, after reviewing and discussing all these proposals, selected 8 projects for funding.

##### 51st Review Cycle (December 2019)

Number of Proposals Received: 38

Number of Proposals Selected for Funding: 1 (see below)

Proposal N-2311: *Use of Synthetic Smart Rocks for Scour Countermeasure Evaluation around Abutments and Bridge Piers* (University of Tennessee).

##### 52nd Review Cycle (June 2020)

Number of Proposals Received: 40

Number of Proposals Selected for Funding: 7 (see below)

Proposal N-2319: *Development of an Automated and Rapid Conditioning and Testing Device for Asphalt Cracking and Rutting* (Texas Transportation Institute/Texas A&M University)

Proposal N-2321: *A Retroreflective Road Lane Marking Tape 1000X Brighter than Existing Technology* (Mark O'Neill, LLC)

Proposal N-2325: *Lab Dielectric Measurement System for Asphalt Mixture Bulk Specific Gravity Determination* (University of New Hampshire)

Proposal N-2331: *Adjustable Cross-Frames for the Erection of Steel Girder Bridges* (University of Notre Dame)

Proposal N-2339: *A Smart IoT Proximity Alert System for Highway Work Zone Safety* (Georgia Institute of Technology)

Proposal N-2342: *An Automated System for Large-Scale Intersection Marking Data Collection and Condition Assessment* (Old Dominion University)

Proposal N-2343: *Fatigue Crack Inspection Using Computer Vision and Augmented Reality* (University of Kansas)

#### Projects Completed during FY 2020

The following NCHRP-IDEA projects were completed during FY 2020:

NCHRP-200: *Rapid Rehabilitation of Highway Slopes using Seeded Microbial Bio-Cement* (South Dakota School of Mines and Technology; P.I.: Bret N. Lingwall); Report Date: February 2020.

NCHRP-201: *Development of a Novel Aerodynamic Solution to Mitigate Large Vibrations in Traffic Signal Structures*

NCHRP- 204: *Biomimetic Antifreeze Polymers: A Novel Biodegradable Deicing Salt Alternative*

NCHRP- 207: *MILDGLASS: GFRP Strand for Resilient Mild Pre-Stressed Concrete*

NCHRP- 208: *Determining Bridge Deck Chloride Quantities with Ground Penetrating Radar*

NCHRP- 212: *Non-Gating Guardrail End Terminals*

## **2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

- The NCHRP-IDEA Program continues to receive a high level of interest as evidenced by the number of proposals it receives, averaging about 50 proposals for each of its half-yearly review, and the number of products entering or being evaluated for actual practice. The NCHRP Project SP 20-30 Panel continues to believe that the NCHRP-IDEA Program, although a modest investment, provides a unique opportunity to innovators and entrepreneurs to pursue their innovative concepts in a variety of technological areas for highway infrastructure applications. Until 2018, the funding level of the NCHRP IDEA Program was \$1.40 million, which, in addition to fund the projects, also covered the cost to administer the program. Now as a result of the integration of the NCHRP-IDEA Program into the NCHRP, the administrative costs for the program are included in the overall NCHRP administrative costs. Therefore, since FY 2020, funds requested are for research projects only. It is anticipated that a sum of \$950,000 will be needed to fund 6-7 projects at \$150,000 per project in the next two 6-month cycles to keep the program viable and attractive to innovators, particularly those in the private sector.

## **3. Funds (in thousands)**



|                         | FY<br>1992-<br>93 | FY<br>1994-<br>97 | FY<br>1998-<br>99 | FY<br>2000-<br>05 | FY<br>2006-<br>09 | FY<br>2010-<br>17 | FY<br>2018-<br>19 | FY<br>2020-<br>21 | FY<br>2022 |
|-------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------|
| Funding from FHWA       | 1125              | 3,000             | 1,500             |                   |                   |                   |                   |                   |            |
| Continuation allocation | 375               | 1,000             | 750               | 6,000             | 4,750             | 10,000            | 2,800             | 1,900             |            |
| Less obligation         | <u>1,500</u>      | <u>4,000</u>      | <u>2,250</u>      | <u>6,000</u>      | <u>4,750</u>      | <u>10,000</u>     | <u>2,800</u>      | <u>1,900</u>      |            |
| Balance (earmarked)     | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               |            |
| Reallocation            | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        | <u>-0-</u>        |            |
| Total available         | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               | -0-               |            |
| Recommended addition    |                   |                   |                   |                   |                   |                   |                   |                   | 950        |

#### 4. Interpretation of AASHTO Problem Statement by Project Panel

This project represents a new approach under the National Cooperative Highway Research Program (NCHRP), for short-term, focused research on new and innovative concepts that have the potential to provide leapfrog technological advances. The NCHRP-IDEA Program is a continuation of the SHRP-IDEA Program which funded exploration of innovative concepts from the public and private sectors in focus areas of SHRP research. The NCHRP-IDEA projects will concentrate on innovative approaches aimed at solving problems in the highway infrastructure area. Unsolicited proposals related to any aspect of the highways or intermodal facilities will be accepted; however, the Project Panel may designate specific technological areas for emphasis.

The NCHRP-IDEA Program is being administered as a special project ((NCHRP Project SP 20-30) under the NCHRP each Fiscal Year, similar to the NCHRP Synthesis Program (Project 20-05). Until June 2017, the NCHRP contracted with TRB's Studies and Special Programs Division for administering the NCHRP IDEA Program. Since June 2017, the NCHRP-IDEA Program has been integrated into the NCHRP. Research investigations for the program are selected by the NRC-appointed NCHRP Project SP20-30 Panel.

#### 5. Original AASHTO Problem Statement Number

Problem No. 1993-SP-23

#### 6. Research Assignment To-Date

NCHRP Project SP 20-30, "NCHRP-IDEA"

#### 7. Last Review Date

October 31, 2020

## Accountability Report for NCHRP Project SP 20-30, *NCHRP-IDEA*

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose:</b>                       | To support deserving proposals from entrepreneurs, inventors, forward thinkers, and problem solvers – anybody who has an innovative solution to a vexing transportation problem. The NCHRP-IDEA includes projects that address technical feasibility or prototyping.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Started:</b>                       | Project SP 20-30 began in 1992; it was co-funded by FHWA through FY 1999. The NCHRP is now the sole sponsor of the NCHRP-IDEA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Funding:</b>                       | Allocated in FY2021: \$950,000<br>Requested for FY2022: \$950,000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Problem Solicitation:</b>          | An announcement is distributed to solicit submittals throughout the year. Proposals are collected twice a year (deadlines: March 1 and September 1) and reviewed. The announcement is posted on the TRB website and highlighted in the TRB E-Newsletter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Process for Selecting Studies:</b> | The NCHRP Project SP 20-30 Panel meets semi-annually to select proposals for award. Proposals are evaluated on the basis of the following four criteria for a total of 100 points: (i) Quality of Innovation (50 points); (ii) Research Approach (15 points); (iii) Potential Benefits (20 points); and (iv) Implementation/Commercialization Plan (15 points). Requested funds must not exceed \$150,000 for a Type 1 project and \$100,000 for a Type 2. Cost sharing is encouraged, which is not mandatory for a Type 1 project but required (at least a 25% match) for a Type 2 project. A high degree of risk will be assumed for scientifically-founded proposals with potentially high value to transportation practice. |
| <b>Consultant Selection:</b>          | The project is managed by the NCHRP staff in the TRB's CRP Division under the oversight of the NCHRP Project SP 20-30 Panel that selects projects for investigation. No contract may exceed \$150,000, and many are for much less.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Studies Requested Last Year:</b>   | 78 proposals were submitted in two cycles in FY 2020.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Studies Funded Last Year:</b>      | Eight studies were funded during FY 2020 (see Section 1, above).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Studies Completed</b>              | Six studies were completed between October 1, 2019 and September 30, 2020 (see Section 1 above).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## **Last Year:**

**Distribution of Findings:** A summary of all completed and active IDEA projects is published each year and made available to sponsors, subscribers, and affiliates. All project final reports are posted on the TRB website and also sent to the National Technical Information Service (NTIS).

**Use of Findings:** IDEA projects are intended to help jump-start the product-development process and eventual commercialization. Some products have been commercialized, others are in the process, and some have been identified as promising. Projects/products in all these categories are identified each year in the continuation request.

**Next Year's Studies:** Funding is requested to support approximately 6-7 new or continuing studies each year.

## **A Sample Listing of IDEA Projects Implemented or Show a High Implementation Potential**

The product development process encompasses many steps and may also require substantial resources. An IDEA project is only intended to help initiate this process – that is, give it a jump start. Before a product is implemented, it usually must go through further development and refinement, testing and evaluation, commercialization, and marketing. These phases can be quite involved and resource-intensive. Considering what it takes to do all this, an IDEA project is a very modest investment (\$100,000-150,000 per project). There is also a high risk associated with untried and unproven approaches; not every IDEA concept is expected to materialize into an implementable product. Still, despite the modest investment of resources and the high risk and uncertainty, a number of NCHRP IDEA projects have not only proved the technical feasibility of their innovative concepts but also led to the development of products that have been implemented and made to the marketplace.

Following is a sample listing of the NCHRP-IDEA projects in three categories. The first category includes products known to be available in the marketplace. The second category includes completed projects that have known follow-on activity, most likely being applied on a trial or experimental basis. The third category includes active projects that are likely to continue beyond the NCHRP-IDEA contract.

### Products in the Marketplace

- A sacrificial anode system using sprayed zinc for protecting reinforcing steel (acting as the cathode) from corrosion in marine bridge substructures – Project #3

- A composite material layer system called, Interlayer Stress Absorbing Composite (ISAC) that helps eliminate or mitigate reflection cracking in asphalt concrete overlays – Project #6
- An organic compound-based additive that inhibits corrosion of reinforcing steel and waterproofs the concrete – Project #13
- A bridge-mounted automated de-icing system to prevent snow and ice on bridge decks – Project # 27.
- A dual phase ferritic martensitic (DFM) steel with improved mechanical properties and corrosion resistance – Project #28
- Lightweight composite bridge made of fiberglass-reinforced polymer honeycomb structural panels – Projects #30 and 46
- A low-cost asphalt pavement density measuring device based on capacitance energy dissipation as a rapid, convenient, and safe alternative to the nuclear gauge – Projects #32 and 47
- A high strength and lightweight hybrid composite beam for bridge structures consisting of an outer fiber-reinforced plastic shell, a compression reinforcement and a tension reinforcement – Project #60
- The application of horizontal wick drains to stabilize slopes and landslides – Projects #57 and 76
- An automated computer controlled image analysis system for measuring aggregate shape characteristics – Projects #77 and 114
- Test methods, based on fracture mechanics, for predicting low temperature performance of asphalt binders – Projects #84 and 104
- A palm-sized video event data recorder (DriveCam) that monitors driving activity by continuously recording video of the roadway, audio, and acceleration/deceleration forces into a digital looping memory – Project ITS #84
- The adaptation of self-compacting concrete (SCC) technology for the U.S. market using domestic concrete-making materials and practice for use in highway structures – Project #89
- A system of vertical composite drains (Earthquake Drains) to dissipate pore pressure to prevent liquefaction during an earthquake – Projects #94 and 103

- A device providing a simple, reliable field-like test for determining thermal cracking temperature of asphalt (Asphalt Binder Thermal Cracking Device) – Project #99
- A hand-held impact echo scanner for non-destructive evaluation of grout /void inside post-tensioned bridge ducts for tendon – Project #102
- A new mobile geophysical method based on electromagnetic induction technology to perform surveys to detect and identify subsurface features and objects for highway-related projects – Project #107
- A real-time hand-held microwave imaging device using smart array antenna for the nondestructive condition evaluation of fiber-reinforced polymer (FRP)-wrapped concrete bridge members (GAP-CAT-110 and 1200) – Project #109
- A portable equipment using a bending plate for rapid measurement of soil modulus for compaction control both in the laboratory and the field – Project #118
- A software system based on 3-D laser scan surveys for the identification, evaluation, and management of unstable highway slopes – Project #119
- A software system consisting of new image pattern recognition algorithms for automatic processing and extraction of information on roadway signs from the roadway video logging images – Project #121
- An accelerometer system based on optical fibers and moiré phenomena to assess structural integrity of highway bridges under traffic, earthquakes, and other dynamic loads – Project #124
- A laser measurement-based technology to improve bridge fabrication quality control by rapid and accurate measurements and reduce overall production costs of steel bridge fabrication – Project #127
- A vehicle-mounted scanner system based on nondestructive evaluation methods such as impact echo, impulse response, spectral analysis of surface waves and acoustic sounding for condition evaluation of concrete bridge decks – Project #132
- Simple test methods to obtain low-temperature creep and strength parameters of asphalt binders and mixtures using small-scale specimens on bending beam rheometer and requiring no additional equipment – Projects #133, 151
- A software package (Bridge Doctor) along with a user's manual for a baseline-free methodology for real-time structural health monitoring and post-event damage assessment of highway bridges for integrity and safety – Project #137

- A methodology based on vision-based object recognition algorithms and integrated GPS and vision technologies to recognize and warn against intruding vehicles – Project #139
- An asphalt pavement raveling detection system based on an algorithm developed using 3-D line laser imaging technology – Project #163
- A traffic sensor based on computer vision technology (TrafficVision) for use on fixed and pan-tilt-zoom cameras for detecting and tracking vehicles, including motorcycles without the need of having to install additional hardware – Project #140
- A software tool for assessing physico-mechanical properties of subgrade, subbase, and base, and lift layers based on intelligent compaction rollers data during construction – Project #145
- A mobile unit for rapid and reliable measurement of pavement marking retroreflectivity – Project #146
- A low-cost cleaning device using pneumatic power and rotary wire brushes to remove debris and chemicals from cracks and joints prior to sealing treatment – Projects #148, 159
- An advanced laser measurement system (Bridge RLS) to accelerate the bridge retrofit process, reducing the time between identifying repair needs and resuming service on a bridge – Project #153
- Drained timber piling for cost-effective liquefaction mitigation and ground improvement strategy for transportation infrastructure and for improving a structure's seismic resilience – Project #180
- Automated turning movement counts at signalized intersections both for exclusive and shared lanes using vehicle trajectory data (obtained from an existing vehicle detection system) for improved traffic safety and operation – Projects #177,198
- A portable field instrument, based on ultrasonic technology, for in-situ measurement of total stress (both dead and live loads) in steel bridge members – Project #179
- A small specimen geometry for uniaxial dynamic modulus and fatigue testing in asphalt mixture performance tester (AMPT) – Project #181

- An event simulation and data fusion system for synthesizing individual travel diaries from multiple passive data sources, including consumer and anonymous location data – Project #184
- A simple performance-based indirect tensile asphalt cracking test for asphalt mix design, quality control, and quality assurance – Project #195
- A multi-channel vertical impedance scanner with large area electrode to detect corrosion in concrete bridge decks assessment without direct rebar connection – Project #202

#### Completed Projects with High Implementation/Commercialization Potential

- Basalt fibers and basalt fiber composite rebars made from domestic basalt for use as an alternative to steel fibers and rebars in reinforced concrete – Projects #25, 45, 86
- A geocomposite layer system placed between a base and subgrade to prevent pavement damage by controlling moisture movement in pavement subgrade and base course – Projects #68, 113.
- A mechanical system based on anvil and hammer concept for crushing and recycling concrete pavement – Projects #79, 95
- A robotic safety marker system consisting of mobile signs, cones, lighting and other safety devices to provide safety to workers in the highway work zone – Project #90
- A second generation improved detection control system (D-CS) for enhanced traffic safety at high speed signalized intersections – Project #115
- A sensor system for the autonomous monitoring and reporting of highway traffic noise data – Project #131
- An “active confinement” bridge rehabilitation techniques using shape memory alloy (SMA) reinforcement to retrofit concrete columns – Project #135
- A vibration absorbing system based on magnetic dampers to reduce fatigue in traffic signal support structures exposed to excessive wind-induced vibrations – Project #141
- A shape memory polymer-based sealant for use in expansion joints in pavements and bridges capable of preventing adhesive and cohesive failures through a self-healing mechanism, eliminating the need for replacing the sealant – Project #142

- An acoustic emission-based system for rapid and reliable characterization of asphalt binder embrittlement temperatures – Projects #144, 170
- A new class of bridge expansion joints based on shape memory alloys to provide superior resistance to fatigue, dynamic loads, and corrosion – Project #147
- Breakaway posts with new design and energy absorbing capability to enhance the safety performance of W-beam guardrail in frozen soil conditions – Project #149
- An automated real-time quality control aggregate monitoring system based on laser-induced breakdown spectroscopy to characterize aggregate properties – Projects #150, 168
- A rapid and reliable non-destructive method based on long-range ultrasound for inspecting bridge cables – Project #152
- An ultrasonic hand-held device for measuring for measuring cumulative stress at critical highway bridge components – Project #158
- A new “super” weathering, corrosion-resistant, and cost-competitive steel for the transportation infrastructure, including highways, bridges, and buildings – Project #160
- A hand-held device for nondestructively measuring in-situ yield strength of in-service steel gusset plates for use in bridge evaluation and rating – Project #161
- Scour-preventing products (scAUR and VorGAUR) for use on scour-critical bridges – Project #162
- A technique based on laser induced breakdown spectroscopy to rapidly identify and profile the presence and severity of corrosion under layers of coatings on steel structures and the presence of heavy metals imbedded in the coatings – Project #164
- Guidelines for using waste concrete fines (and the associated wastewater) in concrete by developing methods to rapidly characterize fines samples and evaluating the performance of concrete using these recycled materials – Project #166
- A prototype system for georeferenced augmented reality visualization of buried utility geospatial data and real-time monitoring of an excavator’s proximity to buried utilities in its vicinity – Project #167



- Bidirectional-ductile end diaphragm in straight and skewed bridge superstructures to provide resistance to bidirectional earthquake excitations – Project #172
- Asphalt binders and mixtures reinforced with grapheme nano-platelets as a multifunctional pavement material providing enhanced durability, the creep stiffness, and low-temperature flexural strength of asphalt binders and mixtures – Project #173
- A thermal zinc diffusion coating with improved corrosion resistance for concrete reinforcing bar with better ductility and durability than commercial coatings currently in use – Project #174
- A nondestructive test procedure based on the impulse response method for rapid detection of fatigue cracking in auxiliary highway structure anchor rods for timely repair and increased service life of highway structures – Project #175
- A Kelvin Probe (KP) electrode device for a rapid and stable electrode potential mapping for early corrosion detection in concrete steel reinforcement in highway structures – Project #176
- A class of renewable biopolymers for use in asphalt pavements. The developed polymers are expected to be used turnkey in asphalt production and construction facilities – Project #178
- Application of biochar to highway soils to increase stormwater infiltration and reduce the quantity and improve the quality (reduced nutrients) of stormwater runoff – Projects #182, 211
- An integrated remote-sensing system based on radio frequency identification (RFID) technology for monitoring, inspection, and life estimation of hydraulic structures for developing an effective scour countermeasure strategy – Project #183
- A prototype of CurvePortal, a web interface for extracting horizontal curve location and geometric information automatically from GIS roadway maps with improved curve data extraction algorithm – Project #185
- An electrical probe that measures the geometry and integrity of ground improvement columns (jet grout, soil mixed, auger cast) during construction or immediately after construction (within 30-60 minutes) – Project #186
- A wireless worker proximity detection and alert sensing system for proactive safety warning at dynamic roadway work zones – Project #187

- V-connectors for bridge deck-piers and pier-footing joints to provide seismic isolation while facilitating accelerated bridge construction and retrofit – Project #188
- A camera-based vision sensor for highly accurate remote, multi-point measurement of bridge displacements enabled by a robust target tracking algorithm, an advanced image distortion filter, and a vibration cancellation technique – Project #189
- Development of equipment and software for advanced automation of ultrasonic testing of bridge members – Project #191
- Microbial-facilitated soil stabilization to mitigate volume changes in expansive pavement subgrades – Project #192
- A self-contained, portable asphalt rheology tester to monitor the consistency and uniformity of asphalt binders in real-world product environment – Project #193
- Development and evaluation of hexagonal boron nitride reinforced multifunctional concrete for transportation infrastructure applications – Project #197
- An imaging method using medical x-ray machine to measure the ion penetration of concrete material to predict the service life of a pavement or a bridge.– Project #199
- Use of native grass and weed seeded microbial induced calcite precipitation to mitigate wind and water erosion of highway slopes – Project #200
- An aerodynamic damping method to mitigate large vibrations in traffic signal structures – Project #201
- A class of low-cost, non-toxic, biodegradable antifreeze biopolymers with behavior similar to natural antifreeze proteins found in fish, plants, insects, etc. to prevent ice formation on roadway and bridge surfaces during winter – Project #204.
- A glass fiber reinforced polymer (GFRP) strand for application in mild-prestressed concrete (MPC) elements to attain higher resiliency, sustainability, and corrosion resistance with respect to traditional steel prestressed concrete – Project #207.
- A new method for measuring chloride quantities in bridge deck concrete using ground-penetrating radar (GPR) – Project #208.

- Non-gating guardrail terminal for roadway safety – Project # 212

#### Active Projects Showing Promise

- A new type of self-de-icing LED signals for highway and railroad intersections as replacement for existing LED signal lights that are too cool to deice or melt snow and may cause accidents in snowy conditions – Project #190
- A sensor-based inexpensive system for monitoring tension in anchor bolts in support structures for highway signs, luminaires, and traffic signals – Project #196
- An automated, self-restoring crash cushion to help enhance safety of motoring public and workers on the highways while minimizing or eliminating maintenance and reducing life cycle costs – Project #203.
- An integrated technology of LiDAR and radio frequency inductive testing (RFIT) to detect discretely locate deep defects/damage in concrete bridge components – Project #205.
- An automated safety monitoring system for work zone safety based on a rule-based software program for location tracking and new generation ultra wide bandwidth (UWB) sensing – Project #206.
- A novel data collection system to automatically detect, classify, and measure specific types of major pedestrian facilities (i.e., sidewalks and crosswalks) from aerial images – Project #209
- Application of Cu-Al-Mn (CAM) superelastic alloys (SEAs) in bridge columns to improve seismic performance of highway bridges – Project # 210
- Biochar amendment to roadway soils across a wide range of geographic locations to increase soil aggregation, stormwater infiltration, and runoff reduction – Project # 211
- SEAHIVE, a novel modular, cost-effective, efficient and ecofriendly shoreline protection system – Project #213.
- A method for assessing network-level curve safety conditions safely and cost effectively by collecting and analyzing vehicles' GPS trajectory and kinematic data using intra-agency, crowdsourced, low-cost mobile devices – Project #214.
- Use of Buckling Restrained Braces (BRBs) to provide seismic resilience to multi-span bridges at low cost while keeping displacement within the allowed limit – Project #215.

- A portable single-lane traffic counting device based on LIDAR sensor and artificial intelligence video technologies – Project #216.
- A real-time intersection proactive safety visualization system (IPSV) based on vehicle and pedestrian trajectory data collected by radar sensors – Project # 217
- A rapid cost effective asphalt mixture fatigue test system – Project # 218
- A novel durable, healable and conveniently removable pavement marking material suitable for both permanent and temporary marking uses – Project # 219
- Bridge deck sealant monitor -- Thermal Sealcheck – Project # 220
- An in-situ cyclic borehole shear soil test device – Project # 221
- Mixed reality assisted infrastructure inspections – Project # 222

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project 20-44, FY 1996 & Continuing**  
*Accelerating the Application of NCHRP Research Results*

**Present Expiration Date:** Continuing

**Recommended Allocation:** \$2,000,000

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**1. Anticipated Accomplishments When Funds Allocated Have Been Expended**

Since 1996, NCHRP panels, researchers, and staff have addressed all the suggested activities listed under section 4 of this form using 20-44 funds. A much larger program was funded in FY2016, and we anticipate providing assistance to a wide range of activities split between implementation (85%) and information dissemination (15%). Candidate activities are suggested by active NCHRP panels, state DOTs, and AASHTO committees/councils. Funding requests are subject to the approval of the 20-44 Panel.

**Information Dissemination Activities**

- NCHRP 2020 Annual Report – The report briefly showcases four examples of NCHRP implementation projects that were undertaken or concluded in 2020.
- NCHRP Impact Report 2019 – The second documentation effort to present the value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data, case studies, and anecdotes compiled from a variety of different sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.
- 2016 NCHRP Publications user survey: Following previous surveys conducted in 2017 and 2018/2019, a new survey of NCHRP research published in the year 2016 was rolled out in 2020. The survey was distributed through RAC, and was also sent to each available download email address from the NAP site. The results will be made available in April 2021.
- Session on “Implementing NCHRP Research: Case Studies and Discussion” and other outreach at 2019 TRB Annual Meeting: A 3 hour session on examples of implementation under the 20-44 program was held at the 2019 TRB Annual Meeting on Sunday, January 13, between 9AM and 12PM. The session was highlighted by 3 case studies on implementing NCHRP research, and also included an overview of the 20-44 program. Brief presentations on the 20-44

program were also made at several TRB committee meetings during the Annual Meeting, which have contributed to increased engagement with those committees on implementing research.

- 2015 NCHRP Publications user survey: Following the survey conducted in 2017 for NCHRP publications released in 2012, a new survey covering 66 NCHRP publications released in 2015 was rolled out in August 2018. 631 surveys were completed by 358 distinct respondents, and the results are summarized in a report that can be found in the Implementation Support Program webpage here.
- Analysis of NCHRP research contributing to the states' High Value Research: As part of the ongoing effort to better capture and understand how NCHRP research results are used in the states, an analysis was undertaken in 2019 to determine how NCHRP research results are referenced in High Value Research (HVR) submissions. The analysis found that in the period 2014 through 2018, HVR submissions from 42 states referenced at least 1 NCHRP research product, and a total of 425 individual NCHRP research products were referenced in that period.
- NCHRP Impact Report 2018 - First attempt to document and present the value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data, case studies, and anecdotes compiled from a variety of different sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.
- NCHRP Implementation Support Program webpage: A webpage on the Implementation Support Program has been developed and is live. The webpage is hosted within the current NCHRP program website (within the parent TRB website), and is intended to serve as an information repository for the Program.
- A one-page flyer was developed providing information on the Program, and was distributed at the TRB Annual Meetings in 2018 and 2019, and at various TRB and AASHTO meetings. The Implementation Program has received over fifty two enquiries on the Program from several states, and will continue to solicit requests for funding from state DOTs, NCHRP panels, and AASHTO committees and councils.
- Research Makes the Difference - Annual eight-page brochure, drawing from the 2015, 2016 and 2017 AASHTO RAC High Value Research compilation and from NCHRP suggestions.
- Impacts on Practice - Readable narrative the impact of the selected NCHRP research projects on state DOT practice.
- Webinar Organization and Communication Services - Prepare the TRB Webinar Submission Forms detailing NCHRP's proposed research projects for the two cycles of the TRB webinar series; prepare moderator PowerPoint template and talking points, and speaker tips (first cycle only); coordinate with NCHRP

manager and TRB webinar staff throughout the process; and follow up with presenters and moderators after TRB has made the webinar selections.

- Paths to Practice - Capture in an interesting, readable narrative successful approaches used for putting NCHRP research to use.
- CEO Briefing / Program Folio - Gather and develop content aimed at highlighting recent NCHRP program and project activities and accomplishments for DOT CEOs.
- Research Briefs - Two-page briefs to disseminate information about key new NCHRP projects. Finalize and deliver 15 briefs in electronic format each year.
- Field Folios / Subject Compilations - Summaries of NCHRP research in key topical areas (e.g. safety, traffic engineering, pavements, structures, etc). Finalize and deliver up to 10 Field Folios in electronic format each year.
- Report Distribution Assistance - Expand and customize alerts for new NCHRP reports by subject area to better promote use of the results. Develop distribution channels and lists that could be used to more effectively target research findings and communication approaches for pushing research results out to these target audiences.
- Tracking Implementation - Develop an online survey for use in gathering information about the use of NCHRP research results from panel members, principal investigators and other research stakeholders (such as DOT managers or field personnel). Create the survey recipient list, distribute the survey and analyze the results.

## **2. Anticipated Accomplishments When Funds Requested Have Been Expended**

Since FY 2016, NCHRP project 20-44 has programmed \$8,929,429, representing 55 projects, and has a current balance of \$1,570,571 (as of January 7, 2021). \$300,000 in potential implementation requests are being discussed. Given the volume of interest the program has generated and the potential requests in the pipeline, \$2,000,000 is being requested for FY 2022 to continue efforts to further the implementation and application of NCHRP research results.

## **3. Funds (in thousands)**

|                                      | <b>FY<br/>2016</b> | <b>FY<br/>2017</b> | <b>FY<br/>2018</b> | <b>FY<br/>2019</b> | <b>FY<br/>2020</b> | <b>FY<br/>2021</b> | <b>FY<br/>2022</b> |
|--------------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Continuation Allocation              | 2,000              | 2,000              | 2,000              | 2,000              | 0                  | 2,000              |                    |
| (Add) Balance brought forward        |                    | 320                | 1,148              | 1,913              | 1,901              | 372                |                    |
| (Add) One time addition <sup>1</sup> |                    |                    |                    |                    | 500                |                    |                    |

|                                                                                                     |       |       |       |       |       |       |       |
|-----------------------------------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| (Less) Total funds programmed                                                                       | 1,679 | 1,171 | 1,234 | 2,011 | 2,029 | 801   |       |
| Balance                                                                                             | 320   | 1,148 | 1,913 | 1,901 | 372   | 1,571 |       |
| Recommended Allocation                                                                              |       |       |       |       |       |       | 2,000 |
| <sup>1</sup> In Dec 2020, R&I provided a one-time addition of \$500,000 to NCHRP 20-44 for FY 2020. |       |       |       |       |       |       |       |

#### 4. Interpretation of AASHTO Problem Statement by Panel

In an applied research program like the National Cooperative Highway Research Program, application of results is the most important measure of success. The NCHRP has been successful by this measure; results of NCHRP research are used by AASHTO committees and member departments, but there is a need to continually look for ways to do better.

The following activities are examples of areas that benefit from greater attention: a) validating research products (e.g., testing NCHRP-developed computer software before widespread distribution); b) using innovative dissemination media to supplement or replace the written report; c) working with AASHTO committees and other code-writing groups to facilitate adoption of NCHRP recommendations; d) providing financial support for NCHRP researchers to assist potential users of NCHRP products; e) offering peer exchanges or demonstrations focused on new NCHRP research results, and f) tracking and documenting applications of NCHRP research.

#### 5. Original AASHTO Problem Statement Number

Problem No. 1996-SP-32

#### 6. Research Assignment to Date

NCHRP Project 20-44, "Accelerating the Application of NCHRP Research Results"

#### 7. Review Dates

November 25, 2015, October 7, 2015, October 14, 2016, October 16, 2017, October 30, 2018, October 31, 2019, March 25, 2020, and January 7, 2021.

#### **Implementation Projects Funded FY 2016 – FY 2021 (as of January 7, 2021)**

| Project number | Title of the implementation project | Amount |
|----------------|-------------------------------------|--------|
| FY 2016        |                                     |        |



| <b>Project number</b>    | <b>Title of the implementation project</b>                                                                                                | <b>Amount</b>      |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| NCHRP Project 20-44(01)  | Increasing WMA Implementation by Leveraging the State-Of-The-Knowledge                                                                    | \$150,000          |
| NCHRP Project 20-44(02)  | Implementation of the AASHTO Guide for Enterprise Risk Management                                                                         | \$299,997          |
| NCHRP Project 20-44(03)  | Dissemination of NCHRP Report 799: Management Guide to Intellectual Property for State Departments of Transportation                      | \$115,500          |
| NCHRP Project 20-44(04)  | Implementing Products from NCHRP Research on Adhesive Anchor Systems                                                                      | \$100,000          |
| NCHRP Project 20-44(05)  | Dissemination of "NCHRP Domestic Scan 14-01: Leading Management Practices in Determining Funding Levels for Maintenance and Preservation" | \$120,000          |
| NCHRP Project 07-22      | Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual                                                    | \$130,816          |
| NCHRP Project 20-44Q     | Communication Services for NCHRP                                                                                                          | \$499,664          |
| NCHRP Project 20-44TS    | Travel Support for Implementation Activities                                                                                              | \$9,156            |
| NCHRP Project 15-52      | Developing a Context-Sensitive Functional Classification System for More Flexibility in Geometric Design                                  | \$50,001           |
| NCHRP Project 20-59(30)A | Train-the-Trainer Regional Workshops for Incident Command System (ICS) Training for Field Level Transportation Supervisors and Staff      | \$100,000          |
| NCHRP Project SCOR-Tech  | SCOR/RAC Website Enhancement                                                                                                              | \$38,040           |
| NCHRP Project 10-86A     | Software for Bidding Alternative Drainage Pipe Systems                                                                                    | \$66,580           |
| <b>FY Total</b>          |                                                                                                                                           | <b>\$1,679,757</b> |
|                          |                                                                                                                                           |                    |
| <b>FY 2017</b>           |                                                                                                                                           |                    |

| <b>Project number</b>   | <b>Title of the implementation project</b>                                                                                                               | <b>Amount</b>      |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| NCHRP Project 20-44(08) | NCHRP Comprehensive Communications Plan                                                                                                                  | \$100,000          |
| NCHRP Project 20-44(09) | Quantitative and Qualitative Methods for Capturing the Impacts and Value of NCHRP Research                                                               | \$1,000,000        |
| NCHRP Project 15-50     | Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation Projects                                      | \$71,468           |
| <b>FY Total</b>         |                                                                                                                                                          | <b>\$1,171,468</b> |
|                         |                                                                                                                                                          |                    |
| <b>FY 2018</b>          |                                                                                                                                                          |                    |
| NCHRP Project 20-44(06) | Consultant Support for Massachusetts DOT's Commission on the Future of Transportation in the Commonwealth                                                | \$100,000          |
| NCHRP Project 03-113    | Guidance for Traffic Signals at Diverging Diamond Interchanges and Adjacent Intersections                                                                | \$99,934           |
| NCHRP Project 03-121    | Incorporating Freight, Transit and Incident Response Stakeholders into Integrated Corridor Management (ICM): Processes and Strategies for Implementation | \$149,743          |
| NCHRP Project 03-127    | Cybersecurity of Traffic Management Systems                                                                                                              | \$32,200           |
| NCHRP Project 20-44(13) | Implementation of NCHRP Research Report 893: The Oregon DOT Statewide Pedestrian and Bicycle Plan                                                        | \$154,000          |
| NCHRP Project 20-44(07) | Implementing Single-User Software for Bidding Alternative Drainage Pipe Systems                                                                          | \$50,530           |
| NCHRP Project 20-44(14) | Implementation of NCHRP Research Report 887 - Guidance for Underwater Installation of Filter Systems                                                     | \$50,000           |

| <b>Project number</b>           | <b>Title of the implementation project</b>                                                                                 | <b>Amount</b>      |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------|
| NCHRP Project 20-44(06) Phase 2 | Consultant Support for Massachusetts DOT's Commission on the Future of Transportation in the Commonwealth                  | \$145,570          |
| NCHRP Project 20-44R            | Loaned staff for impact analysis                                                                                           | \$36,944           |
| NCHRP Project 20-44(10)         | Guidelines for the Use of Mobile LIDAR in Transportation Applications                                                      | \$6,000            |
| NCHRP Project 20-44(11)         | Advancing practices for data governance, information management, and managing the impact of digitization on DOT workforces | \$80,000           |
| NCHRP Project 20-44(15)         | Consultant Support for implementation of Design Hydrology for Stream Restoration and Channel Stability at Stream Crossings | \$99,990           |
| NCHRP Project 20-44(12)         | Dissemination of NCHRP Report 814 Data to Support Transportation Agency Business Needs: A Self-Assessment Guide            | \$220,000          |
| NCHRP Project 20-44TS           | Travel support                                                                                                             | \$10,000           |
| <b>FY Total</b>                 |                                                                                                                            | <b>\$1,234,911</b> |
|                                 |                                                                                                                            |                    |
| <b>FY 2019</b>                  |                                                                                                                            |                    |
| NCHRP Project 20-44(16)         | Development of an IDEAL cracking test for asphalt mix design, quality control and quality assurance                        | \$119,645          |
| NCHRP Project 20-44(18)         | Validation of the PFC Performance-Based Mix Design Method                                                                  | \$85,000           |
| NCHRP Project 03-121            | Incorporating Freight, Transit, and Incident Response Stakeholders into Integrated Corridor Management (ICM)               | \$250,000          |
| NCHRP Project 20-44(19)         | Short- and Long-Term Binder Aging Methods to Accurately Reflect Aging in Asphalt Mixtures                                  | \$120,000          |
| NCHRP Project 20-44(20)         | Transportation System Resilience: CEO Primer and Outreach                                                                  | \$149,000          |

| <b>Project number</b>   | <b>Title of the implementation project</b>                                                                                                                                               | <b>Amount</b>      |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| NCHRP Project 20-44(21) | Synthesis of State Peer Exchanges and RPPM                                                                                                                                               | \$44,785           |
| NCHRP Project 20-44(22) | Right Sizing Transportation Investments                                                                                                                                                  | \$384,260          |
| NCHRP Project 20-44(17) | Implementing the Results of NCHRP Project 20-68A, Domestic Scan 17-01: Successful Approaches for the Use of Unmanned Aerial Systems by Surface Transportation Agencies                   | \$175,000          |
| NCHRP Project 20-44(23) | Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure                                                                                  | \$250,000          |
| NCHRP Project 20-44(24) | Effects of Recycling Agents on Asphalt Mixtures with High RAS and RAP Binder Ratios                                                                                                      | \$150,000          |
| NCHRP Project 03-128    | Business Intelligence Techniques for Transportation Agency Decision Making                                                                                                               | \$35,998           |
| NCHRP Project 20-44(25) | Implementing NCHRP Project 09-60 on Addressing Impacts of Changes in Asphalt Binder Formulation and Manufacture on Pavement Performance through Changes in Asphalt Binder Specifications | \$55,000           |
| NCHRP Project 20-44(26) | Implementing Guide Specifications for the Construction of Chip Seals and Micro surfacing                                                                                                 | \$200,000          |
| <b>FY Total</b>         |                                                                                                                                                                                          | <b>\$2,018,688</b> |
|                         |                                                                                                                                                                                          |                    |
| <b>FY 2020</b>          |                                                                                                                                                                                          |                    |
| NCHRP Project 20-44(27) | Implementation of NCHRP 20-07, Task 406 Development of a Framework for Balanced Mix Design                                                                                               | \$195,000          |
| NCHRP Project 20-44(28) | Development of a tech transfer plan for AASHTO RAC Region 3                                                                                                                              | \$160,000          |
| NCHRP Project 20-44(29) | Development of a training for NCHRP 25-49 Development of a Highway Construction Noise Prediction Model                                                                                   | \$15,904           |

| <b>Project number</b>                   | <b>Title of the implementation project</b>                                                             | <b>Amount</b>      |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------|
| NCHRP Project 20-44(30)                 | Measuring the Effectiveness of Public Involvement in Transportation Planning and Project Delivery      | \$200,000          |
| NCHRP Project 20-44(31)                 | Effective Construction Project Staffing Strategies for Transportation Agencies                         | \$200,000          |
| NCHRP Project 20-44(32)                 | Guidelines for Selecting Travel Forecasting Methods and Techniques                                     | \$375,878          |
| NCHRP Project 20-44(33)                 | Evaluating the suitability of roadway corridors for use by monarch butterflies                         | \$162,800          |
| NCHRP Project 20-44(34)                 | Successful Practices for State Transportation Research Office's Complying with 2 CFR 200               | \$190,000          |
| NCHRP Project 20-44(35)                 | Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges (A.I.I.)         | \$250,000          |
| NCHRP Project 20-44(36)                 | Long-Range Strategic Issues Affecting Preservation, Maintenance, and Renewal of Highway Infrastructure | \$280,000          |
| <b>FY Total</b>                         |                                                                                                        | <b>\$2,029,582</b> |
|                                         |                                                                                                        |                    |
| <b>FY 2021</b>                          |                                                                                                        |                    |
| NCHRP Project 20-44(37)                 | Implementation of Performance Measures in Snow and Ice Control Operations                              | \$225,000          |
| NCHRP Project 20-44(38)                 | Guidebook for Data and Information Systems for Transportation Asset Management                         | \$250,000          |
| NCHRP Project 20-44(39)                 | Guidebook for Managing Data from Emerging Technologies for Transportation                              | \$365,700          |
| <b>FY Total (as of January 7, 2021)</b> |                                                                                                        | <b>\$801,760</b>   |
|                                         |                                                                                                        |                    |
| <b>Grand total</b>                      |                                                                                                        | <b>\$8,929,429</b> |

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project 20-68A/B/C/D, FY 2007 & Continuing**  
*U. S. Domestic Scan Program*

**Present Expiration Date:** Continuing  
**Recommended Allocation:** \$600,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The objective of this project is to plan and manage the execution of domestic technology scans, each addressing a single technical topic. The purpose of each scan and of the program as a whole is to facilitate information sharing and technology exchange among the states and other transportation agencies and identify actionable items of common interest, thereby accelerating the rate of beneficial innovation.

A business plan and pilot demonstration with two scans were funded by FY 2005 and FY 2006 allocations. Subsequent SCOR allocations of \$500,000 each, from FY 2007 through FY 2012, enabled the program's initiation and engagement of a contractor to manage scan logistics and provide a yearly assessment of program performance. The primary contractor was engaged for an initial 3-year term with provision for a second 3-year term subject to availability of funds. That contract became effective 12/27/2007. SCOR allocated an additional \$200,000 of FY 2009 funds to be used particularly for monitoring scan impact and exploring ways to enhance scan effectiveness. The NCHRP project panel used these funds to assess scan impact and explore the mechanisms underlying effective dissemination within and among state transportation agencies. Scan planning and dissemination activities were modified to apply lessons learned from these activities.

A 2<sup>nd</sup> phase of the program was initiated in 2013. A competitive procurement was awarded with terms similar to the 1<sup>st</sup> phase of the program. In approving this 2<sup>nd</sup> phase, SCOR increased the annual allocation to \$600,000 to account for increased costs and increased levels of effort on post-scan information dissemination activities. This second phase is ending with scans initiated in CY2018.

A 3<sup>rd</sup> phase was initiated in 2019. Current plans entail a management review of scan dissemination activities, to be conducted during the first year of the 3<sup>rd</sup> phase. At least until that review is completed, the requested funding level for the Domestic Scan Program will be maintained at \$600,000. To facilitate program management by enabling work on newly selected scan topics to begin immediately following selection, a one-time request for a 2-year funding allocation is being made.

From the program's initiation, NCHRP funds have from time to time been supplemented by additional amounts provided by FHWA; other appropriate sponsors would be welcomed. From the project's pilot phase through September 2022, such supplemental sponsorship has totaled approximately \$588,000.

The NCHRP project panel selects scan topics from among numerous proposals received each year in response to AASHTO's solicitation, sometimes combining multiple proposals into a single scan. Individuals who submitted selected proposals are included when possible in the scan teams. Each scan team produces a report and presentations of the team's findings and a specific plan of actions to encourage dissemination of useful ideas and lessons learned by the developers and early adopters of these ideas. Scan-team reports are made available from NCHRP's project web page. Through September 2020, scans on 48 diverse topics have been scheduled; 44 scan-team reports have been released.

Scan-team members may receive limited support for expenses related to presenting these ideas and lessons to colleagues in other agencies; some scan teams organize post-scan symposia or other activities to encourage broader dissemination of the team's findings. The project panel monitors these dissemination activities and explores new ways to accelerate innovation among transportation agencies. Analysis of dissemination experience indicates that scan information reaches well beyond the scan team.

The panel's request for FY 2022, for \$600 thousand, conforms to the current program plan and will enable the program to continue without interruption in its 3<sup>rd</sup> phase. The panel is undertaking a competitive procurement for logistics support on terms similar to those of the initial phases, but anticipates that the 3<sup>rd</sup> phase funding requests may include additional funds to account for cost increases and to enable greater emphasis to be placed on dissemination of scan results.

## **2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The requested funding will enable scheduling and execution of two to three new scan topics and development of new efforts to accelerate the rate of innovation within and among transportation agencies. The panel anticipates the current request will initiate the 3<sup>rd</sup> phase of the program, and that subsequent requests for annual funding will support the 3<sup>rd</sup> 6-year term of effort that commenced with the FY 2021 request.

## **3. Funds (in thousands)**

|                           | <b>FY<br/>2005</b> |  | <b>FY<br/>2006</b> | <b>FY<br/>2007-8</b> | <b>FY<br/>2009</b> | <b>FY 2010-<br/>17</b> | <b>FY 2018-<br/>21</b> | <b>FY 2022</b> |
|---------------------------|--------------------|--|--------------------|----------------------|--------------------|------------------------|------------------------|----------------|
| AASHTO Initial Allocation | 250                |  |                    |                      |                    |                        |                        |                |
| Continuation Allocation   | -0-                |  | -0-                | 1,000                | 700                | 4,500                  | 2,400                  |                |
| Less Obligation           | 250 <sup>a</sup>   |  | -0-                | 1,000 <sup>b</sup>   | 510 <sup>b,c</sup> | 4,690 <sup>b,c</sup>   | 2,400                  |                |
| Balance (earmarked)       | -0-                |  | -0-                | -0-                  | 190 <sup>c</sup>   | -0-                    | -0-                    |                |

|                      |     |  |     |     |     |     |     |     |
|----------------------|-----|--|-----|-----|-----|-----|-----|-----|
| Reallocation         | -0- |  | -0- | -0- | -0- | -0- | -0- |     |
| Total Available      | -0- |  | -0- | -0- | -0- | -0- | -0- |     |
| Recommended Addition |     |  |     |     |     |     |     | 600 |

Assignment to specific projects: NCHRP 20-68, \$50K; NCHRP 20-68(01), \$200K; NCHRP 20-68A, \$3.0M; NCHRP 20-68B/C, \$200K; NCHRP 20-68A(02), \$3.6M. NCHRP 20-68D total anticipated, \$3.6M.

#### **4. Interpretation of AASHTO Problem Statement by Panel**

Continuing innovation in the practices of U.S. transportation agencies has brought substantial benefits to the nation. Examples of beneficial innovation range from new materials used in pavements and structures, to new ways of collecting and analyzing information about transportation system users and the environment in which the system operates, to new ways of funding the investments needed to improve public safety and efficiency of travel.

Beneficial innovation occurs in any field when new ideas are disseminated and widely adopted by practitioners. Experience in many fields illustrates that expanding the extent of information exchange among practitioners and accelerating the rate of the exchange facilitate innovation.

Experience also shows that personal contact with new ideas and their application is a particularly valuable means for information exchange. U.S. engineering professionals have visited their colleagues in other countries and returned with information that they have subsequently communicated to their domestic colleagues and seen applied to improving domestic practice. The American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and others have been active in technology transfers at the international level with their involvement in such activities as NCHRP Project 20-36 on "Highway Research and Technology---International Information Sharing."

These earlier experiences and the NCHRP 20-68 program to date have shown that the "scan" approach is a productive means for encouraging the dissemination of information and innovation. Many program participants and observers have noted that new ideas are emerging in state and local transportation agencies around the United States, and that faster dissemination of many of these ideas could yield benefits similar to those associated with international information exchange. Domestic scans conducted by various FHWA offices as well as through the NCHRP further illustrate the value of a domestic scan program.

A scan program entails four key steps. First, knowledgeable people identify novel practices in their field of interest. Second, these people assess the likelihood that these new ideas might beneficially be applied in other settings. Third, new practices that offer the most promise are selected and field visits are made to observe the practices, identify pertinent development and application issues, and assess appropriate



technology transfer opportunities and methods. Finally, the results of the initial steps are documented for use by those who participated and for others to apply.

Effective scan programs both supplement and make use of other mechanisms for information exchange such as publications in trade and professional journals, conferences, and peer-to-peer forums. A scan program focuses on face-to-face discussion of current experience, providing opportunities for a uniquely rich exchange of information that is difficult or impossible to replicate through written materials, telephone conversations, and e-mail correspondence. The informal discussions among the scan participants contribute to the extraction of useful information from the individual participant's observations. Executing an effective scan program requires sound understanding of the topic areas to be considered, insightful selection of topics and new ideas to be observed, careful selection of participants who can provide useful insights from their observations, and thoughtful documentation and dissemination of each scan's results. Managing the domestic scan program additionally requires that resources be conserved by not duplicating the information exchange activities of others.

## **5. Original AASHTO Problem Statement Number**

Problem No. 2005-SP-05, 2008-SP-08

## **6. Research Assignments to Date**

NCHRP Project 20-68, "US Domestic Scan Program (Business Plan)" (completed)

NCHRP Project 20-68(01), "US Domestic Scan Program Pilot" (completed, 2 scans)

NCHRP Project 20-68A, "US Domestic Scan Program" (contractor engaged for 3-year term, renewed for second 3-year term)

NCHRP Project 20-68A(02), "US Domestic Scan Program" (contractor engaged for 3-year term, renewed for second 3-year term, extended 1 additional year to accommodate changes in NCHRP schedules and completion of assigned scan topics)

NCHRP Project 20-68B(01), "Accelerating the Rate of Innovation Among State DOTs—Tracing Domestic Scan Impacts"

NCHRP Project 20-68B(02), "Accelerating the Rate of Innovation Among State DOTs—Tracing Domestic Scan Impacts"

NCHRP Project 20-68C, "Research on Innovation Networks--Domestic Scans"

NCHRP Project 20-68D, "US Domestic Scan Program" (contractor engaged for 3-year term, renewable for second 3-year term)

## **7. Review Date**

09/3/2019, 12/5/2019, 9/16/2020

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**

**Continuation Request**  
**Project 20-123, FY 2020 & Continuing**  
*Support for AASHTO Committees and Councils*

**Present Expiration Date:** Continuing  
**Recommended Allocation:** \$833,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The AASHTO Special Committee on Research & Innovation created NCHRP 20-123 to provide a flexible and ongoing source of funding for AASHTO committees and councils for advancing and implementing their vision, mission, and strategic goals, including the role that research can play their efforts. The activities funded by this project must be an eligible use of SPR-B research funds.

Three FY 2021 projects totaling \$675,000 have been approved for advancement at the time this continuation request was prepared. A list of projects accompanies this continuation request.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

This continuation request will support, for another year, funding for research-related activities needed by AASHTO committees and councils. Activities envisioned to be eligible for funding include but are not limited to the preparation of research road maps, research scoping studies, peer exchanges, updates of AASHTO specifications and manuals maintained by a committee, and updates to strategic plans.

**3. Funds (in thousands)**

|                            | <b>FY<br/>2019</b> | <b>FY<br/>2020</b> | <b>FY<br/>2021</b> | <b>FY<br/>2022</b> |
|----------------------------|--------------------|--------------------|--------------------|--------------------|
| Initial Allocation         | 1,500              |                    |                    |                    |
| Continuation<br>Allocation |                    | 475                | 608                |                    |
| Carried Forward<br>balance | -0-                | 900                | 734                |                    |
| Less Obligation            | 600                | 641                | 675                |                    |
| Total Available            | 900                | 734                | 667                |                    |
| Recommended<br>Addition    |                    |                    |                    | 833                |

**4. Interpretation of AASHTO Problem Statement by Panel**

A program is needed that can respond to the needs of AASHTO committee and councils to assist them in identifying and identifying research needs that are important to member state agencies, as well as other activities to assist committees and councils conduct other eligible activities that are related to research.

**5. Original AASHTO Problem Statement Number**

This project did not result from the submission of a problem statement; it was created and decided upon by the AASHTO Special Committee on Research and Innovation at their March 2018 meeting.

**6. Research Assignment to Date**

NCHRP Project 20-123, Support for AASHTO Committee and Councils

**7. Review Date**

December 1, 2020

## Accountability Report for NCHRP Project 20-123

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose:</b>                       | NCHRP 20-123 provides AASHTO committees and councils with timely access to funds to support their missions with the assistance of consultants, for activities that SPR-B eligible.                                                                                                                                                                                                                                                                                               |
| <b>Started:</b>                       | FY 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Funding:</b>                       | Allocated in 2021: \$1,500,000<br>Requested in 2022: \$833,000                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Problem Solicitation:</b>          | Needs are identified by each AASHTO committee or council, and members or AASHTO staff submit a funding request to NCHRP.                                                                                                                                                                                                                                                                                                                                                         |
| <b>Process for Selecting Studies:</b> | Funding requests are considered and approved at periodic meetings of the Project 20-123 panel; meetings are held via conference call as needed in response to receipt of a funding request. The panel includes five members, each drawn from the Councils on Highways and Streets, Active Transportation, and Public Transportation; the Committee on Administration; and the Special Committee on Research and Innovation. The panel also includes liaisons from FHWA, and TRB. |
| <b>Consultant Selection:</b>          | The work will be performed by a contractor and overseen by a panel formed for the specific task and appointed by NCHRP. The panel is responsible for selecting its contractor. This may be a sole source contract, but generally proposals are solicited competitively.                                                                                                                                                                                                          |
| <b>Studies Requested Last Year:</b>   | Three requests for a total of \$675,000 were submitted for FY 2021.                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Studies Funded Last Year:</b>      | Three requests for a total of \$675,000 were approved for FY 2021.                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Studies Completed Last Year:</b>   | No projects were completed in 2020.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Distribution of Findings:</b>      | Final deliverables will be provided to the leadership of the requesting committee or council, and will be posted as appropriate on the NCHRP website.                                                                                                                                                                                                                                                                                                                            |
| <b>Use of Findings:</b>               | The reports are of direct use to members of the requesting committee or council. To the degree that NCHRP problem statements result from these efforts, the NCHRP program                                                                                                                                                                                                                                                                                                        |

should benefit from the submission of thoughtful, well-written, and prioritized research problem statement thereby contributing to NCHRP's ability to address important and meaningful research questions.

**Next Year's Studies:**

This is unknown at this time.

**NCHRP Project 20-123  
Completed and Active Research Projects**

| <b>Project Number</b>   | <b>Project Title</b>                                                                                                                                                    | <b>Stage</b>          |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <u>NCHRP 20-123</u>     | Support for AASHTO Committees                                                                                                                                           | Active                |
| <u>NCHRP 20-123(01)</u> | Transportation Asset Management Strategic Planning and Research Roadmap Development                                                                                     | Research in Progress  |
| <u>NCHRP 20-123(02)</u> | Research Roadmap for the AASHTO Council on Active Transportation                                                                                                        | Research in Progress  |
| <u>NCHRP 20-123(03)</u> | Staying Nimble: Organizational Development for the Cutting Edge                                                                                                         | Anticipated           |
| <u>NCHRP 20-123(04)</u> | Development of a Risk Management Strategic Plan and a Research Roadmap                                                                                                  | Pending               |
| <u>NCHRP 20-123(06)</u> | Merge and Update Policy on the Accommodation of Utilities Within Freeway Right-of-Way (2005) and A Guide for Accommodating Utilities Within Highway Right-of-Way (2005) | Anticipated           |
| <u>NCHRP 20-123(07)</u> | Update proposed Manual for the Maintenance of Roadways and Bridges                                                                                                      | Anticipated           |
| <u>NCHRP 20-123(09)</u> | Scoping study for the development of a platform for innovations                                                                                                         | Anticipated           |
| <u>NCHRP 20-123(11)</u> | High-Value Research Marketing and Communications for 2020                                                                                                               | Anticipated           |
| <u>NCHRP 20-123(12)</u> | System Mobility and Emerging Technologies (SMET): Strategic Planning Session and Research Roadmap Development                                                           | Approved, Anticipated |
| <u>NCHRP 20-123(13)</u> | Transportation Planning Strategic Planning and Research Roadmap Development                                                                                             | Approved, Anticipated |
| <u>NCHRP 20-123(14)</u> | Scoping study for the development of a platform for AASHTO Committee Surveys                                                                                            | Approved, Anticipated |

# **Part 1.2**

## RESEARCH PROJECTS

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project 01-57A, FY 2015**

*Developing Standard Definitions for Comparable Pavement Cracking Data*

**Present Expiration Date:** August 31, 2020

**Recommended Allocation:** \$500,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

NCHRP Project 01-57A, Developing Standard Definitions for Comparable Pavement Cracking Data, developed a set of proposed standard, discrete definitions for common cracking types in flexible, rigid, and composite pavements. The definitions classify cracking type, extent, and severity based on information from images collected by highway-speed data collection vehicles. The definitions facilitate comparable measurement and interpretation of pavement cracking across the highway community. The definitions must be of sufficient detail that quality control measures and processing logic for automated data evaluation software can identify cracking features and excluding non-cracking features. The project results are reported in *NCHRP Web-Only Document 288, Standard Definitions for Common Types of Pavement Cracking*.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The panel judged that the definitions developed in the project should be advanced to verification, validation, and development of an AASHTO standard practice; these activities were not possible in Project 01-57A due to its limited funding.

At its meetings of August 20 and September 23, 2020, the panel identified activities that will advance the proposed standard definitions to an AASHTO standard practice:

1. Design and conduct experiments to validate the three levels of standard cracking definitions on a wide array of pavement surfaces and textures in at least four states using the output of three or more different highway-speed data collection vehicles and associated proprietary semi- or fully-automated crack detection and classification software. Measure the sensitivity of the definitions to actual crack width and severity through “ground truthing.” Propose the “ground truthing” procedure for panel approval. Determine the compatibility of the definitions with existing and prospective data collection equipment and crack detection and classification software.
2. Adapt the definitions to use with pavement management decision trees and thresholds in at least four states and adjust the decision trees to the use of automatic measurements.



3. Identify gaps and shortcomings in the complete workflow in terms of meeting the needs of pavement management systems, pavement design, and reporting, and propose modifications and fine-tuning of the cracking protocols.
4. Develop a draft AASHTO standard practice for the AASHTO Committee on Materials and Pavements.

### 3. Funds (in thousands)

|                           | FY 2015 | FY 2022 |
|---------------------------|---------|---------|
| AASHTO Initial Allocation | 500     |         |
| Continuation Allocation   | -0-     |         |
| Less Obligation           | 500     |         |
| Balance (earmarked)       | -0-     |         |
| Reallocation              | -0-     |         |
| Total Available           | -0-     |         |
| Recommended Addition      |         | 500     |

### 4. Interpretation of AASHTO Problem Statement by Panel

Many state and local agencies collect downward pavement imagery using highway-speed data collection vehicles. The images are subsequently processed using proprietary semi- or fully-automated crack detection and classification software to identify pavement cracking for use in pavement and asset management systems.

There are multiple methods and software for defining, classifying, and reporting cracking data. In addition, these methods, and the cracking data they produce are not always comparable between states, even if similar data collection and detection technologies are used. One outcome of this situation is that vendors must customize the cracking definitions for each client. To unify data reporting, sharing, and evaluation, standardization of pavement cracking definitions is needed.

Research is needed to define cracking measurement terms for uniformity and potential standardization, building upon work done in AASHTO PP 67 and 68. The standard definitions will aid in sharing information among agencies and vendors, reporting to FHWA, and setting national, state, and local performance goals, as well as assisting future improvement of the technologies.

### 5. Original AASHTO Problem Statement Number

Problem No. 2015-D-05

### 6. Research Assignment to Date

NCHRP Project 01-57, Standard Definitions for Comparable Pavement Cracking Data (terminated)

NCHRP Project 01-57A, Developing Standard Definitions for Comparable Pavement Cracking Data

### 7. Review Dates

November 6, 2017; February 28, 2018; November 29, 2018; August 20, 2020; September 23, 2020

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**NCHRP Project 03-119, FY 2015**

*Application of MASH Test Criteria to Breakaway Sign and Luminaire Supports and  
Crashworthy Work-Zone Traffic Control Devices*

**Present Expiration Date:** 10/31/2020 Pending No-Cost Extension approval for 10/31/2021

**Recommended Addition Allocation:** \$280,000

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**1. Anticipated Accomplishment(s) When Current Project Allocation Has Been Expended**

Safety concerns have led to the development of a broad set of requirements for all roadside safety hardware crashworthiness. Recent upgrades to the Federal requirements mandate that states assure that all existing and new roadside hardware meet the crash safety requirements (e.g., sign supports, guardrails, crash cushions, temporary barriers). Highway agencies need to replace all hardware with currently certified versions, and/or certify that the devices they use meet the requirements. Certifications have been granted for many major elements such as guardrails & crash cushions, but the crashworthiness of the vast majority of roadside hardware elements such as sign supports, luminaires, and work zone devices performances are not known. The research aim was to identify non-proprietary and commonly used breakaway signs, luminaire supports, and work-zone traffic control devices and evaluate safety performance, and likelihood to comply with the current MASH crash test criteria. These devices are among the most common, diverse, and long-lasting elements of the highway roadside that have an impact on safety when a vehicle leaves the roadway but a survey of states identified hundreds of heterogeneous devices.

This study included the analysis of the following wood-post signs, perforated square steel tube post signs, u-channel posts signs, and TB1-17 transformer base luminaire poles.

Breakaway Sign Supports (7' mounting height aluminum panels)

- Wood Variations (# posts, post sizes, hole size and location, panel size) [MwRSF]
- PSST Variations (#posts, mast size, anchor size and config, panel size) [CCSA]
- U-Channel Variations (#posts, section, weight, yield strength, bolt config, panel size) [CCSA]

Luminaire Supports

- TB1-17 Base Variations (bolt circle pattern, pole height, pole weight) [MwRSF]

Work-zone Devices

- Non-proprietary Type III Barricade system with sign panel and warning lights (successfully tested with 2270P and 1100C vehicles). Generating a test report and obtaining eligibility letters are in-progress [MwRSF]

## 2. Anticipated Efforts under the Requested Continuation Allocation

While the efforts under the current project identified and tested several families of roadside hardware, additional items are also widely used across the states and require certification by the states. Six additional systems include:

- Breakaway Luminaire Supports – 4-Bolt/Coupling/Transpo Model 5100
- Breakaway Luminaire Supports – 4-Bolt/Transformer-Pedestal Base/TB3-17 or TB2-17
- **Work-Zone Traffic Control Devices – Type II Barricade**
- Work-Zone Traffic Control Devices – Type I Barricade
- **Work-Zone Traffic Control Devices – Generic Temporary Sign Stand with Low Panel Height**
- Work-Zone Traffic Control Devices – Generic Temporary Sign Stand with Tall Panel Height

Of these device types, the following two were prioritized by the NCHRP panel since they are more commonly used and are being presented in this continuation request. The remaining items may be included in future analysis.

### **Work-Zone Traffic Control Devices – Type II Barricade**

Even though no analyses were performed on work-zone traffic control devices under the current part of the project, the team determined the most-used, non-proprietary, A-Frame and Type I, II, and III barricades (as noted within the interim report and noted in Table 16 on page 43). The researchers demonstrated the MASH 2016 TL-3 crashworthiness of a generic Type III barricade system through crash testing. With barricade needs remaining at the TL-2 and TL-1 impact conditions, it is recommended that follow-on research be conducted to configure and investigate the crashworthiness of a generic Type II barricade (based on the tested generic Type III barricade).

### **Work-Zone Traffic Control Devices – Generic Temporary Sign Stand with Low Panel Height**

For the initial allocation of project funding, the research team was unable to perform computer simulations or full-scale crash testing on flag trees, temporary sign stands, temporary ground-mounted sign supports, or wheeled/cart-mounted portable sign supports within work zones. Due to their common use, it is recommended that research investigations be performed on generic temporary sign stands with low panel heights. The research team provides a device list in Table 20 page 51 of the interim report and Tables M15 through M22.

### **Cost breakdown for additional analysis:**

|                                   |             |
|-----------------------------------|-------------|
| Number of systems to be analyzed  | Two Systems |
| Model development and validations | \$60,000    |

|                                    |                  |
|------------------------------------|------------------|
| Simulation analyses                | \$60,000         |
| Component and full- scale testing  | \$150,000        |
| Guidance Development               | \$10,000         |
| Total Additional Funding requested | <b>\$280,000</b> |

Project total if approved - \$879,134

### 3. Project Funding

|                           | FY 2015          | FY 2021   |
|---------------------------|------------------|-----------|
| AASHTO Initial Allocation | \$599,134        |           |
| Continuation Allocation   |                  |           |
| Less Obligation           | <u>\$599,134</u> |           |
| Balance (earmarked)       | -0-              |           |
| Reallocation              | -0-              |           |
| Total Available           | -0-              | \$280,000 |
| Recommended Addition      |                  |           |

### 4. Interpretation of AASHTO Problem Statement by Panel

Recent crash testing of small and medium sign supports and work-zone devices has been problematic for both of the test vehicles required in the 2009 AASHTO *Manual for Assessing Safety Hardware* (MASH). Many of these designs have previously been successfully full-scale crash tested under NCHRP Report 350: *Recommended Procedures for the Safety Performance Evaluation of Highway Features*. Only the small car (1800-lb, Geo Metro or similar) test was performed under NCHRP Report 350. MASH requires testing with both a small car (2420-lb, Kia Rio or similar) and a pickup truck (5000-lb, ½-ton Dodge Quad Cab or similar) into these types of devices. Occupant Impact Velocities (OIVs) and Occupant Ride-Down Accelerations (ORAs) have not been a problem because of the increased weight of the test vehicles, even with the commensurate reduction in impact speed in MASH Test 3-60. However, the change in frontal geometry (i.e., bumper heights, increased frontal area, and wrap around distances) and increased ground clearance has changed the interaction between the vehicle and object struck. In general, small and medium sign supports used to pass over the top of the impacting vehicle with limited or no vehicle contact. With the newer MASH test vehicles, sign supports are now striking the windshield and roof of the test vehicles and failing the occupant compartment intrusion and/or penetration requirements of MASH. Similarly, vehicle collisions with portable work-zone devices are causing unacceptable windshield and roof penetrations and/or deformations as well as floor pan penetrations. No testing was conducted on luminaires (light poles) under MASH upon project initiation, but this recent testing on other breakaway and portable work-zone devices raises questions as to the expected performance of breakaway luminaire poles under the MASH impact safety criteria. The addition of objective vehicle intrusion and deformation criteria has also brought into question the future usefulness of pendulum/bogie testing of breakaway and crashworthy designs. The objective of this research is to identify and evaluate the crash performance of breakaway sign and luminaire supports and crashworthy work-zone traffic control devices that are non-proprietary and commonly used.

## **5. Original AASHTO Problem Statement Number**

Problem No. FY2015-G-29

## **6. Research Assignments to Date**

NCHRP Project 3-119, "Application of MASH Test Criteria to Breakaway Sign and Luminaire Supports and Crashworthy Work-Zone Traffic Control Devices"

## **7. Review Dates**

12/5/2020

## **8. Project Description**

Recent crash testing of small and medium sign supports and work-zone devices has been problematic for both of the test vehicles required in the 2009 AASHTO *Manual for Assessing Safety Hardware* (MASH). Many of these designs have previously been successfully full-scale crash tested under NCHRP Report 350: *Recommended Procedures for the Safety Performance Evaluation of Highway Features*. Only the small car (1800-lb, Geo Metro or similar) test was performed under NCHRP Report 350. MASH requires testing with both a small car (2420-lb, Kia Rio or similar) and a pickup truck (5000-lb, ½-ton Dodge Quad Cab or similar) into these types of devices. Occupant Impact Velocities (OIVs) and Occupant Ride-Down Accelerations (ORAs) have not been a problem because of the increased weight of the test vehicles, even with the commensurate reduction in impact speed in MASH Test 3-60. However, the change in frontal geometry (i.e., bumper heights, increased frontal area, and wrap around distances) and increased ground clearance has changed the interaction between the vehicle and object struck. In general, small and medium sign supports used to pass over the top of the impacting vehicle with limited or no vehicle contact. With the newer MASH test vehicles, sign supports are now striking the windshield and roof of the test vehicles and failing the occupant compartment intrusion and/or penetration requirements of MASH. Similarly, vehicle collisions with portable work-zone devices are causing unacceptable windshield and roof penetrations and/or deformations as well as floor pan penetrations. No testing has been conducted to date on luminaires (light poles) under MASH, but this recent testing on other breakaway and portable work-zone devices raises questions as to the expected performance of breakaway luminaire poles under the MASH impact safety criteria. The addition of objective vehicle intrusion and deformation criteria has also brought into question the future usefulness of pendulum/bogie testing of breakaway and crashworthy designs. The objective of this research is to identify and evaluate the crash performance of breakaway sign and luminaire supports and crashworthy work-zone traffic control devices that are non-proprietary and commonly used. The evaluation should address their in-service safety performance, potential failure modes (and, if possible, design modifications that might address those failure modes), and their likelihood to comply with the current MASH crash test criteria.

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**Project 09-60, FY 2016**

*Addressing Impacts of Changes in Asphalt Binder Formulation and Manufacture on  
Pavement Performance through Changes in Asphalt Binder Specifications*

**Present Expiration Date:** December 31, 2020

**Recommended Allocation:** \$500,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The objective of NCHRP Project 09-60 is to propose revisions to the current performance-graded (PG) asphalt binder specifications (AASHTO M 320, Standard Specification for Performance-Graded Asphalt Binder, and M 332, Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test), tests, and practices that will remedy gaps and shortcomings related to the premature loss of asphalt pavement durability in the form of cracking and raveling. The proposed revisions and supporting commentary will be provided to Technical Subcommittee 2b, Liquid Asphalt, of the AASHTO Committee on Materials and Pavements (COMP TS 2b) for consideration and potential adoption.

Extensive laboratory and field testing conducted by the contractor, Western Research Institute, confirmed two binder properties as good predictors of cracking behavior for both modified and unmodified asphalt binders:  $T_{cr}$ , a rheological property evaluating relaxation measured in the bending beam rheometer and  $\Delta T_f$ , failure property measured with the Asphalt Binder Cracking Device (ABCD).  $T_{cr}$  has been found to reject highly oxidizable, incompatible, inhomogeneous binders.  $\Delta T_f$  evaluates the fracture strength of the binder indicating the improved cracking properties of polymer modified binders. The modifiers evaluated in the experiments include those known to both improve cracking performance such as SBS block copolymer and those implicated in premature pavement failures such as recycled engine oil bottoms. The contractor has prepared draft revisions to M 320 and M 332 incorporating  $T_f$  and  $T_{cr}$  and proposed specification limits to control the cracking behavior of modified and unmodified asphalt binders.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The panel respectfully requests \$500,000 in FY 2022 funds to (a) further validate the specification proposed by NCHRP Project 09-60, (b) refine the proposed specification limits, and (c) refine the test procedures used in the specification. The primary tasks under the project would include:

- Conduct ruggedness and interlaboratory studies (ILS) to determine the precision of the methods to determine the  $\Delta T_{cr}$  and  $\Delta T_f$  parameters.
- Conduct an ILS to determine the precision of the ABCD test.
- Evaluate thermal history effects on binder sample results.
- Refine BBR minimum S value based on m value = 0.300 criteria.
- Evaluate climate temperature versus PG effects on 9-60 specification limits.
- Combine S & m values and fracture to create a single low-temperature PG grade parameter.
- Refine age conditioning requirements (20- or 40-hour PAV) for determining the  $\Delta T_{cr}$  and  $\Delta T_f$  parameters, coordinating with the results of NCHRP Projects 09-54, Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction, and 09-61, Short- and Long-Term Binder Aging Methods to Accurately Reflect Aging in Asphalt Mixtures.
- Conduct further laboratory validation testing on an expanded list of known specific problematic asphalt materials.
- On the expanded binder range, conduct mixture verification crack testing with the AMPT cyclic fatigue test to validate cracking potentials.
- Revise AASHTO standard specifications and supporting tests based on the results from the ILS and validation efforts.
- Develop a detailed field validation procedure to be carried out by highway agencies through a task in NCHRP Project 20-44, NCHRP Implementation Support Program, or regional pooled fund efforts.

The above work tasks were developed in a workshop conducted through NCHRP Project 20-44(25), Workshop to Introduce Proposed Changes to AASHTO M 320 and M 332 to Key Stakeholder Groups. The workshop (a) introduced the tentative changes to the AASHTO M 320 and M 332 performance graded asphalt binder specifications developed in NCHRP Project 09-60 to members of the AASHTO Committee on Materials and Pavement (COMP) and representatives of the asphalt supply industry, (b) identified potential benefits and costs, impediments to adoption, and potential impacts on public and private stakeholders of these changes, and (c) identified necessary actions to expedite their validation and adoption by AASHTO COMP.

### 3. Funds (in thousands)

|                           | FY 2016      | FY 2021    | FY 2022 |
|---------------------------|--------------|------------|---------|
| AASHTO Initial Allocation | 1,000        |            |         |
| Continuation Allocation   | -0-          | 150        |         |
| Less Obligation           | <u>1,000</u> | <u>150</u> |         |
| Balance (earmarked)       | -0-          | -0-        |         |
| Reallocation              | -0-          | -0-        |         |

|                      |     |     |     |
|----------------------|-----|-----|-----|
| Total Available      | -0- | -0- |     |
| Recommended Addition |     |     | 500 |

#### **4. Interpretation of AASHTO Problem Statement by Panel**

Since the implementation of the Performance-Graded (PG) Asphalt Binder specification developed by the Strategic Highway Research Program (SHRP), the formulation and manufacture of asphalt binders used in pavements have changed considerably. Increased global demand for fuels and other petroleum-based products has led to the development of refining techniques that allow the extraction of increased amounts of higher value light products with lower sulfur contents from crude oil. A wider, more variable range of crude oil sources and means of production are being used to produce asphalt binders than was the case when the PG system was first developed. Additionally, materials such as polymers, polyphosphoric acid, re-refined engine oil bottoms (ReOB), paraffinic base oils, rendered oils, bio binders, and ground tire rubber are increasingly being used to formulate and manufacture asphalt binders. Increased use of higher percentages of reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS) is also driving the use of softer asphalt binder grades, which are often produced by adding various products to stiff binders. Although today's asphalt binders typically continue to meet the requirements of the PG specification, highway agencies in the United States and Canada are increasingly experiencing premature failures of newly constructed pavements despite general compliance with existing pavement and mix design standards, construction methods, and materials specifications. These failures include distress typified by low- and intermediate-temperature cracking and raveling, aggregate loss, and instances of total surface course loss within 5 years. The concern is often expressed over embrittlement and a lack of adhesion and tackiness of the asphalt binders.

Based on changes in asphalt binder formulation and manufacture, current asphalt binder specifications, tests, and practices merit a comprehensive review to ensure their effective contribution to satisfactory pavement performance. Research is needed to assess the existing PG binder specification, address the implications of these changes in formulation and manufacture on binder performance, provide tools to measure the performance-related characteristics of asphalt binders and develop an updated specification that addresses current and future asphalt binders.

#### **5. Original AASHTO Problem Statement Number**

Problem No. 2016-D-04

#### **6. Research Assignment to Date**



NCHRP Project 09-60, Addressing Impacts of Changes in Asphalt Binder Formulation and Manufacture on Pavement Performance through Changes in Asphalt Binder Specifications

**7. Review Dates**

11/5-6/2015, 2/18/2016, 7/24/2017, 1/31/2019, 9/26/2019, 06/17, 19, & 22/2020

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, & Medicine**

**Continuation Request**

**Project 12-102, FY 2014**

*Recommended AASHTO Guide Specification for ABC Design and Construction*

**Present Expiration Date:** 12/08/2021

**Recommended Allocation:** \$150,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The objective of NCHRP 12-102 was to develop a recommended AASHTO guide specification for ABC design and construction that compiles the growing body of design and construction specification products for accelerated bridge construction (ABC). AASHTO CBS adopted and published the proposed guide specifications developed under NCHRP 12-102 in 2017. After completing NCHRP 12-102, the remaining funding has been allocated to develop in-person training workshops. Given the current pandemic with limited in-person meetings and workshops, the project panel recommends creating on-line training modules from the technical training material developed for the workshops. The modules and examples will be topic specific that are easily accessible and timely for training and as a re-fresher course, as needed, for the implementation of ABC guide specifications.

Supplemental funding is requested to enable the contractor to expand the training materials beyond NCHRP Project 12-102 original scope of work to cover the administrative and ABC project delivery aspects to support the implementation of the AASHTO ABC guide specifications by state department of transportations (DOTs). At a minimum, the administrative training modules (virtual and in-person workshops) will include:

- Decision-making processes to assist bridge owner in evaluating which project is appropriate for ABC methods vs. conventional construction methods;
- Risk associated with ABC and mitigation strategies using specifications and contracting mechanisms;
- Scoping of projects to select the appropriate ABC technologies (e.g., Prefabricated bridge elements vs. systems);
- Engaging decision makers from state and local agencies, and contractors to ensure buy-in for ABC programs; and
- Implementation of ABC within DOTs by engaging leadership and stakeholders.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The requested funds will be used to add additional training modules related to the administrative and delivery aspects of ABC projects to support the implementation of the AASHTO ABC guide specifications by state DOTs. The training modules will be made available from the NCHRP publication website or the AASHTO CBS website, but there is no tracking of who takes the training and no instructional support.

**3. Funds (in thousands)**

| Funds                | FY2014         |                 | FY2022    |
|----------------------|----------------|-----------------|-----------|
| Project/Phase        | Project 12-102 | Project 12-102A |           |
| Initial Allocation   | \$400,000      | \$123,138*      |           |
| Less Obligation      | \$370,000      | 0               |           |
| Balance (earmarked)  | \$30,000       | 0               |           |
| Continuation Request |                |                 | \$150,000 |

***\*Remaining funds from NCHRP Project 12-102 and the \$30,000 earmarked***

**4. Interpretation of Problem Statement by Panel**

The NCHRP 12-102 Recommended AASHTO Guide Specifications for Accelerated Bridge Construction Design and Construction Project accomplished great strides in advancing ABC for the industry while being extremely efficient with the allotted funding. The project included valuable information that was developed in the NCHRP 12-98 Recommended Guidelines for Prefabricated Elements and Systems Tolerances and Recommended Guidelines for Dynamic Effects for Bridge Systems. Ultimately the project led to the adoption of the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction. In order to help state DOTs with the implementation of the AASHTO ABC guide specifications, the training workshops and materials will provide a holistic view of the ABC program (technical, administrative, and project delivery) and implementation.

**5. Original AASHTO Problem Statement Number**

2014-C-22

**6. Research Assignment to Date**

NCHRP Project 12-102 and NCHRP Project 12-102A, Recommended AASHTO Guide Specifications for ABC Design and Construction.

**7. Review Dates**

November 2020

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, & Medicine**

**Continuation Request**

**Project 15-67, FY 2018**

***Wind Drag Coefficients for Highway Signs and Support Structures***

**Present Expiration Date:** 05/05/2021

**Recommended Allocation:** \$75,000

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

The objective of this research is to propose revisions to the wind drag coefficients in the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LRFDLTS-1). At a minimum, the research shall develop a methodology and design examples to calculate wind drag coefficients for signs and supporting structure members that are included in the LRFDLTS-1.

Safe and economical design of highway sign support structures requires accurate estimation of wind loads acting on the signs and members of their support structures. This research is based on comprehensive numerical simulations to estimate wind loads acting on a variety of isolated signs and those supported on monotube and truss structures. As a result of the project limited funding, a very limited wind tunnel testing and field data were not used to validate the very complex numerical simulations. The AASHTO revisions and design examples were developed based on the modeling simulations and presented to the AASHTO CBS/ T12- Structural Support Signs. T12 acknowledges the complexity of the numerical simulations and has requested additional wind tunnel testing to validate the proposed methodology and the proposed AASHTO revisions.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The requested funds will be used to conduct additional wind tunnel testing to 1) validate the numerical simulations 2) support the adoption and implementation of proposed AASHTO revisions to the LRFDLTS-1, and 3) ensure the safety and economical design of highway sign support structures.

**3. Funds (in thousands)**

| Funds                | FY 2018       | FY 2022 |
|----------------------|---------------|---------|
| Project/Phase        | Project 15-67 |         |
| Initial Allocation   | \$300         |         |
| Less Obligation      | \$300         |         |
| Balance (earmarked)  | \$0           |         |
| Continuation Request |               | \$75    |

**4. Interpretation of Problem Statement by Panel**

The NCHRP Project 15-67 "Wind Drag Coefficients for Highway Signs and Support Structures" generated the data needed to estimate drag coefficients for various highway signs including both static signs and dynamic message sign (DMS). Drag coefficients are also estimated for cases when these signs are placed on monotube; truss including secondary members and gusset plates; and grade separation structures. These simulation results are then used to propose a general methodology to estimate: 1) wind loads on highway signs; and 2) wind loads on monotube and truss structures supporting one or multiple highway signs. Also, a set of design examples illustrating how to apply the proposed methodologies and recommendations to estimate wind loads for highway signs and their support structures were developed.

In order to help state DOTs with the adoption and implementation of the AASHTO proposed revisions, additional wind tunnel testing is required to validate the numerical simulations and ensure the safety and economical design of highway sign support structures.

**5. Original AASHTO Problem Statement Number**

2018-C-09

**6. Research Assignment to Date**

NCHRP Project 15-67 Wind Drag Coefficients for Highway Signs and Support Structures.

**7. Review Dates**

February 2021

**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board**  
**The National Academies of Sciences, Engineering, and Medicine**

**Continuation Request**  
**NCHRP Project 20-50(20), FY 2017**

*LTPP Data Analysis: Develop Practical Tools and Procedures to Improve WIM Data Quality*

**Present Expiration Date:** 03/31/2021

**Recommended Allocation:** \$118,460

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**1. Anticipated Accomplishment(s) When Funds Allocated Have Been Expended**

This objective will be met by developing software tools—to be hosted by FHWA—to aid in improving WIM data quality through improved WIM site selection, WIM technology selection, WIM calibration, WIM data analysis, and quality control/quality assurance (QC/QA). In addition, a guide and training will be developed on how to apply these tools.

**2. Anticipated Accomplishment(s) When Funds Requested Have Been Expended**

The task of obtaining data for analysis took a significantly higher effort than was initially anticipated. The original approach was to work primarily with the data available through the LTPP database and other data provided by the states, if the data are available in a format compatible with the LTPP data. This approach did not include data processing. However, data assessment in Phase 1 of the project showed that many essential data elements were not collected at WIM site locations, as many of the sites with necessary WIM data were located away from LTPP pavement test sections. Per direction of the NCHRP Project Panel, the research team pursued additional data collection from the state agencies, resulting in the expanded effort. The data from the agencies were provided in a raw format and needed further data processing, analysis, and summarization. For example, raw per vehicle WIM records for multiple years were provided by Michigan, and the data were processed and analyzed to obtain axle load spectra used in the analysis and assessment model development for calibration drift assessment. Similarly, raw longitudinal profiles were provided by Indiana. Those profiles were analyzed to obtain IRI values for various pavement sections, before the data could be used in the analyses of the effect of IRI on WIM measurement error. This additional data collection effort and time were not considered during the original project scoping and budgeting. The additional time and budget will allow sufficient time to develop user friendly, 508 compliant software, guide, and training.

The research team and panel have identified the following modified tasks to complete the study.

Task 5 – provide additional funding to cover extended data collection, processing, summarization, and analysis that was necessary to develop analysis data sets.

Additional Funds Requested: \$27,484.58

Task 6 – provide additional funding to (1) develop computation spreadsheets as part of software URS, (2) provide Section 508 compliance for software tools and software manuals, and (3) to integrate WIM software tools with InfoPave software.

Additional Funds Requested: \$48,581.11

Task 8B – provide additional funding for web-based training on how to apply software tools developed in this project to improve quality of WIM data collection.

Additional Funds Requested: \$18,205.41

Task 8C – provide additional funding to cover additional interim technical reporting, status reporting, and additional panel meetings (to compensate for effort/funds spent on meetings and reporting between Dec 2019 and September 2020).

Additional Funds Requested: \$24,188.56

Total Additional Funds Requested: \$118,459.66

### 3. Funds (in thousands)

|                           | FY 2017      | FY 2021       |
|---------------------------|--------------|---------------|
| AASHTO Initial Allocation | \$350*       |               |
| Continuation Allocation   | -0-          |               |
| Less Obligation           | <u>\$350</u> |               |
| Balance (earmarked)       | -0-          |               |
| Reallocation              | -0-          |               |
| Total Available           | -0-          |               |
| Recommended Addition      |              | \$<br>118,460 |

### 4. Interpretation of AASHTO Problem Statement by Panel

Weigh-in-motion (WIM) systems are a vital means for collecting traffic data, critical input for pavement and bridge designs, used for making transportation and freight planning decisions and in highway safety investigations. There are, however, many potential sources of error in WIM measurements which make it difficult for traffic data collectors to evaluate accuracy and consistency of each source. FHWA's decade long collection of WIM data from the LTPP program will help to develop new data collection tools.

### 5. Original AASHTO Problem Statement Number

Problem No. 2018-A-1-5

### 6. Research Assignment to Date

October 1, 2018

### 7. Review Dates

12/5/2020

### 8. Project Description

This research aims to develop advanced tools and procedures to improve accuracy and increase the reliability of WIM data through more appropriate site selections; WIM system selection, installation, calibration, and maintenance; data analysis methods; and QC/QA processes. The research approach focused on development and delivery of practical tools and procedures to improve WIM data quality that are ready for immediate implementation. The tools will incorporate findings of the data analysis tasks and the best practices in WIM data quality management identified through literature review (project Tasks 1-5). The new tools should be easy to use, automated, and not require specialized skills in database management or spreadsheet programming from the users. In addition, users need to have clear guidance on how to apply these tools to improve WIM data quality through improved WIM site selection, technology selection, installation, calibration, maintenance, data analysis, and quality control/quality assurance (QC/QA). This informational information will be provided in a stand-alone guide titled *Practical Guide and Tools to Assure Quality of WIM Data Collection*.



**NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**  
**Transportation Research Board,**  
**The National Academies**

**Continuation Request**  
**Project 22-29B, FY 2018**

*Evaluating the Performance of Longitudinal Barriers on Curved,  
Superelevated Off-Ramps*

**Current Planned Completion Date:** January 29, 2021

**Recommended Addition Allocation:** \$75,000

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**1. Anticipated Accomplishment(s) When Current Project Allocation Has Been Expended**

NCHRP Project 22-29 was completed in 2016 and addressed a longstanding open question about the efficacy of barriers used on curved, superelevated roadway sections (CSRS). At the outset of the research, there had been virtually no in-depth analyses or crash testing of the impact performance of longitudinal barriers when installed on CSRS. Vehicles impacting barriers in these situations are likely to hit at angles different from the 25-degree angles considered in certification testing. Further, because of the effects of slopes of the road and shoulder in these situations, it was not known whether the vehicle-to-barrier interface was adequate. The project provided useful insights after extensive vehicle dynamics and FE crash simulation analyses of barrier effectiveness for the TL-3 crashworthiness standards. It was found that the effects of curvature and superelevation had an effect for passenger cars and light trucks. For large radius curves, the TL-3 barrier performance differences were not significant, but there was a greater likelihood of inadequate barrier interface as the radius of the curves decreased. Recommendations were developed for agencies to improve their barrier selection, placements, and maintenance practices to enhance safety based upon the findings.

Since the effort was unable to address the needs for shorter radius CSRS, it prompted the initiation of NCHRP Project 22-29B which was aimed at conducting similar analyses with a focus on highway ramps where shorter radii are common. The Phase 1 efforts under Project 22-29B found that there was, in fact, a greater likelihood that barriers would not contain errant vehicles because of greater variations in the impact angle and increase chances of poor vehicle to barrier interface. The project panel noted that there are ramp situations where adjoining (opposite direction) ramps might result in serious crashes where larger vehicle might override the barrier. Vehicle and dynamics analyses considered the common range of highway ramp curves to develop barrier guidance for these situations. It was noted that speed controls are often implemented to reduce the potentials for crashes on “tight” ramps, and that data showed a high propensity for vehicles exceeding the speed limits in these situations. The panel noted that the potential hazards of an override problem for larger vehicles (i.e., trucks) warranted research that considered the effectiveness of TL-4 (single-unit trucks) barriers. This research is beyond the original project scope and addressing it would not allow the

highest-level validation and analysis of the research and the planned crash testing to be undertaken.

## **2. Anticipated Efforts under the Requested Continuation Allocation**

The panel respectfully requests continuation funds to expand the analyses for shorter radius ramps for the TL-4 class of vehicles. Models of these vehicles are available to allow both vehicle dynamics analyses and FE crash simulations for the higher barriers. Added resources are needed to modify the barrier models to reflect TL-4 types and conduct the simulation of truck to barrier impacts. The analyses will consider typical TL-4 barriers across a range of ramp curvature, barrier placement, and road/shoulder slope. These analyses are likely to take longer to execute as more finite elements are involved. The analyses will incrementally look at possible impact conditions and barrier effectiveness. The computer analyses will provide critical insights that will help highway agencies to deploy effective barriers in the most appropriate positions for those situations. The efforts will identify potential problems and assess alternative barrier selection, placement, and maintenance guidance to alleviate problems. This guidance will be compatible with previous guidance and that which is expected from the current effort.

## **3. Funds (in thousands)**

|                           | <b>FY<br/>2011</b> | <b>FY<br/>2018</b> | <b>FY<br/>2022</b> |
|---------------------------|--------------------|--------------------|--------------------|
| AASHTO Initial Allocation | 600                |                    |                    |
| Continuation Allocation   | -0-                | 250                |                    |
| Less Obligation           | <u>600</u>         | <u>250</u>         |                    |
| Balance (earmarked)       | -0-                | -0-                |                    |
| Reallocation              | <u>-0-</u>         | <u>-0-</u>         |                    |
| Total Available           | -0-                | -0-                |                    |
| Recommended Addition      |                    |                    | 75                 |

## **4. Interpretation of AASHTO Problem Statement by Panel**

Longitudinal barriers are roadside safety devices commonly used to prevent errant vehicles from impacting hazards located alongside the traveled way. These barriers have been successfully designed in many different variations ranging from rigid concrete parapets to semi-rigid beam guardrail to relatively flexible wire rope barriers. Historically, the development and testing of longitudinal barriers has been done under the assumption that the barriers are installed in relatively straight sections parallel to the roadway. While the barriers designed under this assumption have performed well, their behavior when installed on curved roadways is largely unknown. However, despite this lack of understanding of their safety performance on curved roadways, longitudinal barriers are commonly installed on superelevated curves to protect errant motorists.

NCHRP Project 22-29, "Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections," and NCHRP Project 22-29A, "Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections," demonstrated that

the safety performance of a traffic barrier decreases as its curvature increases. The barriers with the sharpest curvature are found on off-ramps. Although spectacular accidents on off-ramps are occasionally reported in the media, there has been no study of barriers on off-ramps since the early 1980s. In that pioneering study, a series of full-scale tests was conducted of Jersey-shape barriers on a sharply curved off-ramp that also had superelevation and downgrade. While the test vehicles were all smoothly redirected in 40 mph impacts, the results indicated that the barriers were near their performance limits. Today, vehicles often travel at speeds substantially greater than 40 mph on off-ramps, and clear guidance is needed on selecting and designing traffic barriers for curved off-ramps. Based on these considerations, research is needed to quantify the performance of longitudinal barriers on curved, superelevated off-ramps and provide guidelines for their safe application.

## **5. Original AASHTO Problem Statement Number**

Problem No. 2011-G-29

## **6. Research Assignments to Date**

NCHRP Project 22-29, "Performance of Longitudinal Barriers on Curved, Superelevated Roadway Sections"

NCHRP Project 22-29A, "Evaluating the Performance of Longitudinal Barriers on Curved Superelevated Roadway Sections"

NCHRP Project 22-29B, "Evaluating the Performance of Longitudinal Barriers on Curved, Superelevated Off-Ramps"

## **7. Review Dates (for Project 22-29B only)**

September 27, 2018; April 11, 2019; July 2, 2020

# **Part II**

## NEW PROBLEMS

# FY 2022 CANDIDATES FOR FUNDING AS NEW PROBLEMS

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| 2022-A-03   | <b>(Withdrawal)</b> In Case the Big Bus Comes: Enabling Knowledge Management through Leadership Strategy and Culture<br>(\$400,000 - 24 months)       | AASHTO Committee on Knowledge Management                          | A-03/1 |
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| <b>Problem No.</b> | <b>Title</b>                                                                                                                                                                        | <b>Submitter</b>                                            | <b>Page</b> |
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| 2022-B-24          | Guidance to Planning Organizations on How to Update Travel Demand Models to Consider Connected and Automated Vehicles and Their Impacts<br>(\$400,000 - 18 months) | North Carolina                                         | B-24/1      |
| 2022-B-25          | Best Practices for Data Fusion of Probe and Point Detector Data<br>(\$200,000 - 18 months)                                                                         | Ohio                                                   | B-25/1      |



| <b>Problem No.</b> | <b>Title</b>                                                                                                                                    | <b>Submitter</b>                                             | <b>Page</b> |
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| 2022-B-26          | High-Impact/Low-Incidence Travel and Its Effects<br>(\$375,000 - 24 months)                                                                     | Ohio                                                         | B-26/1      |
| 2022-B-27          | Evaluating and Integrating Emerging Data Sources to Support Health-Promoting Transportation Planning and Operations<br>(\$450,000 - 30 months)  | Tennessee                                                    | B-27/1      |
| 2022-B-28          | A Best Practices Handbook for Overcoming Just-In-Time Delivery Challenges<br>(\$350,000 - 18 months)                                            | Texas                                                        | B-28/1      |
| 2022-B-29          | Communicating the Value, Interactions, and Impacts of Freight to Stakeholders<br>(\$350,000 - 24 months)                                        | Texas                                                        | B-29/1      |
| 2022-B-30          | COVID-19's Influence in Shaping E-commerce and Its Last-mile Impact<br>(\$500,000 - 24 months)                                                  | Texas                                                        | B-30/1      |
| 2022-B-31          | United States Army Corp of Engineers Section 404 Permit Decision Matrix<br>(\$650,000 - 24 months)                                              | AASHTO COE Committee on Environment and Sustainability       | B-31/1      |
| 2022-C-01          | Determination of Maximum Safe Gap in Permanent Concrete Barrier<br>(\$600,000 - 36 months)                                                      | AASHTO Committee on Design Tech Committee on Roadside Safety | C-01/1      |
| 2022-C-02          | Development of a Crashworthy Tangent End Treatment for Low Speed Curbed Roadways<br>(\$750,000 - 36 months)                                     | AASHTO Committee on Design Tech Committee on Roadside Safety | C-02/1      |
| 2022-C-03          | Development of Guidance for Enhanced Delineation of Barriers and other Roadside Safety Hardware, Slopes, and Hazards<br>(\$450,000 - 30 months) | AASHTO Committee on Design Tech Committee on Roadside Safety | C-03/1      |
| 2022-C-04          | MASH Hardware Evaluation with New Proposed Test Vehicles<br>\$1,000,000 - 36 months)                                                            | AASHTO Committee on Design Tech Committee on Roadside Safety | C-04/1      |

| <b>Problem No.</b> | <b>Title</b>                                                                                                                                                                                             | <b>Submitter</b>                                      | <b>Page</b> |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------|
| 2022-C-05          | Methods to Relate and Predict In-Service Performance of Pavements from Accelerated Pavement Testing (\$350,000 - 30 months)                                                                              | AASHTO COMP (Pavement)                                | C-05/1      |
| 2022-C-06          | Impact of Flooding and Inundation on the Performance of Pavements (\$650,000 - 24 months)                                                                                                                | AASHTO COMP (Pavement)                                | C-06/1      |
| 2022-C-07          | Develop, Fabricate, and Test Surrogate Bogey Vehicles and Pendulum Masses with Noses for Evaluating MASH Breakaway Performance of Luminaire Poles, Signs, and Work Zone Devices. (\$850,000 - 36 months) | AASHTO COBS Committee on Bridges and Structures       | C-07/1      |
| 2022-C-08          | Development of Prefabricated Concrete Barrier Systems for Accelerated Bridge Construction (\$1,000,000 - 24-36 months)                                                                                   | AASHTO COBS Committee on Bridges and Structures       | C-08/1      |
| 2022-C-09          | Estimating Inelastic Displacement Demands for Bridges under Seismic Forces (\$450,000 - 36 months)                                                                                                       | AASHTO COBS Committee on Bridges and Structures       | C-09/1      |
| 2022-C-10          | Evaluation of Load Rating and Posting of Long-Span Bridges (\$500,000 – 24 months)                                                                                                                       | AASHTO COBS Committee on Bridges and Structures       | C-10/1      |
| 2022-C-11          | Improved Demand Predictions on Shear Studs for Composite Steel Bridge Design (\$900,000 - 48 months)                                                                                                     | AASHTO COBS Committee on Bridges and Structures       | C-11/1      |
| 2022-C-12          | Guidance for Including Right-of-Way and Utilities in VE Studies (\$400,000 - 24 months)                                                                                                                  | AASHTO ROW, Utilities and Outdoor Advertising Control | C-12/1      |
| 2022-C-13          | Guideline for Depicting Existing and Proposed Utility Facilities in Design Plans (\$550,000 - 36 months)                                                                                                 | AASHTO ROW, Utilities and Outdoor Advertising Control | C-13/1      |
| 2022-C-14          | Advancing Multi-Sensor Weigh-in-Motion (WIM) for Improving Weight Data Accuracy and Reliability (\$450,000 - 30 months)                                                                                  | North Carolina                                        | C-14/1      |

| <b>Problem No.</b> | <b>Title</b>                                                                                                                                                                                                                           | <b>Submitter</b>                 | <b>Page</b> |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------|
| 2022-C-15          | Updated Design Guidance for Pull-Off Bays along Public Roadways (\$400,000 - 18 months)                                                                                                                                                | Pennsylvania                     | C-15/1      |
| 2022-C-16          | Analyze Effects of Connected and Automated Vehicles (CAVs) on Freeway Capacity and Operations (\$500,000 - 36 months)                                                                                                                  | Texas                            | C-16/1      |
| 2022-C-17          | Approach Slab participation in Seismic Resiliency of Multi-Span Continuous Bridges (\$250,000 - 24 months)                                                                                                                             | Washington                       | C-17/1      |
| 2022-C-18          | Calibration of Load and Resistance Factors for Segmentally Constructed Bridges (\$250,000 - 24 months)                                                                                                                                 | Washington                       | C-18/1      |
| 2022-C-19          | Developing of Fragility Curve for Multi-Span Precast Girder Concrete Bridges in Seismic Regions (\$250,000 - 24 months)                                                                                                                | Washington                       | C-19/1      |
| 2022-D-01          | Evaluation and Selection of 3D Model Viewers for Construction Inspection (\$300,000-\$400,000 - 15 months)                                                                                                                             | AASHTO Committee on Construction | D-01/1      |
| 2022-D-02          | Guidelines for Digital Technologies and Systems for Remote Construction Inspection for Highway Infrastructure Projects (\$400,000-\$500,000 - 18-24 months)                                                                            | AASHTO Committee on Construction | D-02/1      |
| 2022-D-03          | Considering Binder Availability of Recycled Asphalt Materials (\$750,000 – 36-54 months)                                                                                                                                               | AASHTO COMP                      | D-03/1      |
| 2022-D-04          | Leverage Long-Term Pavement Performance (LTPP) program Falling Weight Deflectometer (FWD) Data to Guide Effective use of Traffic Speed Deflection Measurements for Pavement Management and Design Applications (\$450,000 - 24 months) | AASHTO COMP                      | D-04/1      |
| 2022-D-05          | Recommended Minimum Qualifications for Transportation Project Quality Management Roles (\$250,000 - 18 months)                                                                                                                         | AASHTO COMP                      | D-05/1      |
| 2022-D-06          | Recommended Procedures for Verifying Material Quantities at Asphalt Mix Plants                                                                                                                                                         | AASHTO COMP                      | D-06/1      |

| Problem No. | Title                                                                                                                                                                                                                                          | Submitter                                               | Page   |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------|
|             | (\$400,000 - 24 months)                                                                                                                                                                                                                        |                                                         |        |
| 2022-D-07   | (Withdrawal) Reconnaissance Scanning of Underground Utilities in the Right-of-Way (\$600,000 – 24 months)                                                                                                                                      | AASHTO ROW Utilities and Outdoor Advertising Control    | D-07/1 |
| 2022-D-08   | Beneficial Reuse of Lightly Contaminated Material from Transportation Construction, Maintenance, and Operation Activities (\$200,000 - 36 months)                                                                                              | AASHTO SCOE Committee on Environment and Sustainability | D-08/1 |
| 2022-D-09   | Leveraging experiences in migration from manual to automated pavement condition assessment methods to realize the positive impacts of rapidly evolving pavement data collection technology on pavement decision-making (\$300,000 - 24 months) | Connecticut                                             | D-09/1 |
| 2022-D-10   | Roughness Index and Thresholds for Urban and Low-Speed Pavement Management (\$400,000 - 24 months)                                                                                                                                             | Illinois                                                | D-10/1 |
| 2022-D-11   | Design Review and 3D Model Quality Management for Model-based Design and Construction (\$450,000 - 24 months)                                                                                                                                  | Iowa                                                    | D-11/1 |
| 2022-D-12   | Developing Performance and Safety Specifications for Rejuvenating Seals (\$450,000 - 24 months)                                                                                                                                                | Rhodes Island                                           | D-12/1 |
| 2022-D-13   | A Methodology for Converting Condition State of Bridges to Condition Ratings (\$250,000 - 12 months)                                                                                                                                           | Virginia                                                | D-13/1 |
| 2022-D-14   | A New Methodology for Calculation of Bridge Health Index For Bridge Management System (\$250,000 - 12 months)                                                                                                                                  | Virginia                                                | D-14/1 |
| 2022-E-01   | Standardizing Rigid Inclusions for Transportation Projects Design Methodology, Evaluation of Installation Effects, Specifications, and Basis of Payment (\$600,000 - 36 months)                                                                | California                                              | E-01/1 |

| <b>Problem No.</b> | <b>Title</b>                                                                                                                                      | <b>Submitter</b>                | <b>Page</b> |
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| 2022-E-02          | Soil Structure Interaction Construction Dynamics of Transportation Earthworks and Structures<br>(\$300,000 - 12 to 18 months)                     | North Dakota                    | E-02/1      |
| 2022-F-01          | Tools and Technology for Roadside Landscape Asset Management<br>(\$350,000 - 24 months)                                                           | AASHTO Committee on Maintenance | F-01/1      |
| 2022-F-02          | Validating and communicating the long-term effects of aging Government Fleet Assets<br>(\$250,000 - 18 months)                                    | AASHTO Committee on Maintenance | F-02/1      |
| 2022-F-03          | Construction Guide Specifications for Pavement Treatments - Sand Seals and Ultra-thin Bonded Surface Treatments<br>(\$200,000 - 12 months)        | Rhodes Island                   | F-03/1      |
| 2022-G-01          | Criteria for Selecting an Appropriate Target Speed on Multi-Modal Urban and Suburban Roadways<br>(\$500,000 - 24 months)                          | AASHTO Committee on Safety      | G-01/1      |
| 2022-G-02          | Safe System in the U.S.: Developing a Roadmap for Transportation Road Designers, Planners, and Engineers<br>(\$550,000 - 24 months)               | AASHTO Committee on Safety      | G-02/1      |
| 2022-G-03          | Safety Performance for Active Transportation Modes using Exposure Models<br>(\$700,000 - 36 months)                                               | AASHTO Committee on Safety      | G-03/1      |
| 2022-G-04          | Using Big Data and Artificial Intelligence to Streamline Safety Data Analyses<br>(\$650,000 - 24 months)                                          | AASHTO Committee on Safety      | G-04/1      |
| 2022-G-05          | Developing Multidisciplinary Safety Strategies from Understanding Roadway Fatality Trends during the New Millennium<br>(\$500,000 – 18-30 months) | AASHTO Committee on Safety      | G-05/1      |
| 2022-G-06          | Improving Bicyclist and Pedestrian Safety Using Perceived Risk and Surrogate Safety Measures<br>(\$500,000 - 24 months)                           | AASHTO Committee on Safety      | G-06/1      |
| 2022-G-07          | Enhancement of Roadside Design Features Safety Performance Models for the Highway Safety Manual<br>(\$500,000 - 30 months)                        | AASHTO Committee on Safety      | G-07/1      |

| <b>Problem No.</b> | <b>Title</b>                                                                                                                                             | <b>Submitter</b>                                             | <b>Page</b> |
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| 2022-G-08          | Cloud Computing and Software as a Service Solutions for Traffic Management Systems<br>(\$350,000 - 12 months)                                            | AASHTO Committee on Transp. System and Operations            | G-08/1      |
| 2022-G-09          | ITS & Traffic Sensor Evaluation Methodology and Testing Program<br>(\$400,000 - 30 months)                                                               | AASHTO Committee on Transp. System and Operations            | G-09/1      |
| 2022-G-10          | MASH Crashworthiness of Luminaire Poles<br>(\$600,000 - 36 months)                                                                                       | AASHTO committee on Design Tech Committee on Roadside Safety | G-10/1      |
| 2022-G-11          | Evaluating the Impacts of Real-Time Warnings and Variable Speed Limits on Safety and Travel Reliability during Weather Events<br>(\$400,000 - 24 months) | AASHTO CTSO                                                  | G-11/1      |
| 2022-G-12          | Driver Distraction in an Era of Rapid Technological Change in Advertising Sign Lighting<br>(\$600,000 - 24 months)                                       | AASHTO ROW, Utilities Outdoor Advertising Control            | G-12/1      |
| 2022-G-13          | Assessment of Technologies for Measuring Work Zone Intrusion Frequency and Characteristics<br>(\$500,000 - 24 months)                                    | AASHTO SCOTE (Traffic Engineering)                           | G-13/1      |
| 2022-G-14          | Exit Advisory Speed Warning Sign Standards for Freeways and Major Highways<br>(\$200,000 - 18 months)                                                    | AASHTO SCOTE (Traffic Engineering)                           | G-14/1      |
| 2022-G-15          | Warrants for a Pedestrian Traffic Control Signal and for Other Pedestrian Traffic Control Devices<br>(\$750,000 - 24 months)                             | AASHTO SCOTE (Traffic Engineering)                           | G-15/1      |
| 2022-G-16          | Motorist Behavior and Safety Impacts on Bicyclists from Centerline and Shoulder Rumble Strips on High-Speed Two-Lane Highways<br>(\$400,000 - 24 months) | California                                                   | G-16/1      |
| 2022-G-17          | Improve Highway Safety by Developing Guidance and Standards for the Design of                                                                            | California                                                   | G-17/1      |



| <b>Problem No.</b> | <b>Title</b>                                                                                                                                                       | <b>Submitter</b> | <b>Page</b> |
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|                    | Left Turn Pocket Approach Tapers on Single and Multilane Highways<br>(\$500,000 - 18 months)                                                                       |                  |             |
| 2022-G-18          | Best Practices for Roundabout and Alternative Intersection/Interchange Lighting<br>(\$750,000 - 18 months)                                                         | Delaware         | G-18/1      |
| 2022-G-19          | Work Zone Intrusion Frequency and Characteristics<br>(\$600,000 - 24 months)                                                                                       | FHWA             | G-19/1      |
| 2022-G-20          | Identifying Operations Performance Measures and Targets<br>(\$275,000 - 18 months)                                                                                 | Florida          | G-20/1      |
| 2022-G-21          | Future-Proofing Automatic Traffic Signal Performance Measurement Systems for Scalability, Transferability, and CAV Integration<br>(\$500,000 - 24 months)          | Iowa             | G-21/1      |
| 2022-G-22          | Develop Crashworthy Hardware Mounted on Median Concrete Barrier to Prevent Unlawful Pedestrian Crossing Without Reducing Sight Distance<br>(\$600,000 - 36 months) | New Jersey       | G-22/1      |
| 2022-G-23          | Leveraging Existing Traffic Signal Assets to Obtain Quality Traffic Counts<br>(\$250,000 - 18 months)                                                              | North Carolina   | G-23/1      |
| 2022-G-24          | Integrating Safety into Development Reviews<br>(\$400,000 - 24 months)                                                                                             | North Carolina   | G-24/1      |
| 2022-G-25          | Simulating Mixed Heterogeneous Traffic Flows for Better Assessment of Heavy Vehicles<br>(\$650,000 - 36 months)                                                    | North Carolina   | G-25/1      |
| 2022-G-26          | Machine Vision Interface with Light Emitting Diode Traffic Control Device Displays<br>(\$400,000 - 24 months)                                                      | South Dakota     | G-26/1      |
| 2022-G-27          | Incorporating Demand, Capacity, and Operational Impacts of Incidents and Safety Treatments in the HCM Freeway Facilities Methodology<br>(\$400,000 - 36 months)    | Texas            | G-27/1      |

| <b>Problem No.</b> | <b>Title</b>                                                                                                                                                                                        | <b>Submitter</b>                            | <b>Page</b> |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-------------|
| 2022-G-28          | Identify Relationship Between Traffic Operational Performance and Safety Evaluation for Highway Facilities (\$600,000 - 36 months)                                                                  | Texas                                       | G-28/1      |
| 2022-G-29          | Develop Crash Modification Factors (CMFs) for Alternative Intersections, Including Displaced Left-Turn (DLT), Median U-Turn (MUT), and Restricted Crossing U-Turn (RCUT) (\$600,000 - 36 months)    | Texas                                       | G-29/1      |
| 2022-G-30          | Crash Modification Factors (CMFs) for Automated Traffic Signal Performance Measures (ATSPMs) (\$400,000 - 30 months)                                                                                | Utah                                        | G-30/1      |
| 2022-G-31          | Traffic Analysis Tools for Evaluating Traffic Systems Management and Operations (TSMO) of Work Zones for inclusion into the Transportations Systems Simulation Manual (TSSM) \$600,000 - 24 months) | Virginia                                    | G-31/1      |
| 2022-SP-01         | Best Management Practices to Address Encampments on State Highway Rights of Way (\$350,000-\$400,000 - 24 months)                                                                                   | AASHTO Committee on Maintenance, Washington | SP-01/1     |



# **Research Field A**

ADMINISTRATION

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022–A-01**

**Problem Title**

Increasing Competition on Projects Delivered by Alternative Methods by Defining and Assessing Contractual Risk Profiles

**Background**

In August of 2019, *Engineering News Record* reported that three large design-build contractors announced they would no longer pursue fixed price large projects delivered using design-build (DB) or public private partnerships (P3) because the risk/reward ratio was no longer favorable. This announcement was made even at a time when the infrastructure project market was growing as a result of a variety of factors. While the COVID-19 pandemic has put a near-term damper on the availability of public infrastructure funding, the impact of current public project risk profiles on competition remains a significant issue, and public transportation agencies still need the major industry players to build infrastructure projects. The number of firms that are financially capable of competing for billion-dollar plus contracts is relatively limited, and if “business-as-usual” procurement practices continue to perpetuate a lop-sided risk profile and/or if the market slowly but steadily attempts to transfer more and more risk to the private sector on a go-forward basis, the pool of available, qualified contractors will continue to shrink. Therefore, practical guidance is needed for public agencies to be able to assess their procurement models and appropriately allocate the risk profile for a given project with consideration of the perspective of potential bidders. Public agencies are being encouraged to re-evaluate the assigning of risk per the concept of “best-able to manage” the risk in the best interest of the taxpayers. In other words, if the small pool of contractors is assigning extreme contingency values to unbalanced risk/reward structures, this is not in the best interest of the taxpayers to transfer such risk levels

**Literature Search Summary**

The proposed research need is revolutionary, rather than the typical evolutionary NCHRP research project. To be successful, it must focus outside the public agency’s traditional risk management procedures and determine how various risks and the agency’s contractual remedies to manage and mitigate those risks are perceived by industry, as well as, how such risks are viewed in relation to each other and in combination. NCHRP Report 884: *Geotechnical Risk Management for Design-Build Projects* found that a significant difference in the perception of geotechnical risk existed between DOT personnel with DB experience and experienced design-builders in industry. The state engineers rated geotechnical risks far lower than their industry counterparts. The report also found that the difference resulted in large contingencies being added to DB projects to cover geotechnical risks. Separately, the same study found that regardless of the

contractual exculpatory language used in a DB project's RFP, the DOT rarely won a differing site conditions claim if it went to court. Thus, the agency paid for the risk twice: first in the increased lump sum price due to the inclusions of contingencies and second after the claim was lost. Additionally, the report found that if there were no differing site conditions encountered that the agency still paid the cost of the unrealized risk in increased proposed price. This is merely one example of the result of the risk profile portrayed in a lump sum DB project's solicitation. However, it serves to prove that the perception of project risk from the design-builder or P3 concessionaire's perspective does impact both project cost and potential competition.

The proposed research should address the following questions:

- What are the key risks that drive competition for projects?
- Which contractual risk management measures trigger industry contractors to not pursue projects for which they are well qualified?
- How can a given project's risk profile be quantified, communicated, and visualized?
- What is the difference between the agency and the industry perception of common risks found in projects?
- What techniques have been used to reduce the industry's perception of various risks? Which have been most effective and which have been less effective?
- What risk mitigation measures have proven most effective to ensure an incentivized private sector approach but do not place unbounded, unmanageable risks on the private partner?
- What risk-sharing mechanisms have been used for different risks to help protect both parties, but also to have the parties work together to manage such risks, and result in reasonable contingency pricing?

### **Research Objective**

The research objective is to develop a rigorous methodology based on empirical data for identifying, assessing, and measuring the perceived risk to industry in the solicitation for projects delivered using DB, DB-Finance, and P3. The goal would be a tool and accompanying guidance that would provide an agency the means to complete a structured risk analysis of the procurement and contractual framework embodied in the solicitation for a given project. Upon completion of the assessment, the tool would provide a menu of options for the agency's consideration to make changes in the solicitation that would make its resultant risk profile more attractive to industry and thereby enhance potential competition. It is thought that many of those options would be opportunities to share rather than shed specific risks, using techniques that have already been successfully applied on past projects. For example, NCHRP Report 884 has a list of 22 options for managing geotechnical risk on DB projects. The tool might go as far as to assist in identifying necessary changes to enabling legislation needed to create a more balanced risk profile.

The purpose of this project is to (1) investigate the different risk management arrangements used in the transportation industry, and link them to DOT project goals

and objectives, (2) examine the industry perception of those used by DOTs, as well as other countries in the delivery of transportation infrastructure; (3) document lessons learned; and (4) make implementation recommendations that will improve U.S. policy and practice. This project will produce an empirical guide based on effective practices regarding the selection of performance measures for P3 projects and provide guidance on selecting different P3 arrangements/structures given DOT goals and objectives, as well as effective practices for implementing performance measures.

Specific tasks of the research to accomplish the main objective include:

- Task 1 – Conduct a comprehensive literature review of studies related to project risk profiles, how they are linked to DOT project goals and objectives versus industry project goals and objectives.
- Task 2 – Benchmark the state-of-the-practice, across the various transportation agencies, related to developing the risk profile of projects delivered using alternative methods. Survey both DOT and major contractor industry practitioners to establish the baseline of risk perception for the major risks typically found on projects.
- Task 3 – Prepare a research work plan that describes the details of the research methodology and methods for identifying effective practices and developing conclusions.
- Task 4 – Conduct representative detailed case studies on current and completed projects to identify effective risk-sharing tools, explore agency/industry disconnects regarding risk perception, and document lessons learned.
- Task 5 - Execute the research work plan and prepare an interim research report that articulates the data collection and analysis, as well as emerging conclusions, effective practices, lessons learned; develop a proposed outline for the guidebook, the case study report and draft project risk profiling tool.
- Task 6 – Test the risk profiling tool in a minimum of three different DOTs with a range of alternative project delivery experience. Revise the tool as necessary
- Task 7 – Develop the guidebook to assist DOTs in implementing the project risk profile development and adjustment process, based on proven effective practices.
- Task 8 - Prepare a final research report detailing the complete results of the research.

### **Urgency, Potential Benefits, And Implementation**

Once the recession triggered by the pandemic has run its course, US infrastructure will be in worse shape than it was prior to the emergency as a result of lost revenues. Hence, state DOTs will need to maximize competition between their private sector partners to be able to complete the rapid renewal of infrastructure that stalled due to COVID-19. This research can be completed during the downturn and the product can be ready for implementation in time to assist in the jumpstart that will be required. Large projects delivered using DB and P3 are the most likely mechanism for delivering the required capacity in the least amount of time. Therefore, an agency whose solicitation risk profile is more attractive than that of neighboring state will be able to generate the required level of competition to attain project objectives. The payoff of this research will

be improved decision making for DOT on various project arrangements, as well as administration and control of these major projects, which ultimately will result in higher public satisfaction. Considering the enormous amounts of funding associated with these projects, the potential payoff just by reducing contingencies can be in the millions of dollars per project alone. If it is successful in increasing competition for these critical projects, the payoff nationwide will be enormous. The guidelines will become available to transportation agencies through the traditional NCHRP distribution processes.

### **Recommended Research Funding and Research Period**

The estimated project budget is \$500,000 and the period is 24 - 36 months

### **Problem Statement Authors**

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### **Others Supporting the Problem Statement**

AASHTO Committee on Construction  
AFH-15 Committee on Delivery Methods

### **Potential Panel Members**

Gary Angles, Ohio DOT, AASHTO COC, (614)-466-7057, gary.angles@dot.state.oh.us

### **Related Research**

FHWA *Public-private partnerships for highway infrastructure: Capitalizing on international experience*. International Technology Scanning Program.

NCHRP Report 884, *Guidelines for Managing Geotechnical Risk in Design-Build Projects*.

NCHRP Report 939, *Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods, Volume 1: Design-Build Delivery*.

NTC Report 2014-SU-R-18, *Quantifying and Benchmarking the Delivery Performance of U.S. Public-Private-Partnership (PPP) Transportation Projects*.

SHRP2 R09 *Managing Risk in Rapid Renewal Projects*

SHRP2 R10 *Project Management Strategies for Complex Projects*

### **Person Submitting the Problem Statement**

Casey Soneira, AASHTO (on behalf of the Committee on Construction), 202-624-5824, csoneira@aashto.org

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## **NCHRP Review of A-01**

Reviewed By:  
Christopher T. McKenney  
CMcKenney@nas.edu

Comments:

Projects delivered by alternative methods has become increasingly competitive today, especially with current technology, but this concept is not as viable as the competition that has already been developed and available for the industry. In addition, there has been research conducted on this topic, but not specifically looking at how COVID-19 has effected transit and freight. Estimating projects tend to use historical data, so conducting this research through empirical data would seem not to be conducive to this project. One software which comes to mind is R.S. Means, which has been on the market several decades. It uses collected verified data, and can be defaulted not to just a state, but also large Metroplexes in each state. Another variable that would have be monitored is how productivity rates are calculated and accuracy is ensured. From previous experience, job diaries do not always provide great detail when it comes to material, labor, and equipment. Finally, this tool seems to represent itself as a "One size fits all," which does not work as each state DOT has their own processes for estimating projects. The initial budget proposed in this problem statement (\$500,000) and the period of time is adequate.

Review Date:  
12/18/2020

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**FHWA Evaluation of A-01**

Reviewed By: HRDI-20/Matt Corrigan - HIF/Gerald Yakowenko

Comments: This is a timely and important subject to both the States and industry. ARTBA has a task force that has been addressing risk-related issues in P3s and design-build. At the virtual AASTHO Committee on Construction Meeting this past August, FHWA staff chaired a panel discussion with AASHTO, ARTBA and AGC members on risk issues. If approved as a project, it is imperative that a) ARTBA and AGC provide panel members, or b) the researchers should interview ARTBA/AGC members and incorporate their perspectives in the early stages of the research.

Review Date:  
12/18/2020

## **AASHTO Committee Evaluation for A-01**

Submitted By:

Casey Soneira  
AASHTO Staff  
Committee on Construction

Priority #: 3

Comments: Identifying and mitigating the risks that exist in projects that utilize alternative designs in order to make these projects more favorable in the eyes of private partners is a high priority in today's business climate. Understanding and mitigating these risks are an important part of a successful project delivery.

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Submitted By:

Patricia Bush  
AASHTO Staff  
Committee on Design

Priority #: N/A

Comments: The TC on Alternative Project Delivery would like to have a member on this panel.

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## **Submitter Response for 2022-A-01**

Thank you for the opportunity to respond to the comments. We agree with the comments made by FHWA and would definitely support industry panel members if the project is approved. However, it appears that the NCHRP reviewer misread the problem statement and appears to believe it is about developing an estimating tool for construction projects as evidenced by the remark regarding RS Means already providing a similar product.

The research is to quantify NOT the cost of a project but rather the cost of contractual risk associated with the general and special provisions included in the solicitation for a design-build or P3 procurement. The past NCHRP research cited in the RNS found that DOTs perceive that the actual risk is less than the industry teams that bid on these large projects. This results in award growth and a reduction in competition, especially in light of the cited ENR article. Current DOT risk management processes purely rely on the professional judgement of the DOT project team members to estimate the impact and probability of each identified risk in the risk register. These are educated guesses based on the DOT perception... not the bidding industry perceptions of the same risks. The proposed research seeks to reconcile the gap between the two perceptions in a manner that would allow DOTs to rationally determine which potential risks they will retain, share, or transfer. The current practice is to shed as much risk as possible, which cannot be done without the cost impact described in the RNS. If successful the risk

profiling tool will provide a structured approach to making those decisions along with quantifying the cost and time impact of each risk allocation decision. The project's vision is that such a contribution will serve to increase the level of competition for projects delivered using alternative delivery methods among the best, qualified teams in the industry.

If you have any questions, please feel free to contact me. I'm the chair of TRB Standing Committee on Project Delivery Methods, and we strongly support this RNS.



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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-02**

**Problem Title**

Data Governance Design and Implementation - Links Between Governance Approaches and Performance Effects in DOTs.

**Background**

Cross-functional data governance design and implementation optimized for different organizations is a recognized challenge for the transportation community. The TRB AED40 Committee on Geographic Information Science and Applications developed this problem statement to advance the application of Data Governance toward the goal of increasing the value of data as an enterprise asset while minimizing data related costs and risks associated with poorly governed data, or low quality data.

The experience with data governance approaches is varied among DOTs, and there is an ongoing need for greater understanding of the most effective approaches, and for process improvement as feasible. This study is proposed to examine existing best practices for data governance and conduct further qualitative and quantitative research on the complexity of DOT data ecosystems in this context, including existing governance approaches; data sources; data-related costs; data-related risks; data supply and value chains; technology platforms; performance metrics; and user demands.

The location, condition, and performance of transportation assets, facilities, and infrastructure are typically represented geospatially. In addition, the integration of heterogeneous data -- which is frequently required to support the variety of transportation applications, business functions, and analytical needs of a State DOT -- is often done geospatially. The data policies, standards, and procedures to facilitate these needs are an important element of Data Governance, and it is known that other TRB Committees (e.g. AED30 Information Systems and Technology, and AED10 Statewide Transportation Data and Information Systems) are stakeholders in this topic. This has also been a topic of discussion in many AASHTO GIS-T symposiums.

**Literature Search Summary**

Data governance has been a topic of interest for a long time. Various efforts have been carried out at various levels to explore different strategies with different outcomes. NCHRP Report 754 presents subject of Improving Management of Transportation Information<sup>1</sup>. It touches subjects of Open Data, Metadata Standards, Terminologies and Glossaries, and case studies from DOTs around the United States. Even though this is a

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<sup>1</sup> [https://www.camsys.com/sites/default/files/publications/nchrp\\_rpt\\_754\\_0.pdf](https://www.camsys.com/sites/default/files/publications/nchrp_rpt_754_0.pdf)

comprehensive study, it fails to provide a structured approach for DOT wide data governance of GIS and related data.

More recent case studies were presented in the FHWA's report on Data Governance and Data Management<sup>2</sup>. This report discovered that many of agencies surveyed did not have official data management or data governance policies. They also presented lessons learned and challenges in this report.

This primary summary found that topics for the literature search include: Data Governance; Information Governance; Data Management; Information Management; Data Ownership (and Stewardship); Data Quality; Metadata; Data Value (and Value Chains); Data Provisioning (and Supply Chains); Data Economy; Data Ecosystem; Data Standards; Data Policies; Etc.

### **Research Objective**

The objectives of this research are as follows:

- 1) Fill gaps in our understanding and application of different data governance approaches in state Departments of Transportation (DOTs).
- 2) Identify key areas of data governance with merit for longitudinal studies to gather data from DOTs on the performance effects of different approaches across time.
- 3) Optimize the design and implementation of data governance approaches for different organizational contexts.
- 4) Prepare an implementation document. This document will include an implementation plan with approaches developed in section 3.

### **Urgency and Potential Benefits**

Key trends driving the urgency of this research topic are: 1) The accelerating increase in the amount of data created/collected every year; and, 2) The growing variety of data from different sources, both internal and external to DOTs. These trends exacerbate the traditional challenges of data quality, access, security, and suitability for DOT requirements.

The benefits expected from this research will accrue from the advancement of the understanding and optimized application of Data Governance, resulting in the increased value of data as a strategic enterprise asset, while minimizing data related costs and risks associated with poorly governed data, or low quality data.

### **Implementation Considerations and Supporters**

Implementation will be an integral part of this research.

- State DOT Chief Data Officers or equivalent officer will be key persons researchers will contact to provide implementation guidelines.
- Researchers will prepare a detailed guideline document to provide precise definitions of terms and operating procedures keeping in mind diverse operational contexts in different state DOTs.

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<sup>2</sup> [https://www.gis.fhwa.dot.gov/reports/GIS\\_Data\\_Governance\\_and\\_Data\\_Management\\_Case\\_Studies.pdf](https://www.gis.fhwa.dot.gov/reports/GIS_Data_Governance_and_Data_Management_Case_Studies.pdf)

- AASHTO GIS-T symposium and ITE conference with TRB annual meeting will be effective information dissemination places.
- Researchers can also use FHWA webinars to provide these guidelines.
- AASHTO Committee on Data Management and Analytics will be supportive of this project.

### **Recommended Research Funding and Research Period**

Recommended Funding: \$350,000.

Recommended Research Period: The research effort is expected to take approximately 18 months.

### **Problem Statement Author(s)**

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### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Chad Baker
- 916-651-5720
- [chad.baker@dot.ca.gov](mailto:chad.baker@dot.ca.gov)
- Affiliation (limited to): AASHTO Committee on Data Management and Analytics

### **NCHRP Review of A-02**

#### Reviewed By:

Andrew C. Lemer  
[alemer@nas.edu](mailto:alemer@nas.edu)

#### Comments:

The subject area is relevant to all transportation agencies and suitable for at least a synthesis effort, but the scope and objectives do not seem clear to this reader. The problem title refers to links between data governance and performance (whether those of the agency's or the transportation system's for which the agency is responsible is not clear), but I found it difficult to understand how the research might illuminate those links or what may be the contributions of data governance approaches to improving performance. The text illustrates what I believe are pressing needs for clear and precise

explanation of what are (a) the value of data as an enterprise asset for a transportation agency, (b) the distinctions between objectives and practices of "management" and "governance" regarding the data transportation agencies use in pursuit of their missions, (c) the very different nature of risks related to use of poor quality (for example, untimely, erroneous, biased) data versus the security and protection of data held by the agency, and (d) how costs of data collection, purchase, and management may be justified.

Review Date:  
12/8/2020

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## **FHWA Evaluation of A-02**

Reviewed By: HPL/Clayton Clark, HEP/Mark Sarmiento, HIF/Nelson Hoffman, HRDI/Morgan Kessler

### Comments:

HPL, Clayton Clark - This is an area needing attention from both technical and efficiency standpoints. However, the budget of \$350,000 seems high at this stage. \$150k to \$200k should be sufficient.

HEP, Mark Sarmiento - Based on recent FHWA work, State DOTs have identified data governance as a key issue to be addressed in enabling them to efficiently manage transportation infrastructure and deliver transportation improvements. This is timely and needed work. The Problem Statement should be more specific on how the Research Objectives will be met. What activities will be done to meet Objectives 1 and 2; a literature review, surveys, interviews, peer exchanges? It would be useful to have case study reports or synthesis reports capturing that information, in addition to the guideline document and implementation document, to share with the transportation community. What would also be useful is a white paper, or similar, that expresses the importance of data governance, as expressed by the State DOTs in meeting Research Objective 1. This might be part of the implementation document, but it is not clear from the Problem Statement.

HIF, Nelson Hoffman - Data governance is an area that needs more attention. However, the research outline doesn't appear to clearly state what actionable/implementable product(s), training, guidance is will delivered. I'm not really sure what #5, 3. "Optimize the design and implementation of data governance approaches for different organizational contexts." means. Are they going to select notable practices, a combination of notable practices and fine tune them? Are they going to develop an example(s) based on the research? As stated, NCHRP 754, "fails to provide a structured approach for DOT wide data governance of GIS and related data." Will this research provide that structured approach? Assuming that's the overall goal?

HRDI, Morgan Kessler - This work sounds very similar to an in-progress FHWA effort titled "Identifying Data Frameworks and Governance for Establishing Future BIM for Infrastructure Standards". This work is presently in final draft format, and publication is expected mid-2021. If this present RNS were to move forward, I highly suggest that the authors compare the proposed outcomes to the FHWA project, and refine the RNS to address the needs and gaps resulting from the FHWA effort. Otherwise, there risks duplication of effort.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for A-02**

Submitted By:  
King Gee  
AASHTO Staff  
Knowledge Management

Priority #: 2

Comments: Data governance helps knowledge workers leverage performance feedback, and supports data driven decision making. These are critical elements for knowledge management. Understanding the current state of data governance will help identify opportunities for improvement. It would be beneficial to include the status of information and enterprise architectures into this study. A significant amount of information is available in literature, professional organizations and web resources available for data management and governance. Care should be taken to include the findings of the work already conducted on data governance - within the transportation sector and beyond. That said, a state DOT focused assessment and the development of a guide for developing data governance that builds on existing work could be very beneficial.

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## **Submitter Response for 2022-A-02**

**From:** [email: chad.baker@dot.ca.gov;joe.horton@dot.ca.gov]

### **Comments:**

In addition to the specific comments received and responded to below, we also conducted an additional literature review (attached).

#### **1. FHWA Evaluation of A-02**

Reviewed By: HPL/Clayton Clark, HEP/Mark Sarmiento, HIF/Nelson Hoffman, HRDI/Morgan Kessler

Comments:

HPL, Clayton Cark - This is an area needing attention from both technical and efficiency standpoints. However, the budget of \$350,000 seems high at this stage. \$150k to \$200k should be sufficient.

**Response:** *Budget depends on scope. The scope could be reduced, or split into separate research components, if required. We believe that the recommended \$350,000 budget is commensurate with other funded research projects of this nature.*

HEP, Mark Sarmiento - Based on recent FHWA work, State DOTs have identified data governance as a key issue to be addressed in enabling them to efficiently manage transportation infrastructure and deliver transportation improvements. This is timely and needed work. The Problem Statement should be more specific on how the Research Objectives will be met. What activities will be done to meet Objectives 1 and 2; a literature review, surveys, interviews, peer exchanges? It would be useful to have case study reports or synthesis reports capturing that information, in addition to the guideline document and implementation document, to share with the transportation community. What would also be useful is a white paper, or similar, that expresses the importance of data governance, as expressed by the State DOTs in meeting Research Objective 1. This might be part of the implementation document, but it is not clear from the Problem Statement.

**Response:** *Activities related to the 4 research objectives are added to each objective, below, in response to the comment.*

- 1) Fill gaps in our understanding and application of different data governance approaches in state Departments of Transportation (DOTs).
  - a. Literature search, review, and report on findings
  - b. Identify similar efforts (e.g. the FHWA effort titled "Identifying Data Frameworks and Governance for Establishing Future BIM for Infrastructure Standards") and seek congruence
  - c. Develop questionnaire and conduct a survey of State DOT Chief Information Officers (CIOs), Chief Data Officers (CDOs), and Geospatial Information Officers (GIOs) to help determine different approaches (e.g. enterprise-wide, departmental, functional) and mechanisms (e.g. Executive Council, Committees, Advisory Board) to Data Governance; analysis and report of survey results
  - d. Interviews with a subset of CIOs, CDOs, and GIOs to further assess different approaches to Data Governance; synthesis and report on interview findings
  - e. Identify before and after case studies of implementing data governance approaches, including obstacles and constraints along the way, and key-enablers
  - f. Categorize identified approaches into similar sets for further attention in the following objectives

- 2) Identify key areas of data governance with merit for longitudinal studies to gather data from DOTs on the performance effects of different approaches across time.
  - a. Based on the results from the activities related to the first objective, identify both qualitative (e.g. increased transparency and accountability) and quantitative outcomes (e.g. reduced number of redundant data sets and elimination of unnecessary ones); distinguish anecdotal benefits from measurable ones
  - b. Select a baseline of these outcomes to track and measure across time
  - c. Establish procedures for tracking and measuring these outcomes across time
  - d. Identify State DOTs willing to track and measure effects over time of their data governance approaches
- 3) Optimize the design and implementation of data governance approaches for different organizational contexts.
  - a. Based on the findings from the previous objectives, derive from each set of similar approaches the principles, organizational means for decision-making, level of effort and investment, and best practices that are representative of each set, respectively
  - b. Describe the obstacles and constraints faced by State DOTs that have implemented data governance, and key lessons-learned
  - c. Describe the type of organizational structure and culture where one approach to data governance may work better than another, and recommend the pairings for an adaptive approach
- 4) Prepare an implementation document. This document will include an implementation plan with approaches developed in section 3.
  - a. Organized by each of the sets that will be initially identified in Objective1, the implementation document will include guidance and a structured approach for implementing each, accordingly
  - b. This guidance will include sample governance goals, principles, decision-making structures, alignment processes, communication and coordination methods
  - c. It will also include recommended phasing, staffing, timelines, level of effort estimates, and budgetary estimates
  - d. It will also include a whitepaper on the benefits of data governance to help promote the importance and effectiveness of implementing it as part of a DOT enterprise strategy to help achieve performance goals for data as an enterprise asset

HIF, Nelson Hoffman - Data governance is an area that needs more attention. However, the research outline doesn't appear to clearly state what actionable/implementable product(s), training, guidance is will delivered. I'm not really sure what #5, 3. "Optimize the design and implementation of data governance approaches for different organizational contexts." means. Are they going to select notable practices, a combination of notable practices and fine tune them? Are they going to develop an example(s) based on the research? As stated, NCHRP 754, "fails to provide a structured approach for DOT wide data governance of GIS and related data." Will this research provide that structured approach? Assuming that's the overall goal?

**Response:** *Addressed in the response to the comment above.*

HRDI, Morgan Kessler - This work sounds very similar to an in-progress FHWA effort titled "Identifying Data Frameworks and Governance for Establishing Future BIM for Infrastructure Standards". This work is presently in final draft format, and publication is expected mid-2021. If this present RNS were to move forward, I highly suggest that the authors compare the proposed outcomes to the FHWA project, and refine the RNS to address the needs and gaps resulting from the FHWA effort. Otherwise, there risks duplication of effort.

**Response:** *Agreed – see response to Mark Sarmiento's comment.*

## **2. NCHRP Review of A-02**

### Reviewed By:

Andrew C. Lemer  
alemer@nas.edu

### Comments:

The subject area is relevant to all transportation agencies and suitable for at least a synthesis effort, but the scope and objectives do not seem clear to this reader. The problem title refers to links between data governance and performance (whether those of the agency's or the transportation system's for which the agency is responsible is not clear), but I found it difficult to understand how the research might illuminate those links or what may be the contributions of data governance approaches to improving performance. The text illustrates what I believe are pressing needs for clear and precise explanation of what are (a) the value of data as an enterprise asset for a transportation agency, (b) the distinctions between objectives and practices of "management" and "governance" regarding the data transportation agencies use in pursuit of their missions, (c) the very different nature of risks related to use of poor quality (for example, untimely, erroneous, biased) data versus the security and protection of data held by the agency, and (d) how costs of data collection, purchase, and management may justified.

**Response:** *The research will examine the linkage between data governance and State DOT organizational goals for positive performance effects on data collection, storage, management, sharing, and desired efficiencies and effectiveness for these things. Indirectly these things support the State DOTs mission requirements and*



*responsibilities for the transportation system's performance, but the research is not specifically intended to address the transportation system's performance.*

**Contact Info:**

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T: 916-651-5720, C: 916-247-1625

Review Date:

February 5, 2021

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**WITHDRAWAL**

(This problem statement has been withdrawn by the submitter.)

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: (2022–A-03) Withdrawal: This project was funded under NCHRP 20-24, “Administration of Highway and Transportation Agencies”**

**Problem Title**

In Case the Big Bus Comes: Enabling Knowledge Management through Leadership Strategy and Culture

**Background**

What is the problem, and whom does it affect? As workforce turnover has increased and the COVID-19 pandemic has accelerated remote work, the need for knowledge management (KM) has increased. Many state DOTs are striving to establish KM practices but with limited success. Organizations that have succeeded in establishing a sustainable enterprise-wide KM practice have one common factor – they have put in place an intentional KM strategy that aligns their knowledge strategies with business strategies, and their knowledge cultures with business cultures. In each case, active leadership support has been a critical success factor.

Achieving a sustainable KM practice is challenging in a transportation organization for several reasons.

- KM is still new within many transportation agencies so employees are unfamiliar with the concept and associated practices.
- Transportation business strategies are dynamic and are influenced by many factors including geographical locations, populations, structure, modes of transportation, technical disciplines (e.g., engineering, planning ...), administrative structures, and the financial environment.
- Transportation cultures are complex. A single DOT will have an engineering culture, administrative culture, a business culture, a research culture, an operations culture, a political culture, etc. One or more of these cultures may be dominant at a given level (e.g., organization level, team or unit level, or individual).

Culture and strategy are co-dependent. Culture exerts powerful influences on the behavior of units, teams, and individuals and, therefore, a major impact on its ability to carry out objectives. When a team or an organization’s culture is not well aligned with its strategy, activities fail to be sustained. In other words, as coined from Peter Drucker’s work “Culture eats strategy for breakfast”.

In addition, it is critical in the knowledge economy that there is a good fit between the knowledge strategy and the knowledge culture. For example, a strategy to employ smart technologies will fail if it exists in an organization dominated by an industrial-era culture.

This project targets the alignment of KM strategies and cultures with business strategies and cultures and is specifically intended to help the KM leads in state DOTs and, through them, the business units they work with. However, it is anticipated that the outcome of this research will have value for any business area seeking to introduce new practices.

How will the research solve the problem? This research will help agencies identify the unique business strategies and cultures within their organization and provide guidance on how to use this information to: 1) gain leadership buy-in for KM; and, 2) develop a KM strategy and culture that aligns with the business strategy and culture. Increasing recognition of cultural attributes will help improve the success of organizational change and transformation initiatives.

How is this problem statement related to the strategic plan or research agenda of an AASHTO Committee(s) and/or Council(s)? This research will provide information to support the AASHTO Committee on Knowledge Management's Strategic Plan:

- Goal 2: KM Leadership – Create expectations for DOTs to build KM capabilities
- Goal 5: Information Management – Align information management practices with the needs of knowledge workers and organizational objectives.

### **Literature Search Summary**

There are two relevant bodies of research and literature on this topic. The first is found in the business and management literature and identifies several references on strategy, culture, leading culture change, organizational effectiveness, and performance in business and organizational sources. The second is generated by the transportation research community and addresses efforts to develop cultures that support cycling, safety, innovation, and other objectives.

While both of these resources offer strong guidance and advice, there is a more limited body of work around knowledge cultures and strategies and focus on relating information culture to information policies and management strategies.

This research is intended to build off this body of knowledge by identifying key points for success and developing actionable strategies that DOTs can use to assess their own strategies and culture and promote alignment.

### **Research Objective**

The objective of this research project is to enable knowledge management professionals to:

- Identify and profile the business strategies that their knowledge management strategies should support
- Identify a method guiding how to assess agency culture relative to knowledge and knowledge management

- Identify methods for creating a resilient and relevant knowledge management strategy that supports business
- Analyze and profile the cultural environment for the purpose of aligning and adapting their knowledge management strategy to support and be supported by leadership
- Design effective culture-based arguments for leadership to adopt that will sustain knowledge management strategies
- Outline success criteria for an agency KM strategy

### Tasks

1. Conduct a literature review on culture change, the alignment of culture and strategy, cultural assessment, and knowledge management culture and strategy. This review should include literature generated within the transportation community and beyond.
2. Characterize and assess the role that leadership, strategy and culture have played in successful knowledge management projects, programs and initiatives (transportation and non-transportation).
3. Develop a framework for understanding and characterizing levels and types of culture in place and at play in an organization. The framework should help an organization to identify which factors and levels of culture are dominant at any point in time. The framework is essential to helping an agency “see” their organizational culture, and also see what factors will help them align those cultures to support KM strategies.
4. Develop a set of current awareness and training materials on organizational culture analysis and KM strategy alignment.
5. Select a set of representative state agencies and conduct interviews with a set of business units representing different kinds of cultures and strategies, and conduct “desk exercises” at various position levels (e.g., from front line workers, management, and executives).
6. Propose a framework and methodology that can be used and adapted by any agency to manage their challenges.
7. Identify organizations that have a KM strategy and how it interfaces with their business strategies and cultures and best leadership buy-in approaches.
8. Prepare a guidebook that walks the reader through the framework and methodology.

Research products are anticipated to include a report on the methodology used, a guidance document that is useable by knowledge management leads, and outreach materials about the results.

### **Urgency and Potential Benefits**

Today’s transportation agencies are challenged to deliver projects and services to address a complex and evolving set of needs within a dynamic economic, technological and socio-political environment. Information is available on the

mechanics of KM implementation but in-depth guidance on how to align KM with organizational culture is lacking. This research would provide transportation agencies with the tools they need to develop effective and sustainable KM programs – and help KM practitioners to avoid pitfalls and make best use of available resources. Without an understanding of these important aspects, investments in KM implementation may not produce the expected results.

While this project focuses on KM, its products would be more widely applicable given that culture, strategy and leadership alignment affect every aspect of an organization's success and performance. Transportation agency leaders understand that culture is a major factor behind the success of any change initiative, but lack practical tools for understanding and assessing transportation agency culture – and then acting on the results to maximize organizational success. This research would help to fill this gap.

### **Implementation Considerations and Supporters**

- Likely users of the research results: transportation agency leaders and managers responsible for knowledge management, innovation, and workforce development.
- How will state DOTs implement this? It is anticipated that the guidebook would be used as a resource for developing and implementing knowledge management and organizational development strategies and initiatives. Users would follow a step by step process outlined in the guidebook to understand their organizational culture, identify factors that inhibit successful KM implementation, and develop a plan for aligning culture and organizational improvement strategies.
- What venues can be used to support implementation? At a minimum, the product of the research will be shared through relevant AASHTO committees including: Knowledge Management, Human Resources, and Agency Administration. In addition, the product will be shared through activities conducted by the TRB Standing Committee on Information and Knowledge Management, Workforce Development and Organizational Excellence, Strategic Management, and Research Innovation Implementation Management. These committees will be asked to help promote awareness and use of the guide.
- What products and activities will help create awareness and facilitate implementation? This request includes development of a guidebook and supporting awareness and training materials. Once these research products are available, they can be publicized through webinars, conference presentations, and briefings to interested AASHTO and TRB committees. Links to the research products can be added to the National Transportation Library LibGuide, and the AASHTO Committee on Knowledge Management and the TRB Information and Knowledge Management Committee's websites. A brochure can be developed to support dissemination activities.
- Organizations that may have interest and help implementation:
  - AASHTO Committee on Knowledge Management
  - AASHTO Committee on Agency Administration
    - AASHTO Committee on Human Resources

- TRB Standing Committee on Information and Knowledge Management (AJE45)
- TRB Standing Committee on Workforce Development and Organizational Excellence (AJE15)
- TRB Standing Committee on Strategic Management (AJE10)
- TRB Standing Committee on Data for Decision Making (AJE70)
- AED10 Standing Committee on Statewide/National Transportation Data and Information Systems

### **Recommended Research Funding and Research Period**

Research Funding: \$400,000

Research Activities: \$350,000

Outreach Activities: \$ 50,000

Research Period:

Research Activities: 18 months

Outreach Activities: 6 months

### **Problem Statement Author(s)**

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- Benjamin Anyacho, MBA, PMP, Knowledge Management Program Lead, Texas DOT, (512)463-0253 (Desk), (512)739-8549 (Cell), Benjamin.anyacho@txdot.gov

### **Others Supporting the Problem Statement**

- AASHTO Committee on Agency Administration (Amanda Holland)
- AASHTO Committee on Human Resources (Lee Wilkinson)
- TRB Standing Committee on Information and Knowledge Management (Frances Harrison) (AJE45)
- TRB Standing Committee on Workforce Development and Organizational Excellence (Victoria Beale) (AJE15)
- TRB Standing Committee on Data for Decisions (Joe Schofer) (AEJ70)
- TRB Standing Committee on Statewide/National Transportation Data and Information Systems (AED10)

### **Potential Panel Members**

- AASHTO Committee on Knowledge Management Representatives:
- Benjamin Anyacho, MBA, PMP, Knowledge Management Program Lead, Texas DOT, (512)463-0253 (Desk), (512)739-8549 (Cell), Benjamin.anyacho@txdot.gov
- Michael Pipp, Chief Data Governance & Knowledge Management Officer, Montana Dept. of Transportation, 406-444-6060 | [mipipp@mt.gov](mailto:mipipp@mt.gov)
- Aaron D. Johnson, P.E., Region Engineer, Michigan DOT – Superior Region, Johnsona25@michigan.gov, 906/786-1800, C 906/250-5442

- Brigitte Kornbroke, Organizational Development Office, Manager,  
brigitte.kornbroke@dot.state.fl.us, (850) 414.4067

**Person Submitting the Problem Statement**

Leni Oman, 360-705-7974, OmanL@wsdot.wa.gov, Washington State DOT and  
Vice Chair, AASHTO Committee on Knowledge Management

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-04**

**Problem Title**

Develop Methods to Allow Agencies to Incorporate Quantitative Risk Assessment at Project and Network Level

**Background**

Managing risk is a critical component of asset management. On a day-to-day basis transportation asset managers spend much of their time responding to or mitigating a large number of risks, which may range from external events that damage transportation infrastructure to unplanned changes to budget or workloads resulting from unexpected events. Various recent and on-going research efforts aim to improve approaches for risk management for transportation agencies. However, most of these efforts treat risk management as a high-level activity. Further research is needed to develop quantitative, repeatable approaches at the appropriate staff level, to assessing and identifying the highest priority risks transportation agencies face in managing physical assets. This project aims to develop such approaches to assess risks (e.g., financial, strategic, operational, political, environmental, technological, social justice risks) and incorporate them into life cycle analysis and planning efforts.

**Literature Search Summary**

Risk management has been studied quite extensively in the transportation sector. Risk management encompasses four major steps: Risk identification, risk assessment, risk mitigation, and continuous updating of results. Risk assessment focuses on determining the magnitude of risk, which is directly proportional to the likelihood and consequences of an event to occur. Risk assessment has been a major area of study in pavement and bridge management efforts. In recent decades, the focus has shifted from assessing risk in single networks towards more holistic risk assessment approaches.

Between 2012 and 2013, Federal Highway Administration (FHWA) published a five-part report series on Risk Based Asset Management. These reports focus on: (1) Overview of risk management, (2) Managing risk at different levels, (3) Strategic risk management (risks to agency objectives), (4) Managing risk to critical assets, and (5) Managing external threats such as climate change and extreme weather risks. These reports played an important role in introducing risk management concepts into asset management efforts. In 2016, American Association of State Highway and Transportation Officials (AASHTO) published the Guide for Enterprise Risk Management. In this Guide, risk management is defined as *“the systematic application of policies, procedures, and practices to the identification and management of uncertainty or variability on achievement of agency objectives.”* In addition, the Guide introduces four levels at which



risks need to be managed: Strategic, Program, Project, and Activity levels. Enterprise Risk Management is defined as management of risks at all levels. Other research projects (recently completed, active, or pending) in this area include:

- NCHRP 08-113: Integrating Effective Transportation Performance, Risk, and Asset Management Practices
- NCHRP 08-118: Risk Assessment Techniques for Transportation Asset Management
- NCHRP 20-44(02): Implementation of the AASHTO Guide for Enterprise Risk Management
- NCHRP 20-123(04): Development of a Risk Management Strategic Plan and a Research Roadmap
- NCHRP 08-129: Incorporating Resilience Concepts and Strategies in Transportation Planning
- NCHRP 23-09: Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis.

Managing risk at program (or network) and project levels is particularly important to achieve desired performance levels and to improve resilience of a transportation system. While existing research efforts in this area are highly significant, there is a need for developing more practical and repeatable risk assessment calculation methods for project and network level risks. *This proposed study will build on these recent efforts, particularly NCHRP 23-09, and serve as the next phase in risk assessment and management.*

### **Research Objective**

The objectives of this research are to:

- Generate risk identification techniques to determine high risk threats at project and network levels,
- Develop quantitative, repeatable approaches for assessing likelihood and consequences for these threats,
- Develop visual, interactive characterization methods (e.g., dashboards) to reflect an agency's level of risk and the effectiveness of proposed mitigation actions,
- Allow risk and resilience to be on par with traditional performance measures.

High risk threats to be studied include, but are not limited to, extreme events (e.g., earthquakes, fires, hurricanes, avalanches, tornadoes), asset failure (structural and operational), financial, strategic, political, environmental (e.g., sea level rise, flooding), technological, and social justice risks.

The final deliverables could include guidebook with a spreadsheet or a framework for assessing high risk threats and incorporating the results into TAM efforts. The guidebook should feature a comprehensive review of existing literature and current practice. It should present a standard definition of resilience as well as step-by-step instructions to develop models, methods, and metrics for estimating resilience of highway systems to high risk threats. Pilot studies should be conducted with select agencies to test the guidance and calculation procedures.

## **Urgency and Potential Benefits**

While existing reporting mechanisms allow agencies to see the parts of their network that are in good and poor condition, risks associated with different threats and the impact of failure are not reported as an explicit performance measure. Competing design documents, financial implications, legal concerns, maintenance practices, focus on building new capacity rather than managing existing infrastructure, and other factors that affect decision making procedures may counter-act risk-based TAM practices. Issues related to social justice and equity, and consequences of failures make risk-based TAM even more important. Creating harmony in the TAM decision making space in consideration of risk and resilience represents an urgent need. A practical, quantitative, and repeatable risk assessment process could play a major role in addressing this need.

## **Implementation Considerations and Supporters**

The target audience for the research results is asset management and risk-management champions at state and local government transportation agencies. The results of this project will potentially empower these individuals in convincing other decision makers in these agencies to take actions that not only align with traditional performance management objectives but also that result in lower risk and higher resilience for the whole transportation system. The results of this project can also be effective in communicating the rationale behind risk-based decisions to the general public. Due to legal implications of identifying and documenting risks, the research and final product should include advice on how to protect the agency from litigation if they cannot implement a recommended action.

Risk assessment is at the core of implementing a risk-based asset management approach. Therefore, FHWA and AASHTO view this as a subject of great importance. In addition, risk management cuts across all areas of a state DOT's business and just about any AASHTO Committee and any state DOT and local agency could realize benefits from these research results.

## **Recommended Research Funding and Research Period**

Recommended funding: \$500,000.

Recommended research period: 12 to 18 months.

## **Problem Statement Author(s)**

The following individuals contributed to development of this problem statement:

- Baris Salman, Syracuse University, (315) 443-1452, bsalman@syr.edu
- Jean Wallace, Minnesota Department of Transportation, (651) 366-3181, jean.wallace@state.mn.us
- Nathan Lee, Utah Department of Transportation, (801) 965-4082, nlee@utah.gov
- Emily Burns, City of Seattle, (206) 733-9972, emily.burns@seattle.gov

## **Others Supporting the Problem Statement**

List organizations, including AASHTO Committees or Councils, which support this problem statement, and provide contact information.

- AASHTO Committee on Performance-based Management, Tim Henkel, Chair
- AASHTO Subcommittee on Risk Management, Jean Wallace, Chair
- AASHTO Subcommittee on Asset Management, Matt Haubrich, Chair
- AASHTO Subcommittee on Organizational Management, Charlie Purcell, Chair

### **Potential Panel Members**

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-based Management and the Subcommittee on Risk Management. Below are those indicating their desire to serve:

- Jean Wallace, Minnesota Department of Transportation, Chair, AASHTO Subcommittee on Risk Management, 651-366-3181, Jean.Wallace@state.mn.us
- Nathan Lee, Utah Department of Transportation, Vice Chair, AASHTO Subcommittee on Risk Management, (801) 965-4082, nlee@utah.gov
- Mónica Alemán-Smoot, MPA, JD, Texas Department of Transportation, (512) 305-9506, Monica.AlemanSmoot@txdot.gov.

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Matthew Hardy
- 202-624-3625
- mhardy@ashto.org
- Affiliation:  
AASHTO staff on behalf of the AASHTO Committee on Performance-based Management, Tim Henkel, Chair.

### **NCHRP Review of A-04**

#### Reviewed By:

Andrew C. Lemer  
alemer@nas.edu

#### Comments:

The problem statement seems to represent a useful, albeit incremental, extension of risk assessment and management practices to a new level of specificity--project and network level--addressing concerns of all transportation agencies. Guidance for how project development and network operations can more effectively be used to reduce the risks to access and mobility, public safety, and stewardship of public investment would certainly be helpful to agency personnel and contractors. The issues of somehow combining risk assessment and management assessment across multiple projects or sub-networks to reflect an agency's overall risk may be too broad and complex for this project to address.

Review Date:  
12/8/2020

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#### **AASHTO Committee Evaluation for A-04**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Design

Priority #: N/A

Comments: The TC on Project Management would like to have a member on this panel.

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Submitted By:  
King Gee  
AASHTO Staff  
Knowledge Management

Priority #: 5

Comments: This project will help model the how risk assessments translate into action (knowledge flow and use). The project should include examine the information that is useful to for recipients expected to integrate risk assessments and findings into their work and the activities that support development of this information. We also recommend adding an objective on data and information access (push and pull) and role descriptions to help enable use of the work.

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#### **Submitter Response for 2022-A-04**

**From:** [email: mhardy@ashto.org]

#### **Comments:**

Thank you, NCHRP, for the supportive comments. In response to the concern "the issues of somehow combining risk assessment and management assessment across multiple projects or sub-networks to reflect an agency's overall risk may be too broad and complex for this project to address", we agree that agencies holistically view this as a broad and complex issue, which drives the need for research. This research is intended to provide much needed focus and approach.

**Contact Info:**

Matt Hardy on behalf of the Committee on Performance-Based Management

Review Date:

1/29/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022 –A-05**

**Problem Title: Interstate Information Sharing of State Truck Regulatory Requirements**

**Background**

The goal of trucking industry is to move goods safely, quickly, and profitably. From 2012 to 2018, freight movement on trucks increased 11%, or nearly 2% per year according to the USDOT Bureau of Transportation Statistics (BTS). BTS reported that two-thirds of all US freight was moved by truck in 2018. BTS predicts a 21% increase in truck tonnage between 2018 and 2045, driven by the world economy and consumption within the United States. In 2045, trucks are expected to still haul two-thirds of all freight.

Regulatory functions like safety inspections are important to take unsafe vehicles off the road and to verify compliant companies' safety record. State agencies, who are expected to handle increases in trucking without corresponding increases in staff, have used technology—such as electronic screening, tire anomaly checking, thermal brake inspection, over-dimension detection, and automated permitting systems—to keep pace. State agencies share truck size and weight and safety inspection information within their own boundaries and report to the Federal Motor Carrier Safety Administration, but rarely share directly with neighboring states.

Sharing information with neighboring states could reduce the cost and workload for size, weight, and safety enforcement. If each state could bypass trucks that have satisfied the mutual requirements of both states, recently processed trucks would not have to be detained again. Arizona and Utah already share information at Utah's I-15 St. George facility, located just 70 miles upstream from a planned Nevada site. A data-sharing arrangement with Utah could save Nevada the cost of the I-15 site they have planned. Conversely, Nevada could save Utah costs on northbound I-15 traffic. The value to the states would be much greater than data sharing through federal databases because the shared information would have immediate operational value.

Sharing real-time data requires an information architecture, data standards, and enabling technology. For example, the information system technology that supports the International Registration Plan (IRP) is AAMVAnet, developed by the American Association of Motor Vehicle Administrators (AAMVA).

Institutional arrangements are also necessary. One potential mechanism is the interstate compact. An interstate compact is an agreement established by legislatures of 2 or more states to enable states to act jointly outside the constraints of the federal

government. Interstate compacts were used before the establishment of the federal government and are referenced in Article 1, Section 10 of the US Constitution. The Council of State Governments describes interstate compacts as "the most powerful, durable, and adaptive tools for ensuring cooperative action among the states." Each state is already a member of on average 25 compacts. Four compacts related to trucking—the International Registration Plan (IRP), the International Fuel Tax Agreement (IFTA), the Driver License Compact, and the Vehicle Title Compact—have operated for more than 35 years. IRP and IFTA include 49 States and the 10 Canadian provinces.

The need, benefits, technology, and institutional arrangements related to sharing interstate data using standard messages need to be studied nationally. Full regulatory harmonization will never be found using the state by state approach, with statutes that vary from state to state. The entry point to harmonizing starts with data sharing between states. After data sharing is proven on regulatory processes, multi-state permits and other harmonization could be added.

### **Literature Search Summary**

The American Association of State Highway Transportation Officials (AASHTO) and the four regional bodies of NASTO, MAASTO, SASHTO and WASHTO have worked on potential regulatory harmonization and information sharing among states for many years. Federal representatives have also sought solutions that could be promoted by the federal sector. In 2017 the AASHTO Board of Directors adopted some harmonizing principles supported by organizations like the Specialized Carriers & Rigging Association (SC&RA), the Commercial Vehicle Safety Alliance (CVSA), and the American Trucking Association. In recent years the Working Group on Freight within the Committee on Transportation System Operations (CTSO) has addressed the subject of harmonization and data sharing.

SC&RA has worked for decades toward some semblance of state-to-state harmonization of oversize and overweight permitting. The group's Uniform Permit Transport 2021 initiative, ongoing now for almost two years, has seen some success with its goal of state-by-state enabling of auto-issue permitting for non-divisible oversize or overweight loads. By 2010 the number of states participating was well over 30, in some cases "for loads of 200,000 pounds or more" and with varying width and length.

### **Research Objective**

The objective of this research is to:

- Evaluate the need, feasibility, and benefits of establishing real-time commercial vehicle data sharing among states.
- Design an information architecture, including data elements and standards, to support data sharing among states.

- Propose an institutional arrangement to establish and sustain ongoing data sharing among states.

## **Urgency and Potential Benefits**

Research concerning the means and cost savings for states sharing information is critical as state budgets are adversely affected by the coronavirus. State transportation and public safety agencies share the responsibility and cost of ensuring safe travel for trucks and other road users and of preserving highway infrastructure. Unless more effective methods are found, highway costs and crashes will continue to grow at current rates.

## **Implementation Considerations and Supporters**

This project will identify ways to establish data sharing agreements and procedures among states. The research will require working with the broad spectrum of state and industry stakeholders, including the National Conference State Legislatures (NCSL), which helped AAMVA establish the IRP agreement with all the state legislatures.

If there is agreement on technology and institutional arrangements to achieve data sharing, AASHTO or AAMVA or both will need to develop an agreement that the states will agree upon. Such activity could be a good candidate for the NCHRP 20-44 project to implement NCHRP research results.

## **Recommended Research Funding and Research Period**

The research funding that is expected be needed for this project is \$400,000. The research period is estimated at 24 months because of the need to involve all states and to determine the feasibility of certain information technology platforms.

## **Problem Statement Author(s)**

- Michael Onder, Metro Analytics, 703.598.4950, [monder@metroanalytics.com](mailto:monder@metroanalytics.com)
- Dave Huft, Co-Chair AASHTO Committee on Transportation System Operations Freight Working Group, South Dakota DOT, 605.773.3358, [dave.huft@state.sd.us](mailto:dave.huft@state.sd.us)
- Geno Koehler, Co-Chair AASHTO Committee on Transportation System Operations Freight Working Group, Illinois DOT, 217.725.4690, [geno.koehler@illinois.gov](mailto:geno.koehler@illinois.gov)
- Steven Todd, SC&RA, 217.248.0402, [stodd@scranet.org](mailto:stodd@scranet.org)
- Stephen Goodrich, Utah DOT, 801.965.4637, [sgoodrich@utah.gov](mailto:sgoodrich@utah.gov)
- Steve Kalina, Arizona DOT, 602.712.7434, [skalina@azdot.gov](mailto:skalina@azdot.gov)

## **Others Supporting the Problem Statement**

- AASHTO Committee on Transportation System Operations Freight Working Group, Dave Huft (Co-Chair) 605.773.3358, [dave.huft@state.sd.us](mailto:dave.huft@state.sd.us), Geno Koehler (Co-Chair), 217.782.2984, [geno.koehler@illinois.gov](mailto:geno.koehler@illinois.gov)



- AASHTO Special Committee on Freight, Luke Reiner (Chair), 307.286.2930, luke.reiner@wyo.gov
- TRB AT060 Standing Committee on Trucking Industry Research, Michael Onder, Metro Analytics, 703.598.4950, monder@metroanalytics.com
- Ken Chambers, Research Program Manager, Nevada Department of Transportation, 775. 846.6324, kchambers@dot.nv.gov

#### **Potential Panel Members**

- Dave Huft, South Dakota DOT, AASHTO Committee on Transportation System Operations Freight Working Group, Dave Huft, 605.773.3358, dave.huft@state.sd.us
- Geno Koehler, Illinois DOT, AASHTO Committee on Transportation System Operations Freight Working Group, 217.782.2984, geno.koehler@illinois.gov

#### **Person Submitting the Problem Statement**

David Huft  
605.773.3358  
dave.huft@state.sd.us  
South Dakota DOT  
AASHTO Committee on Transportation System Operations Freight Working Group

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#### **NCHRP Review of A-05**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

#### Comments:

The scope will likely require the development of systems requirements for an information sharing mechanism. It may also include study of potential for /or implications of disproportionate resources allocation by states with ports or origin of truck trips. The timeframe and budget should increase to 500K and 36 months to provide addition a time and resources for data collection.

#### Review Date:

12/21/2020

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#### **FHWA Evaluation of A-05**

Reviewed By: HOFM/John Berg

#### Comments:

This research is a high priority of the FHWA Office of Freight Management and Operations and will support future activities such as OS/OW multi-state permitting, and efficient truck transportation response during national emergencies. This project has the potential to reduce administrative burden at the state boundaries for the State DOT and Industry. Should year 2010 be 2020 in the literature search?

Review Date:

12/18/2020

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**Submitter Response for 2022-A-05**

**From:** [email: dave.huft@state.sd.us ; pzelinski@aathto.org]

**Comments:** The Federal Highway Administration's endorsement of the importance of this work is gratifying. Thanks also for the perceptive notice of the date error in the literature summary. The date "2010" should indeed be "2020". Regarding cost, I will defer the NCHRP staff's judgement and expertise, and suggest increasing the funding amount to \$500,000. Ms. Crichton-Sumners raises very good points about the need for requirements definition. These comments are greatly appreciated.

**Contact Info:** David L. Huft, Research Program Manager, South Dakota Department of Transportation, 700 East Broadway Avenue, Pierre, SD 57501-2586 605.773.3358  
dave.huft@state.sd.us

Review Date: 02/05/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-06**

**Problem Title**

Measuring Impacts and Performance of State DOT Resilience Efforts

**Background**

State DOTs increasingly focus on resilience as a key solution to the impacts of short-term events and long-term stresses, including climate change. The frequency and severity of damaging weather events, sea level rise, wildfires, and other climate impacts are forcing state governments to seek more long-term solutions. Economic shifts, demographic changes, and other disruptions also cause DOTs to adapt and modify their practices to accommodate uncertainty.

State DOTs need more/better tools and approaches to track resilience efforts, investments, and progress towards improving resilience of the transportation system. There is no clear standard for tracking goals, effectiveness, and outcomes of resilience efforts. Identifying and establishing resilience performance measures would benefit state DOTs and all transportation agencies.

This project should consider different resilience needs between state DOTs and build on past NCHRP resilience research that identifies methods to incorporate resilience into DOT business. However, past research does not provide a comprehensive approach to evaluate the effectiveness of policies, programs, project implementation, and other resilience actions from state DOTs.

**Literature Search Summary**

There is existing research on strategies and frameworks for resilience initiatives within DOTs, but there is no comprehensive report summarizing best practices for resilience performance measures.

**Research Objective**

This research project will develop a set of resources and recommendations for performance measures, and proxies, that can track resilience performance and investments for state DOTs. The goal is for DOTs to evaluate progress, identify gaps, and prioritize investments to improve resilience.

Results could be presented as guidance on performance measures for effectively tracking change in resilience of transportation infrastructure. This could include a table of effective resilience measures by asset type and/or by risk type (flood, sea level rise, wildfire, etc.), as well as consideration of performance measures for future risk

reduction. Methods and tools for data collection to calculate the measures would be helpful, including discussion of data availability/creation.

### **Urgency and Potential Benefits**

Resilience is a priority for DOTs and FHWA. Currently, state DOTs may be asked to justify additional expenses on projects that improve the resilience of transportation projects even when these investments are forecasted to reduce long-term costs and disruptions. Having a consistent set of performance measures will accelerate the cost-effective use of resilience-related funds and incorporation of resilience into standard DOT practices and programming.

### **Implementation Considerations and Supporters**

Leadership and staff within state DOTs that are involved with resilience activities, risk mitigation and/or performance measures are a key audience for the research results. MPOs, local governments, regional agencies, transit and other transportation agencies, and others will also use the products.

Numerous AASHTO and TRB committees would be interested in this research, including the AASHTO Committees on Transportation System Security and Resilience, Planning, Environment and Sustainability, and Maintenance; and the TRB Standing Committees on Critical Infrastructure Protection and Extreme Weather and Climate Change Adaptation.

### **Recommended Research Funding and Research Period**

Approximate timeframe for the research is 1-2 years, and would require time for literature review, interviews, focus groups, developing potential pilot proposals, and completing the final report. A rough estimate of cost is \$200,000-300,000.

### **Problem Statement Author(s)**

Jeffrey Meek, MnDOT, (614) 366-4263, [jeffrey.meek@state.mn.us](mailto:jeffrey.meek@state.mn.us)  
Jennifer Carver, FDOT, (850) 414-4820, [Jennifer.carver@dot.state.fl.us](mailto:Jennifer.carver@dot.state.fl.us)

### **Others Supporting the Problem Statement**

AASHTO Committee on Transportation System Security and Resilience

### **Potential Panel Members**

### **Person Submitting the Problem Statement**

Tim Sexton, Assistant Commissioner, Minnesota DOT  
Chair, Research Subcommittee, AASHTO Committee of Transportation Resilience and System Security, [timothy.sexton@state.mn.us](mailto:timothy.sexton@state.mn.us)

Reviewed By:  
Stephan A. Parker  
saparker@nas.edu

Comments:

This is an important and timely topic. The proposed research at the \$200,000 to \$300,000 level could summarize and provide selection guidance for numerous resources listed below. Particularly relevant are the self-assessment guide in **NCHRP 20-117**; CBA guidance and tools in **NCHRP Report 938**; the \$750,000 effort just getting under way in **NCHRP Project 15-80**, Design Guidance and Standards for Resilience; and the current TRB policy study focused on metrics that directly addresses this topic: **Transportation Resilience Metrics**. The committee authoring that report is holding its tenth meeting on January 4, 2021. Their project scope is:

- "The committee will identify and examine metrics that can be used to assess the resilience of existing infrastructure and inform the planning of investments in infrastructure for the surface, marine, and aviation modes of passenger and freight transportation. Consideration will be given to the types and key features and qualities of metrics that can inform investments intended to increase the resilience of transportation system assets and their critical functions following natural disasters as well as for longer-range resilience planning for a wide array of natural hazards such as hurricanes, floods, wildfires, heat waves, high winds, and changing freeze-thaw patterns. The kinds of data, methodologies, and analytic tools needed to design and apply such metrics will be examined as well as to evaluate their relevance and prioritize their use. Consideration will be given to metrics described in the literature and being used, developed, or recommended by federal agencies, state, tribal, and local governments, metropolitan planning organizations, and other public and private transportation practitioners.
- "Based on the findings of this review, the committee will make recommendations, as appropriate, on how metrics can be developed, improved, and applied to make more informed decisions such as when to employ higher design and construction standards and when to increase investments overall to strengthen the resilience of transportation infrastructure and systems. The committee will give special attention to metrics that can be applied by Congress and other policymakers to inform decisions about when and how much to invest in transportation resilience, and how to design infrastructure funding programs that prioritize resilience."

There are several recent NCHRP projects that also specifically address this issue, including three that are in the publication process:

1. **NCHRP 20-117, Deploying Transportation Resilience Practices in State DOTs**. The objectives of this project were to assist state DOTs and other entities in achieving a resilience-focused culture in their organization through developing

- (1) a Transportation Resilience Guide and Toolkit and (2) a national summit and peer exchange on transportation resiliency. Mainstreaming System Resilience Concepts into Transportation Agencies: A Guidebook will be published in the regular NCHRP series; Deploying Transportation Resilience Practices in State DOTs: Final Report will be published in the NCHRP Web-Only Document series; and three deliverables will be posted on the TRB summary web page: NCHRP 20-117: Deploying Transportation Resilience Practices in State DOTs (PowerPoint); Transportation Resilience Innovations Summit and Exchange (RISE) 2018 Summit/Peer Exchange Final Program; and Transportation RISE 2018 Attendee Posters Compilation.
2. NCHRP 20-59(55), Resilience: A DOT Imperative: A Primer for Transportation Executives, an interim deliverable for the subject project. The objective of this phase of the project was supporting implementation at state DOTs throughout the country by distributing it to CEOs and senior executives, with the endorsement of peers, at a convenient venue they attend, including regional AASHTO meetings and other national meetings. Work on other tasks in the subject project continue apace. The project's primary deliverable is the primer, supplemented with a pocket guide. The project is also supporting implementation at state DOTs throughout the country by distributing it to CEOs and senior executives, with the endorsement of peers, at a convenient venue they attend, including regional AASHTO meetings and other national meetings. This phase has been delayed by the pandemic, but is anticipated to resume in 2021.
  3. NCHRP 20-59(54), Resilience Research Roadmap and White Papers. The objectives of this project were (1) to prepare three executive level discussion papers or reports on special topics related to transportation resilience in support of the national summit on resilience included in the scope of work in NCHRP Project 20-59(117), Deploying Transportation Resilience Practices in State DOTs; and, (2) to develop a 5-year research roadmap for use in focusing the efforts of the transportation community in implementing a broad based program addressing a resilient transportation system. The work was designed to inform, complement, enhance, and augment work and conclusions arising from NCHRP Project 20-59(117).

Other NCHRP research has been recently published:

4. **NCHRP Project 20-101, NCHRP Research Report 938: Incorporating the Costs and Benefits of Adaptation Measures in Preparation for Extreme Weather Events and Climate Change: Guidebook**

This report provides an overview of the current state of the practice on the use of cost-benefit analysis (CBA) in the decision making process within transportation agencies, identifies how CBA can be incorporated into transportation planning processes along with climate adaptation, and develops two frameworks for evaluating the potential cost effectiveness of incorporating climate adaptation measures into projects. This report has the potential to serve as:

- A single resource that summarizes the current state of the practice for incorporating CBA into adaptation planning and analysis;
  - A source for identifying existing, relevant data and tools to support CBA for adaptation planning; and
  - An intuitive guide for incorporating CBA into state and local transportation asset management and planning policies and procedures that incorporate climate change and extreme weather adaptation planning.
5. NCHRP Synthesis 556, Asset Management Approaches to Identifying and Evaluating Assets Damaged Due to Emergency Events (2020)

Other NCHRP research is in progress:

- 08-129 Incorporating Resilience Concepts and Strategies in Transportation Planning
- 20-125 Strategies for Incorporating Resilience into Transportation Networks
- 23-03 Targeted Guidance and Information Support to State DOT CEOs on Cybersecurity Issues and Protection Strategies
- 23-09 Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis
- 20-127 Business Case and Communications Strategies for State DOT Resilience Efforts

Other NCHRP research is in development:

- 08-146 Integrating Resiliency into Transportation System Operations
- 08-148 Utility Abandonment, Out of Service Plant, and Decommissioning without Removal on Public Right of Way
- 15-61A Updates to the Design Practices Guide for Applying Climate Change Information to Hydrologic and Coastal Design of Transportation Infrastructure
- **15-80 Design Guidance and Standards for Resilience**

Review Date:  
12/18/2020

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## FHWA Evaluation of A-06

Reviewed By: HEPN/Elizabeth Habic, Rob Kafalenos

Comments:

Resilience performance measures are needed. It may be helpful to specify the types of potential performance measures for resilience; statewide/metropolitan or project scales? It's important the panel chosen represent the diverse experts that deal with

resilience issues such as maintenance, project design, bridge rehabilitation, operations/emergency response, environmental permitting, and planning.

Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for A-06**

Submitted By:  
Casey Soneira  
AASHTO Staff  
Committee on Materials and Pavements

Priority #: N/A

Comments: This project may have some benefits to COMP for Pavements. We have a project that parallels this in C-06 which will study the impacts of flooding on pavements.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-07**

**Problem Title**

Transportation workers recognized as first responders.

**Background**

- Transportation workers are inconsistently recognized and trained in incident command and response throughout the country, leading to risks to their safety as well as the traveling public.
- Existing training includes National Traffic Incident Management Responder (developed under SHRP2), Incident Command System (ICS) Training for Field-Level Supervisors and Staff (developed under NCHRP), and FEMA ICS training (100/200 have been taken by most DOT members). TIM training is about working together as incident responders, and all of these trainings point out that DOT workers are incident responders/commander, a.k.a. first responders. Every local or state entity there is considered a first responder except DOT.
- There is a need to nationally recognize DOT employees as first responders in every TIM situation.
- Ongoing Traffic Incident Management and transportation-specific training programs may enhance DOT abilities to respond to incidents safely as well as to better integrate with Fire, law enforcement, and EMS personnel on-scene.
- Some states have agency-specific ICS programs already built and may provide insight and best practices to other states, nationwide.
- Agencies or capabilities designated as “First Responders” may have improved chances of receiving Federal grant monies.

**Literature Search Summary**

- Current Traffic Incident Management system
- Ongoing AASHTO ICS for Transportation ICS curriculum development.
- National Academy Press “The Legal Definitions of First Responder (2013)”

**Research Objective**

- Determine requirements to have transportation workers designated as First Responders
- Create framework training roadmap to enhance transportation workers professionalization in Incident Command and TIMS
- Conduct survey of states to determine which have designated transportation workers as first responders
- Results should be presented as research documents, supported by a Powerpoint synoptic product

## **Urgency and Potential Benefits**

Concisely explain:

- State transportation workers respond to incidents daily and without proper training, will continue to be in harm's way.
- Transportation workers will be designated, better trained, and more able to safely integrate into ICS structure which already exist, as well as to generate their own structure, when required.
- State DOTs will have the same level of benefit and will be consistent across all states and territories, making communication around best practices more efficient.
- Additionally, Workman's Compensation for PTSD (dispatchers are covered, while DOT, which is on scene of numerous traumatic events, is not), plus move over law carries more weight, the recognition to our hard working employees and being recognized (part of the team) for our capabilities at an incident.

## **Implementation Considerations and Supporters**

To aid the AASHTO R&I Committee in deciding whether to fund this project, describe:

- Emergency managers and safety/risk assessment managers will be the responsible parties.
- Legislative action information and increased emphasis on this training to include a detailed training plan.
- Training sections, legislative outreach coordinators, FHWA TIM information and the handouts from ICS for transportation workers.
- Brochures, presentations, training workshops, peer exchanges would all help create awareness and facilitate implementation of the research results.

List the AASHTO Committee(s) and/or Council(s) – and any other organization – that might be interested in the research results and could help support implementation.

- Committee on Transportation System Security and Resilience

## **Recommended Research Funding and Research Period**

Research Funding: Provide separate estimates of the total funds needed to accomplish (a) the research objective(s) and (b) any initial activities designed to facilitate the communication and implementation of key research products.

- 250,000k with the support of DOT's and FHWA should complete this project

Note: If the problem statement is selected, the level of funding provided may be adjusted by the AASHTO R&I Committee.

Research Period: Provide separate estimates of the time needed to (a) complete the research and (b) to engage in some level of communication and implementation activity.

Note: If the problem statement is selected, the research period may be adjusted by the project panel to allow for panel review of interim and final deliverables.

**Problem Statement Author(s)**

Anyone may author or contribute to an NCHRP problem statement, and should be identified in this section.

- Neal Murphy, Idaho Transportation Department 208 334 8414  
neal.murphy@itd.idaho.gov

**Others Supporting the Problem Statement**

List organizations, including AASHTO Committees or Councils, which support this problem statement, and provide contact information.

- CTSSR
- New Jersey Department of Transportation, Robert M. Burd, 609-963-1468,  
Robert.Burd@dot.nj.gov
- Idaho Transportation Department, Neal Murphy, 208 334 8414,  
Neal.murphy@itd.idaho.gov
- Vermont Agency of Transportation, Todd R. Sears, 802-431-5769,  
Todd.Sears@vermont.gov

**Potential Panel Members****Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Neal Murphy
- 208 334 8414
- Neal.murphy@itd.idaho.gov
- Affiliation (limited to): Idaho Transportation Department

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**NCHRP Review of A-07**Reviewed By:

Stephan A. Parker  
saparker@nas.edu

Comments:

This is an important and timely topic. There are essentially three approaches inherent in this research problem statement:

(1) Identifying where and how transportation workers are or could be recognized as first responders. That was done comprehensively in work under the NCHRP Legal Research program and resulted in publication of National Academies of Sciences, Engineering, and Medicine. 2013. The Legal Definitions of "First Responder". Washington, DC: The National Academies Press. <https://doi.org/10.17226/22451>. The proposed research could update that report.

(2) Changing the recognition of transportation workers as first responders. The avenues identified in the Legal Definitions project lie essentially at the state level: those are policy changes. The research proposed in the problem statement appears to call for one approach identifying specific policy recommendations on a state by state basis. That is a sensitive topic and needs to be explicitly approved as an objective prior to authorizing such an approach.

(3) A second approach appears to be creating certification programs for the recognition of transportation workers as first responders. That is an appropriate topic of research; however, the budget proposed would likely not get further than scoping such an effort. A certification program will require development of a testing regime. TRB's Transit Cooperative Research Program (TCRP) developed a certification series for Automotive Service Excellence for bus technicians. It cost approximately \$5 million spread over several fiscal years. Once established, the certification program has been self-sustaining through testing fees. Thousands of tests have been taken; about half of those tested pass, so the tests are meaningful. A scoping effort could look at the feasibility of certification, including financing. Agency willingness to pay for test fees and/or to associate increases in hourly wages for those achieving certification were central to the success of the transit bus certification program's success, as was the availability of training and test preparation guidance for potential test takers.

Review Date:

12/18/2020

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## **FHWA Evaluation of A-07**

Reviewed By: HOTO/Paul Jodoin

Comments:

We support the research but recommend that the project may want to consider the following:

- All "DOT workers" are not responders. Further clarification of which DOT workers are the focus.
- Police and Fire may not agree with the designation of DOT as First Responders.
- Further clarification of the benefit and reasoning for the importance of the first responder designation.

Review Date:

12/18/2020

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## Submitter Response for 2022-A-07

From: [email: Neal.murphy@itd.idaho.gov;pzelinski@ashto.org]

We support the research but recommend that the project may want to consider the following:

- All “DOT workers” are not responders. Further clarification of which DOT workers are the focus.

The research should include DOT operations/maintenance workers that are in direct support of any road incident, disaster relief or hazmat effort. A key component is involvement in ICS responses to disasters (snow, slides, floods, ice etc.) and support mutual assistance requests from other first responder organizations. Mutual assistance of this type is very common, especially in rural and agricultural communities.

Current required training/qualifications for DOT operation/maintenance workers (Certification)

1. Traffic Incident Management
2. ICS 100, 200, 300, 400 and the new program “ICS for Transportation workers”
3. Hazmat Awareness, Operations or Technician Qualifications
4. CPR/AED/First Aid certification

- Police and Fire may not agree with the designation of DOT as First Responders.

Possibly, though this is not about status or turf. This is about how closely we work with them during incidents, maybe the perception of all DOT employees as First Responders (Comment #1). (In Idaho, our dispatching agency is considered first responders but DOT at an incident is not)

- Further clarification of the benefit and reasoning for the importance of the first responder designation.

- Workermens compensation for PTSD for job related events.
- DOTs are part of the multi-stakeholder team that responds to a myriad of events to ensure the safety of the travelling public during incidents and emergencies. This validates the importance that DOT plays in emergency, disaster and incident response.
- Establishes enhanced credibility within an ICS response framework
- Clarifies an issue which has remained ambiguous for a significant amount of time
- Could open up increased training opportunities for our DOT field professionals such as advanced ICS position-specific (Operations, Planning Section, Incident Commander, Emergency Operations Center

- etc.) training, safety, first aid, hazmat, critical incident stress leadership and others
- Could affect prioritization of services, eg. Vaccines, in times of pandemic, which serves to enhance public safety response capability

This is an important and timely topic. There are essentially three approaches inherent in this research problem statement:

(1) Identifying where and how transportation workers are or could be recognized as first responders. That was done comprehensively in work under the NCHRP Legal Research program and resulted in publication of National Academies of Sciences, Engineering, and Medicine. 2013. The Legal Definitions of "First Responder". Washington, DC: The National Academies Press. <https://doi.org/10.17226/22451>. The proposed research could update that report.

(2) Changing the recognition of transportation workers as first responders. The avenues identified in the Legal Definitions project lie essentially at the state level: those are policy changes. The research proposed in the problem statement appears to call for one approach identifying specific policy recommendations on a state by state basis. That is a sensitive topic and needs to be explicitly approved as an objective prior to authorizing such an approach.

(3) A second approach appears to be creating certification programs for the recognition of transportation workers as first responders. That is an appropriate topic of research; however, the budget proposed would likely not get further than scoping such an effort. A certification program will require development of a testing regime. TRB's Transit Cooperative Research Program (TCRP) developed a certification series for Automotive Service Excellence for bus technicians. It cost approximately \$5 million spread over several fiscal years. Once established, the certification program has been self-sustaining through testing fees. Thousands of tests have been taken; about half of those tested pass, so the tests are meaningful. A scoping effort could look at the feasibility of certification, including financing. Agency willingness to pay for test fees and/or to associate increases in hourly wages for those achieving certification were central to the success of the transit bus certification program's success, as was the availability of training and test preparation guidance for potential test takers.

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-08**

**Problem Title: Return on Investment and Economic Impact of Travel Demand Management Programs**

**Background**

Travel demand management (TDM) programs have an important role in transportation systems. TDM helps mitigate traffic congestion, reduce automobile trips, and increase our transportation system's efficiency by moving more people in fewer vehicles. Moreover, TDM strategies can be implemented quickly and at low cost and result in increased transit ridership, increased person throughput, and help mitigate impacts during road construction. Finally, TDM supports other environmental goals regarding energy use, air quality and carbon emissions.

Currently, methods exist for measuring TDM results in terms of reductions on vehicle trips, vehicle miles traveled and auto emission. In fact, several models can calculate the cost savings and trip reduction of various TDM strategies. While public transit has established the economic impacts of investing in transit, there is a gap in the understanding of TDM's economic impact. For TDM to be an effective tool for policymakers and transportation professionals, quantifying the economic impacts and Return on Investment (ROI) in TDM programs and services is in dire need of study.

**Literature Search Summary**

During this literature search, models and reports were found that involve TDM and ROI of public transportation investment. However, none of these models or literature do what this project sets out to do. The following citations and models were discovered in relation to calculating the benefits of TDM:

- Trip Reduction Impacts of Mobility Management Strategies TRIMMS  
A spreadsheet model that evaluates TDM strategies directly affecting the cost of travel, like public transportation subsidies, parking pricing, pay-as-you-go pricing, and other financial incentives.
- Economic Impact of Public Transportation Investment  
An American Public Transportation Association (APTA) study that focused on how investment in public transportation affects the economy in terms of employment, wages and business income.
- TDM Return on Investment Calculator  
Calculates benefit-cost ratios of accidents avoided, noise pollution reduced, road construction deferred, congestion reduction, and emission reduction.
- Economic Impacts of Public Transportation in the Commonwealth of Virginia

A Virginia Department of Rail and Public Transportation (DRPT) study examined how the investment in existing transit services generate economic value to the state. The economic impact of the direct benefits attributed to transit were estimated in terms of employment opportunities created, personal income earned, Gross State Product (GSP) generated, and tax revenue collected.

- Byars, Michelle; Wei, Yishu; Handy, Susan. State-Level Strategies for Reducing Vehicle Miles of Travel. National Center for Sustainable Transportation; University of California Institute of Transportation Studies, 2017, 36p <https://trid.trb.org/view/1503344>  
McKeever, Benjamin; Skabardonis, Alexander; Mauch, Michael; Campbell, Robert; Alexiadis, Vassili; Wornum, Christopher. San Francisco Bay Area US-101 Existing Conditions, ITS Assets, and Active Transportation and Demand Management Assessment. University of California, Berkeley; California Department of Transportation; Federal Highway Administration; Cambridge Systematics, 2017, 182p <https://trid.trb.org/view/1532566>

This research and the development of cost-benefit calculators provides good tools to help evaluate TDM programs and make decisions on the types of programs is beneficial to state DOTs and the transit community. However, they do not address the economic and business impacts of TDM, nor do they evaluate state level investment beyond California. By investing in the research to address the ROI of TDM programs and services, state, regional and local officials would have the necessary tools to make critical decisions about and encourage greater use of these strategies.

### **Research Objective**

For the purpose of this research, TDM is defined as commuter assistance programs that provide ridematching, carpool formation, vanpool formation, marketing and promotion of travel options. It also includes commuter assistance programs that provide trip planning, employer outreach, assistance to employers to establish commuter benefit and telework programs, and online and mobile application delivery of services and commute options information to the public.

The objective of this research is to analyze the benefits of commuter assistance programs to the economy and society. This research would particularly explore the benefits of investment in commuter assistance programs that provide ridematching services that form carpools, vanpools, increase transit ridership, assist employers and their employees, and increase telework. Finally, the objective of this research is to arrive at a quantifiable benefit of the investment in TDM. The deliverables would include a guide for conducting an economic impact analysis to measure how a state's travel demand management programs and services affect the state economy. Another product will be an approach for measuring and quantifying the societal costs and benefits to determine the return on the investment.

### **Urgency and Potential Benefits**

A significant amount of federal, state, and local funding is invested in TDM and operators of commuter assistance programs are requesting more funding every year. The effects of TDM, however, cannot always be directly experienced or counted,



making it difficult for decision makers to understand the benefits of the investment. Although MPOs and state departments of transportation (DOTs) use travel forecasting models as part of their planning and project selection processes, those models do not provide economic benefit analysis. This research project is urgent in that it focuses on calculating the return investments in TDM have on jobs and economic activity.

More importantly, this research is urgent for state DOTs, metropolitan planning organizations and regional transportation planning organizations as funding decisions are considered on transportation projects and services. This project will result in data that these stakeholders can use to demonstrate the economic benefits of TDM investments, helping make the case for continued and even increased investments in the future.

### **Implementation Considerations and Supporters**

The ROI benefits of TDM can significantly effect change in the decision process by assessing TDM as first-use strategies to enhance operational efficiency of the existing transportation system before expanding the system. The products developed by this research would lead to state DOTs leveraging limited resources by using proven TDM strategies as integral components of transportation projects to address travel demand, congestion, and optimizing person throughput and travel flow.

In addition, this project will inform state DOTs on how they may estimate their state's economic benefits of TDM which will help DOTs consider the full benefits of TDM during project selection and funding evaluations. Furthermore, federal, state and local leaders and agencies can benefit from this research as decisions are considered about providing the necessary funding for TDM programs and services. Finally, this research is critical to informing other public officials, community leaders and the public of the benefits of investing in TDM.

This project will produce a report with accompanying infographics that illustrate the economic impact of Virginia's investment in TDM programs. An example is DRPT's Economic Impacts of Public Transportation in the Commonwealth of Virginia that answers the questions:

- In dollars, how much in statewide economic activity does an investment in TDM generate?
- In dollars, how much in statewide economic benefits does an investment in TDM generate?
- How many statewide jobs are supported by investment in TDM?

Additionally, this project should produce a guide for state DOT's to use the methodology developed through this project to conduct their own economic impact analysis to measure how a state's travel demand management programs and services affect the state economy, and compare the societal costs and benefits to determine the complete return on the investment.

**Recommended Research Funding and Research Period**

Recommended Funding: \$275,000

Research Period: 18 months; 12 months of research and six months of communication and implementation

**Problem Statement Author**

Christopher Arabia, Manager of Mobility Programs, Virginia Department of Rail and Public Transportation, (804) 786-1059, christopher.arabia@drpt.virginia.gov

**Others Supporting the Problem Statement**

AASHTO's Council on Public Transportation

AASHTO's Multi-State Transit Technical Assistance Program

**Potential Panel Members**

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Charles Carr, Research Chair, AASHTO's Council on Public Transportation; Mississippi Department of Transportation, (601) 359-7025, ccarr@mdot.state.ms.us

**Person Submitting the Problem Statement**

AASHTO's Council on Public Transportation

Contacts: Shayne Gill

Program Director for Multimodal Transportation

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Richard Price

Associate Program Manager, Transit Policy and Technical Assistance

AASHTO

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**NCHRP Evaluation of A-08**

Reviewed By: Dianne S. Schwager

Comment:

This project presents several objectives (1) analyze the benefits of commuter assistance programs to the economy and society, (2) explore the benefits of investment in commuter assistance programs that provide ridematching services that form carpools, vanpools, increase transit ridership, assist employers and their employees, and increase telework, and (3) to arrive at a quantifiable benefit of the investment in TDM. The Problem Statement requests a guide for conducting an economic impact analysis to measure how a state's travel demand management programs and services

affect the state economy and an approach for measuring and quantifying the societal costs and benefits to determine the return on the investment. Historically, TDM has represented a small part of commuting travel behavior in most communities. TDM strategies have often been pursued as a means for congestion mitigation and to support environmental goals related to air quality, rather than economic benefit. Benefits of TDM accrue, at least in part, to employers who may be able to reduce parking. Estimates of economic benefits may be feasible for different communities, in particular if the research explores different scenarios and outcomes. The willingness of employees to commute with other individuals post-Covid is still unknown. Carpooling and telecommuting may increase if there is a sustained reluctance to travel in high capacity vehicles such as buses and subways. The economic and societal implications of TDM may consequently have greater, and more far reaching, impacts than in the past.

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## **FHWA Evaluation of A-08**

Reviewed By: HOTM/Allen Greenberg

### Comments:

This area is one worthy of NCHRP exploration, however the research statement seems too focused on commuter assistance programs (there are plenty of TDM measures not associated with such programs) and should instead be broadened to TDM strategy and program costs generally, whatever their origin (including, for example, costs of incentives, vanpool programs, app-based strategies, etc.). Particularly problematic is this language: “TDM is defined as commuter assistance programs...” disagree with the work statement specifically promising to assess costs-benefits of TDM in Virginia. The pledge to choose a few locations to do this is okay, but such locations should be chosen by the project panel and contractor together after the completion of preliminary research. But big picture, this project is worthy of pursuit.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-A-08**

**Comments:** Response to Reviewer Comments in attached file. (Below)

### **Contact Info:**

Richard Price  
Associate Program Manager, Transit Policy and Technical Assistance  
American Association of State Highway and Transportation Officials (AASHTO)

555 12th Street NW Suite 1000  
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**Review Date:** 2/3/2020

| <b>Problem Number: 2022-A-08: Return on Investment and Economic Impact of Travel Demand Management Programs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <b>Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Response to Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p><b>Reviewed By: HOTM/Allen Greenberg</b></p> <p>This area is one worthy of NCHRP exploration, however the research statement seems too focused on commuter assistance programs (there are plenty of TDM measures not associated with such programs) and should instead be broadened to TDM strategy and program costs generally, whatever their origin (including, for example, costs of incentives, vanpool programs, app-based strategies, etc.). Particularly problematic is this language: "TDM is defined as commuter assistance programs..." disagree with the work statement specifically promising to assess costs-benefits of TDM in Virginia. The pledge to choose a few locations to do this is okay, but such locations should be chosen by the project panel and contractor together after the completion of preliminary research. But big picture, this project is worthy of pursuit.</p> | <p><b>Response to HOTM/Allen Greenberg -</b></p> <p>Narrowing the definition of TDM for this project was intentional to keep project costs down and to keep the scope manageable. We intentionally removed the large TDM projects, such as bus only lanes, optimizing signal timing, HOV/HOT lanes, etc. These types of TDM projects require large financial investments and there are methods currently used to measure the benefits of them. Also, including all TDM strategies in this project would more than double the cost of this project.</p> <p>We are in agreement with the comment that this project should include "costs of incentives, vanpool programs, app-based strategies, etc." Typically those kinds of strategies are implement by commuter assistance programs operated by state or local governments, or by transit or other transportation agencies. For that reason, we used the term "commuter assistance programs" in defining TDM for this project.</p> <p>Our hope is that Virginia programs would be selected for analysis in the research project, among other programs around the country. The objective of this project is to create a tool to calculate the economic benefit of TDM programs that can be used by all states and therefore we agree that TDM programs in a number</p> |

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| <p><b>NCHRP comment</b> - This project presents several objectives (1) analyze the benefits of commuter assistance programs to the economy and society, (2) explore the benefits of investment in commuter assistance programs that provide ridematching services that form carpools, vanpools, increase transit ridership, assist employers and their employees, and increase telework, and (3) to arrive at a quantifiable benefit of the investment in TDM. The Problem Statement requests a guide for conducting an economic impact analysis to measure how a state's travel demand management programs and services affect the state economy and an approach for measuring and quantifying the societal costs and benefits to determine the return on the investment. Historically, TDM has represented a small part of commuting travel behavior in most communities. TDM strategies have often been pursued as a means for congestion mitigation and to support environmental goals related to air quality, rather than economic benefit. Benefits of TDM accrue, at least in part, to employers who may be able to reduce parking. Estimates of economic benefits may be feasible for different communities, in particular if the research explores different scenarios and outcomes. The willingness of employees to commute with other individuals post-Covid is still unknown. Carpooling and telecommuting may increase if there is a sustained reluctance to travel in high</p> | <p><b>Response to NCHRP comment</b> - This is a spot-on summarization of the proposal and it highlights exactly what we are looking to accomplish.</p> <p>Thanks again for your comments on this research proposal. Please know that this problem statement ranked #4 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program.</p> |

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| capacity vehicles such as buses and subways. The economic and societal implications of TDM may consequently have greater, and more far reaching, impacts than in the past. |  |
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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number:** 2022-A-09

**Problem Title:** Sustaining a Zero Fare Public Transportation Program in a Post COVID-19 World

**Background**

The coronavirus outbreak continues to create numerous challenges to public transportation providers and the communities they serve. Stay-at-home orders, social distancing regulations, and the heightened demand of essential workers are forcing public transportation providers to adapt to these extraordinary circumstances and consider new approaches to make transit functional yet safe during the COVID-19 pandemic response.

One accepted best practice deployed by transit systems throughout the nation is a temporary zero fare system, a fare collection policy aimed to limit interactions between operators and riders, remove human bottlenecks at ticketing locations, and provide relief to essential workers depending on transit throughout the pandemic. Before COVID-19, many communities were embracing a zero fare structure as a way to improve personal mobility and quality of life for their public transit riders. The pandemic, however, sped up this fare policy shift drastically, with both urban and rural transit agencies beginning to operate on zero fare. As more businesses open and people begin returning to work, policy makers are now facing key decisions: remain on zero fare, begin transitioning back to the old fare system, or create a new collection policy that more effectively limits interactions.

To understand the associated tradeoffs, policy makers need to have a proper analysis of the benefits and risks associated with remaining zero fare. A key element of this effort is to catalog the changes in ridership and the societal, economic, and public health benefits of implementing a zero fare policy. In 2012, 'NCHRP Synthesis 101' captures examples of transit agency implementation of zero fare programs and their associated outcomes. As more agencies have implemented this approach during the pandemic, the current state of practice and documented outcomes is in critical need of an update.

**Literature Search Summary**

During this literature search, the following citations with summaries were discovered. All of these resources are recent and highlight a unique aspect of this conversation. It was purposeful to select diverse research from different localities, perspectives, and expertise.

- Barone, Christina (2020). Fare Policy- & Zero Fares- Can Help Transit Agencies & the Communities They Service Post- Pandemic. [Paper] written by Nelson Nygard's

team to expand on the advantages of zero fare programming mid and post coronavirus outbreak. Paper focuses on the following advantages: making fares understandable, affordable, and limiting interactions associated with cash fare.

- Brough, Rebecca et al. (2020). Understanding Socioeconomic Disparities in Travel Behavior during the COVID-19 Pandemic [Academic paper] written by faculty at the University of Notre Dame emphasizes the disparities in transportation amidst the coronavirus pandemic. This research focuses on low income populations and essential workers and their continued dependence on public transportation throughout the changes in mobility introduced by the coronavirus.
- Budd, Lucy (2020) Responsible Transport: A post- COVID Agenda for Transport Policy and Practice. [Paper] that recognizes the functionality of public transportation amidst a pandemic and applies an emphasizes on responsible policy making and operational changes. This paper introduces a unique concept of responsible transit and response planning and starts a conversation on community outreach amidst pandemic.
- Schwartz, Sam (2020) Public Transit and COVID-19 Pandemic. [Report] commissioned by the American Public Transportation Association (APTA) provides a comprehensive review of national and global research regarding COVID-19's impact on transit use. It reviews the linkages between public transportation and public health while highlighting the needs for accessible transportation options. Additionally, evidence is provided that limiting interactions on transit, through elimination of fares, can lead to transit's success and positive public image.

State departments of transportation (DOTs) and their transit providers desperately need a better understanding of the impacts of zero fare programming during the pandemic and in a post COVID-19 world. This proposal would analyze the limited available research and provide a more detailed and comprehensive analysis of the impact of these programs in a public health crisis and the possibility of sustaining a zero fare structure as communities adapt and begin to recover.

### **Research Objective**

The objective of this research is to analyze the costs and benefits of sustaining zero fare transit programming, including impacts to ridership and societal, public health, and economic benefits. This proposed research would explore existing approaches to fare structure decision making, a potential development of a scenario-planning tool based on actual implementation outcomes, a cost-benefit analyses and evaluation of risks associated with implementation of zero fare transit approaches. The purpose is to provide state DOTs with the information necessary to evaluate zero fare approaches, post pandemic, on their transit systems. The research deliverables should include the following:

- A report of pandemic-related findings;
- A scenario-planning tool for evaluation; and
- Recommendations for presenting the findings to the transit community and its partners.



A scenario-planning tool is a critical need/result from this research, especially since there are significant benefits, costs, and now possible risks associated with the collection and management of fare revenues. A planning tool should consider not only the tradeoffs associated with the loss of revenue and the benefit of limiting human bottlenecks, but also the reduction in operating and capital costs that would be realized with the elimination (or partial elimination) of fares.

### **Urgency and Potential Benefits**

This research is timely and urgent as state DOTs and transit providers are beginning to review their fare policies as communities continue to respond to the coronavirus. Transportation will continue to be an issue and challenges of access and equity are specifically important due to mobility changes introduced by the pandemic. By not furthering this research now, the public transportation industry will have limited consistency and objectivity in response efforts contributing to inadequate mitigation measures. In order for the transit industry to recover and regain community trust in an equitable and efficient manner, the impact of sustaining a zero fare policy must be analyzed. Additionally, this research will benefit both urban and rural agencies, as it will outline possible scenarios for all sized systems.

### **Implementation Considerations and Supporters**

State DOTs will utilize this research when working with public transportation providers, other state agencies that fund public transportation, and transit systems in evaluating methods to increase ridership, improve personal mobility (including access to jobs and healthcare), increase pandemic response efforts, and community functionality and economic resiliency.

This information can be helpful for public meetings and presentations, trainings, peer exchanges, brochures, websites, and guidance documents provided to transit agencies and state DOTs. After the information is disseminated, state DOTs and transit agencies can utilize the research to evaluate the viability of implementing fare free policies.

### **Recommended Research Funding and Research Period**

- Recommended Funding: \$300,000
- Research Period: 18 months; 12 months of research and six months of communication and implementation

### **Problem Statement Author(s)**

- Lauren Fishbein, Virginia Department of Rail and Public Transportation, (804) 351-6791, [Lauren.Fishbein@DRPT.virginia.gov](mailto:Lauren.Fishbein@DRPT.virginia.gov)

### **Potential Panel Members**

- Lauren Fishbein, Virginia Department of Rail and Public Transportation, (804) 351-6791, [Lauren.Fishbein@DRPT.virginia.gov](mailto:Lauren.Fishbein@DRPT.virginia.gov)
- Mike Mucha, Virginia Department of Rail and Public Transportation, (804) 516-2654, [mike.mucha@drpt.virginia.gov](mailto:mike.mucha@drpt.virginia.gov)

- Jennifer Debruhl, Virginia Department of Rail and Public Transportation, (804) 786-1063, [jennifer.debruhl@drpt.virginia.gov](mailto:jennifer.debruhl@drpt.virginia.gov)

**Person(s) Submitting the Problem Statement**

AASHTO's Council on Public Transportation

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**NCHRP Evaluation of A-09**

Reviewed By: Dianne S. Schwager

Comment:

This research is timely and will be of considerable value to public transportation agencies and the communities they serve. Research on fare-free public transportation has been conducted in the past ten years by NCHRP and TCRP, as well as other organizations. Prior to Covid-19 fare-free transit was not wide-spread in the U.S., except in small communities and specialized markets such as resorts. Few U.S. transit agencies viewed zero-fare as a viable financial strategy, although its potential for improving mobility, equity, and the environment were recognized. The proposed NCHRP project would dovetail well with a recently initiated TCRP project (\$100,000) to develop a framework to evaluate fare-free public transportation, addressing the benefits and costs and the trade-offs of eliminating fares, in whole or in-part. Since the NCHRP project will be initiated as the TCRP project is approaching completion, the NCHRP project will have the opportunity to further analyze post-Covid data on transit ridership and financing strategies, address implementation strategies that have significant promise, and develop scenario-planning on costs, benefits, and risks that will have national value.

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**FHWA Evaluation of A-09**

Reviewed By: HPTS/Charles Noble

Comments:

This an important emerging topic with significant transportation policy implications. This study would inform state DOTs of current work surrounding zero-fares, create a scenario-planning tool, and provide information on how to interact with local transit authorities on the topic. This research proposal would be a good use of funds, and aligns well with FHWA HPTS work on emerging mulitmodal trends.

Review Date:

12/18/2020

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**Submitter Response for 2022-A-09  
Sustaining a Zero Fare Public Transportation Program in a Post COVID-19  
World**

**Comments:** Response to Reviewer Comments in attached file.(below)

**Contact Info:**

Richard Price  
Associate Program Manager, Transit Policy and Technical Assistance  
American Association of State Highway and Transportation Officials (AASHTO)  
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**Review Date:** 2/3/2020

| <b>Problem 2022-A-09: Sustaining a Zero Fare Public Transportation Program in a Post COVID-19 World</b>                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| <b>Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Response to Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>Reviewed By: HPTS/Charles Noble -</b><br/>This an important emerging topic with significant transportation policy implications. This study would inform state DOTs of current work surrounding zero-fares, create a scenario-planning tool, and provide information on how to interact with local transit authorities on the topic. This research proposal would be a good use of funds, and aligns well with FHWA HPTS work on emerging multitmodal trends.</p> | <p><b>Response to HPTS/Charles Noble -</b><br/>Thank you for your feedback, Charles. I agree this study would have significant policy implications. Furthermore, this topic will bring light to the multitude of positive impacts zero fare programming can have on transit ridership and transit's function in the community. I specifically appreciate your comment on how this can improve discussions with local transit authorities, who are currently conducting cost/ benefit analyses for zero fare programming amidst and following a pandemic.</p> <p>Please know that members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program also agree with your assessment of the significance of this</p> |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | research. The Council and MTAP members ranked this problem statement as its #1 priority among its submitted problem statements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <p><b>NCHRP comment</b> - This research is timely and will be of considerable value to public transportation agencies and the communities they serve. Research on fare-free public transportation has been conducted in the past ten years by NCHRP and TCRP, as well as other organizations. Prior to Covid-19 fare-free transit was not wide-spread in the U.S., except in small communities and specialized markets such as resorts. Few U.S. transit agencies viewed zero-fare as a viable financial strategy, although its potential for improving mobility, equity, and the environment were recognized. The proposed NCHRP project would dovetail well with a recently initiated TCRP project (\$100,000) to develop a framework to evaluate fare-free public transportation, addressing the benefits and costs and the trade-offs of eliminating fares, in whole or in-part. Since the NCHRP project will be initiated as the TCRP project is approaching completion, the NCHRP project will have the opportunity to further analyze post-Covid data on transit ridership and financing strategies, address implementation strategies that have significant promise, and develop scenario-planning on costs, benefits, and risks that will have national value.</p> | <p><b>Response to NCHRP comment</b> - Thank you for your insightful feedback. Your comment shows how this research proposal would align with current work and goals of NCHRP. I appreciate your time in reviewing my proposal and providing a summary of existing and relevant work completed by NCHRP and TCRP.</p> <p>Please know that members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program also agree that this research is both timely and of considerable value. The Council and MTAP members ranked this problem statement as its #1 priority among its submitted problem statements.</p> |
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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022-A-10**

**Problem Title**

Interdependence of Federal, State, and Local Transportation Funding and Ownership

**Background**

Transportation infrastructure is built, maintained, and operated by multiple levels of government and each level plays a role in delivering an integrated transportation system to serve national, state, and local needs. Components of the transportation system are owned and operated by all levels of government creating a complex network of entities that plan, build, and operate our roads, bridges, and transit systems.

Current funding mechanisms consist of federal, state, and local revenue sources and federal and state aid programs. This multi-layered system of ownership and funding can present challenges for project development and delivery. While there is a desire on the part of some policymakers for more “local control” of federal funding, the complexities and requirements of the federal-aid programs can prove burdensome to local entities.

The transportation system providers are strained to maintain investment at all levels of government. Wide variations in system ownership and reliance on federal funding reveals a variety of system functions funded by various sources.

**Literature Search Summary**

This research would seek to update and expand on information included in reports such as “Financing Transportation in the 21<sup>st</sup> Century: An Intergovernmental Perspective” (Intergovernmental Forum on Transportation Finance, 2008) and “Intergovernmental Challenges in Surface Transportation Funding” (The Pew Charitable Trusts, 2014).

**Research Objective**

The objective of this research is to document the different scales and complexities of owning, funding, building, and maintaining the transportation system for all levels of government. Additionally this research will investigate the interdependence of funding sources and flexibility and system ownership and responsibility.

Research tasks and activities could include:

- 1) A detailed analysis of ownership and operational control of transportation system elements and how different needs and functions of the system are met in different states and at different levels of government.
- 2) Exploration of state-local funding issues including a compendium of state methods for state and local-government revenue generation.

- 3) Identifying the reasoning for differences in transportation system ownership, project delivery responsibilities, and funding.
- 4) Examining how federal funding flexibility is used currently to improve efficiency and accommodate these differences.

### **Urgency and Potential Benefits**

Research into the complex and interdependent funding mechanisms for transportation is important to state DOTs and local transportation agencies as they face constrained budgets and shortfalls in federal funding. If local governments are encouraged to accept more responsibility for project delivery and funding to meet highway and transit needs, this research will benefit policy makers and stakeholders at all levels of government.

This research will directly support goals in the AASHTO Committee on Funding and Finance's strategic plan:

- Provide leadership in the review and development of national funding and finance policy
- Advance research and support educational and technical assistance initiatives on current and emerging transportation funding, finance, and financial management research topics

### **Implementation Considerations and Supporters**

This research will be used by finance and revenue departments at State DOTs and local governments. In addition to AASHTO's Committee on Funding and Finance, stakeholder organizations including Congress, the National League of Cities, National Association of Regional Councils, and National Association of Counties will benefit from the findings of this research. Inviting these groups to participate on the panel and encouraging their involvement through periodic review of the research will increase the likelihood, scale, and quality of implementation.

### **Recommended Research Funding and Research Period**

Recommended Funding: \$450,000

Research Period: 18 months

### **Problem Statement Author(s)**

Ben Orsbon, FAICP  
South Dakota Department of Transportation  
700 East Broadway Avenue  
Pierre, SD 57501

### **Others Supporting the Problem Statement**

AASHTO Committee on Funding and Finance  
Susan Howard  
202-624-3698  
showard@aashto.org

### **Potential Panel Members**

Members of the AASHTO Committee on Funding and Finance

**Person Submitting the Problem Statement**

Susan Howard

202-624-3698

showard@aashto.org

AASHTO staff on behalf of AASHTO Committee on Funding and Finance

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**NCHRP Review of A-10**

Reviewed By:

Andrew C. Lemer

alemer@nas.edu

Comments:

The instructional analysis that this problem statement seems to envision (considering the “reasoning for differences” among states and likely entailing review of states’ constitutions and legislative practices ) may be inappropriate to an NCHRP effort or even a TRB policy study. However, much of the factual basis for discussion would seem to be covered by the “Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation, 2nd Edition” report published by AASHTO and currently proposed for update under the NCHRP 20-24 program.

Review Date:

12/8/2020

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**FHWA Evaluation of A-10**

Reviewed By: Mark Sullivan/HCFB-33

Comments:

From the perspective of the Federal Government, the analysis promises to offer fundamental insight contributing to national funding and finance policy. The research steering committee should consider establishing a policy framework – especially a State and local perspective on what comprises the “Federal interest” – and exploring how policy translates into practice. This perspective would offer lasting relevance to this research, beyond its value as a compendium of current practice.



Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for A-10**

Submitted By:  
Susan Howard  
AASHTO Staff  
Committee on Funding and Finance

Priority #: 1

Comments: N/A

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**Submitter Response for 2022-A-10**

**From:** [email: showard@ashto.org]

**Comments:** The complexity of state-federal and state-local funding relationships have not been covered in the scope of the Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation. While these topics consistently presented the most attractive temptations to veer outside the defined scope of that AASHTO-published report, both topics are extensive enough to be deemed deserving of their own research.

**Contact Info:** Susan Howard  
showard@ashto.org  
202.624.3698

Review Date: 2/8/21

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-11**

**Problem Title**

Environmental Requirements and Practices in the Context of Law, Regulation, Agreements, Policy, and Guidance

**Background.**

- What is the problem, and whom does it affect?  
Environmental requirements and practices in transportation are founded in established law and regulation. Law and regulation is augmented by defined requirements of environmental agreements/contracts and filtered through agency policies and guidance. Environmental activities, however, sometimes are carried out by DOTs - at the insistence of regulatory agencies - outside of the context of law, regulation, and agreements/contracts. The corollary to knowing what's required by law and regulation is knowing what's not.
- How will the research solve the problem?  
Understanding the explicit requirements of law, regulation and agreements/contracts leads to understanding what is *not required, discretionary, or open to subjective interpretation*. Such an understanding allows for the identification of opportunities for flexibility of environmental practice and provide DOTs a critical platform for negotiating more efficient practices with regulatory agencies to support project delivery.
- This problem statement is directly related to the strategic plan of AASHTO's Standing Committee on Environment and Sustainability (CES), specifically to "provide policy support to the AASHTO Board of Directors, Transportation Policy Forum, Councils, Committees, and Members" (Goal 1) and to "provide technical support to members to increase their capacity to efficiently and reliably deliver environmentally sound transportation programs and services" (Goal 2).

**Literature Search Summary**

There is no research that specifically addresses the problem defined here. However, there is case law where these issues have been litigated. A summary of available case law could contribute to a better understanding of when the requirements of law and regulation are ambiguous.

**Research Objective**

The objective of this research is to identify common examples of where environmental requirements and practices are based on discretionary agency policy and guidance, therefore exceeding the requirements of law, regulation, and agreements/contracts. In

doing so, the study will enhance the ability of the regulated community (DOTs) to negotiate more efficient practices that more directly conform to the requirements of law, regulation, and agreements/contracts than regulatory policy or guidance.

To do so, this study would examine at least five of the most impactful federal environmental statutes and their implementing regulations to highlight defined requirements and to examine to what extent environmental practices satisfy those statutory and regulatory requirements; and to identify examples of when "required" environmental practices exceed requirements outside of a basis in law and regulation.

Those statutes include:

- National Environmental Policy Act
- National Historic Preservation Act
- Endangered Species Act
- Clean Air Act
- Clean Water Act

For example, most State Historic Preservation Officers have issued guidance documents on the identification of historic properties relative to the requirements of the National Historic Preservation Act and its implementing regulation, guidance that often is treated as requirements but that often do not have statutory or regulatory standing on their own. Another example could pertain to climate change impacts and greenhouse gas (GHG) emissions, as currently there are no explicit federal requirements pertaining to transportation project-related GHG emissions, yet numerous guidance documents exist, and some state DOTs have even asked by FHWA to complete quantitative GHG emissions analyses for NEPA.

Major tasks include:

- Summarizing the legal context of law, regulation, agreements/contracts, policies, and guidance.
- Identifying examples of agreements/contracts, policies, and guidance that are used by federal and state regulatory agencies to administer the subject statutes.
- Identifying examples of where practices required by discretionary policies and guidance exceed the requirements of law, regulation, and agreements/contracts.
- Summarizing relevant case law and legal decisions related to the use of policies and guidance by federal and state agencies that exceed the requirements of law, regulation, and agreements/contracts.
- Identify opportunities and recommend strategies to negotiate more efficient practices with regulatory agencies that still conform to the requirements of law, regulation, and agreements/contracts.

The results of the research should be presented both as a publication of the National Academies and as the basis for a webinar or training program to disseminate the results to DOTs.

## **Urgency and Potential Benefits**

DOTs are among the most heavily regulated communities with regard to environmental requirements and practice. Currently more than 60 environmental statutes and regulations apply to transportation project development and construction. Yet in addition to those statutes and regulations, there exists a vast universe of discretionary policies and guidance documents that create a considerable burden above-and-beyond the requirements of law, regulation, and agreements/contracts. This universe of discretionary policies and guidance can expand without limit and without being subject to formal lawmaking and rulemaking. Often, it is policy and guidance from regulatory agencies that is as much a burden to DOTs as law and regulation. This situation exists nationwide and impacts every state DOT; and every state DOT will benefit from this research. Coincidentally, the environmental regulatory community could also benefit from the research by gaining a better understanding of the impact of discretionary policies and guidance, and be willing to collaborate with DOT partners to define more efficient practices where flexibility is available beyond the requirements of law and regulation.

### **Implementation Considerations and Supporters**

This research would primarily be implemented by state DOT environmental programs through negotiation of efficiencies to environmental analysis and project development with their regulatory partners. Negotiated efficiencies that more closely conform to the requirements of law and regulation would then be consistently implement in project development and construction, likely through consistency afforded by interagency agreements.

Other organizations that might be interested in the research results and could help support implementation include:

- Environmental and Legal Standing Committees of the Transportation Research Board (TRB)
- Federal Highway Administration
- Federal Transit Administration
- Federal Railway Administration
- State Environmental Agencies

### **Recommended Research Funding and Research Period**

Research Funding: \$350,000

Research Period: 2 Years

### **Problem Statement Author(s)**

- Antony F. Opperman  
Virginia Department of Transportation, Environmental Division  
Mobile: 757-254-9045  
Email: a.opperman@vdot.virginia.gov

### **Others Supporting the Problem Statement**

List organizations, including AASHTO Committees or Councils, which support this problem statement, and provide contact information.

- AASHTO Standing Committee on Environment and Sustainability (CES)

### **Potential Panel Members**

- To be determined, though environmental and legal representation from DOTs, FHWA, relevant TRB Standing Committees, and environmental regulatory agencies would be appropriate. Panel members should include representation from AASHTO's CES Steering Committee.

### **Person Submitting the Problem Statement**

- Timothy M. Hill  
Phone: (614) 644-0377  
Email: Tim.Hill@dot.ohio.gov  
Affiliation: AASHTO Standing Committee on Environment and Sustainability
- 

### **NCHRP Review of A-11**

#### Reviewed By:

Gwen Chisholm-Smith  
gsmith@nas.edu

Comments: A. The problem statement should be tweaked a bit before it can be solved. B. The topic of research should be of interest to at least 2/3s of state DOTs. C. The objective, as stated in the problem statement, does not provide a clear intent of the research. Reconsider use of "ambiguities" per comments in text. D. Not sure that the scope, as stated, is reasonable. Consider narrowing the scope to federally funded projects. Also, a consideration should be whether this research could put TRB in a position adversarial to its Federal sponsor/partners. What is the problem, and whom does it affect? Text as stated: Environmental requirements and practices in transportation are founded in established law and regulation. Law and regulation is augmented by defined requirements of environmental agreements/contracts and filtered through agency policies and guidance. Environmental activities, however, sometimes are carried out by DOTs - at the insistence of regulatory agencies - outside of the context of law, regulation, and agreements/contracts. The corollary to knowing what's required by law and regulation is knowing what's not. SPO Comment: What is meant by "outside the context of law"? Not clear how or why it should be anything other than in context. How will the research solve the problem? Text as stated: Understanding the explicit requirements of law, regulation and agreements/contracts leads to understanding what is not required, discretionary, or open to subjective interpretation. SPO Comment: Two points: In environmental law DOT's are often dealing with both state and federal law on the same project. Some state laws apply when there are no federal funds in a project and others augment or supplement federal laws/regulations. As a general rule states are permitted to enact requirements that are stricter than federal standards. California is Exhibit "A" in this regard. I say all this because for a researcher to convey the desired "understanding" they are going to have to analyze

Federal, state and in some cases local law and regulations. That will be a huge task so I suggest it would be essential to establish some reasonable boundaries for this project. Even if it were to be limited to NEPA and state “baby NEPA’s” it will be a substantial undertaking. Text as stated: Such an understanding allows for the identification of opportunities for flexibility of environmental practice and provide DOTs a critical platform for negotiating more efficient practices with regulatory agencies to support project delivery. SPO Comment: It is a big part of determining what is and/or is not required and if there is no case law on point will be a substantial undertaking. Also, understanding the legal opportunities to obtain exceptions from statutes/regulations is a factor here. Example: the USDOT/ Council on Environmental Quality SEP 15 process. Literature Search Summary Text as stated: There is no research that specifically addresses the problem defined here. However, there is case law where these issues have been litigated. A summary of available case law could contribute to a better understanding of when the requirements of law and regulation are ambiguous. SPO Comment: Volume 3 - Environmental Law and Transportation is a good starting point on the case law component. This segment reads like perceived ambiguity in law or regulations connotes a choice or option on the part of the transportation agency to follow a less rigorous path. Ambiguities in laws or regulations are subject to separate laws and regulations that expressly address how ambiguities are to be resolved. It can be through court decisions, statutes or other regulations. For example, in many states there is the statutory construction act which prescribes methodologies for understanding/interpreting statutory and regulatory language. Goal one is to ascertain the legislative intent behind the statute and interpret it accordingly. There are also set protocols for resolving conflicts, both internal and with other statutes/regulations. If these measures don’t provide a resolution then what you have left may be a loophole. It’s worth knowing where loopholes exist but generally once they are identified they are closed. Research Objective Text as stated: The objective of this research is to identify common examples of where environmental requirements and practices are based on discretionary agency policy and guidance, therefore exceeding the requirements of law, regulation, and agreements/contracts. In doing so, the study will enhance the ability of the regulated community (DOTs) to negotiate more efficient practices that more directly conform to the requirements of law, regulation, and agreements/contracts than regulatory policy or guidance. SPO Comment: A regulatory agency’s authority to prescribe policy and guidance is itself a creature of law. Substantive (nonprocedural) requirements and practices that exceed/fail to conform to the requirements of law/regulations are extralegal which is a defense to a charged violation. A DOT can choose to attempt to negotiate a change in the regulatory agency’s discretionary policy and guidance rather than litigate its enforceability but it either conforms to the law or it does not it’s not a matter of degree. Text as stated: To do so, this study would examine at least five of the most impactful federal environmental statutes and their implementing regulations to highlight defined requirements and to examine to what extent environmental practices satisfy those statutory and regulatory requirements; and to identify examples of when “required” environmental practices exceed requirements outside of a basis in law and regulation. Those statutes include: “National Environmental Policy Act “ National Historic Preservation Act “ Endangered Species Act “ Clean Air Act “ Clean Water Act For example, most State Historic Preservation

Officers have issued guidance documents on the identification of historic properties relative to the requirements of the National Historic Preservation Act and its implementing regulation, guidance that often is treated as requirements but that often do not have statutory or regulatory standing on their own. Another example could pertain to climate change impacts and greenhouse gas (GHG) emissions, as currently there are no explicit federal requirements pertaining to transportation project-related GHG emissions, yet numerous guidance documents exist, and some state DOTs have even asked by FHWA to complete quantitative GHG emissions analyses for NEPA. Have DOT's mounted legal challenges' SPO Comment: Have they appealed permit denials? Should NCHRP be identifying potential legal challenges to FHWA and/or EPA? Implementation Considerations and Supporters This research would primarily be implemented by state DOT environmental programs through negotiation of efficiencies to environmental analysis and project development with their regulatory partners. Negotiated efficiencies that more closely conform to the requirements of law and regulation would then be consistently implement in project development and construction, likely through consistency afforded by interagency agreements. SPO Comment: It goes unsaid that, failing in negotiations, the next step could be litigation based on this research product. Can NCHRP put itself in this position? The estimated budget of \$350,000 seems appropriate for this level of effort.

Review Date:  
12/22/2020

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## **FHWA Evaluation of A-11**

Reviewed By: HEPE/Emily Biondi; HEPN/Gary Jensen

Comments:

The statement does not define a clear problem that could be addressed through research, but should be addressed as a series of policy papers or discussions between transportation agencies and regulators.

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-A-12**

**Problem Title**

Identify and Weigh the Benefits and Co-benefits to Create a CRP Knowledge Base at the Intersection of Community Resilience and Transportation Resilience

**Background**

There are tens of thousands of published resources related to resilience – especially within the last five years. The diversity and foci of these publications and the diversity of the journals that carry them, testify to the multi-disciplinary reach and continued expansion of resilience. For those attempting to navigate, learn from, and apply the insights and learnings in this vast and growing body of knowledge, there are few avenues available that aggregate and organize these resources for easy access and consumption for specific purposes. This is especially true when accessing combinations of foci, such as knowledge related to the intersections of transportation resilience and community resilience. A simple online search for transportation resilience yields 118 million possibilities, while community resilience yields 123 million. A combined search (transportation and community resilience) results in 86.6 million with 378,000 scholarly articles, and of those 20,200 were published over the last two years.

For those needing to rely on this body of work with the purpose of credibly and successfully guiding others -- in this case, for the furtherance of DOTs and their ability to both develop and enhance their position on transportation resilience with full comprehension, inclusion, and support of community resilience -- it will be essential to focus on defining a strategy for sorting through, prioritizing, building, and managing a CRP Resiliency Knowledge Base that is robust, trusted, and dynamic. This will involve creating a framework of parameters for selecting and categorizing content, inclusive of all common and interdependent aspects of both transportation resilience and community resilience, as well as identifying and vetting aspects of resilience that continue to move into consideration or shift the emphasis for either transportation or community resilience to characterize their potential influence and impacts on DOTs position on resilience (e.g., mobility, pandemics, & governance).

**Literature Search Summary**

The goal of the proposed project is to provide a means to summarize the extensive existing literature. Some high-level existing literature includes:

- Business Case and Communications Strategies for State DOT Resilience Efforts (TRB, 2020)
- Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazard Risk and Resilience Analysis (TRB, 2020)



- Incorporating Resilience Concepts and Strategies in Transportation Planning (TRB, 2020)
- Design Guide and Standards for Resilience (TRB, 2020)

### **Research Objective**

The research will culminate in a guidebook inclusive of a defined strategy for building a CRP Resiliency Knowledge Base in the DOTs. Benchmarks will feature topic areas of interest, the suitability of such topic areas relative to a resiliency knowledge base, and a sustained approach to managing the knowledge base. The data collection will formulate a holistic network of individuals and cataloged resources of resiliency information products in the transportation sector.

### **Urgency and Potential Benefits**

The data collection component creates a vast network of engaged professionals passionate about resilience in the transportation sector. Working relationships generate the potential for expansion and commitment to integration, evaluation, and evolution of resiliency concepts and application within a cohesive strategy that features measurable benchmarks for evaluating implementation.

### **Implementation Considerations and Supporters**

NIST CRP is part of broader disaster resilience work of critical importance to the public and private sectors. Senior transportation leaders and practitioners building a capacity for resilience, integrating resilience in transportation (or other) systems, pursuing resilience transportation systems or components, and in pursuit of resilience communities would benefit from the multi-faceted approach.

### **Recommended Research Funding and Research Period**

Research Funding: \$300,000

Research Period: 18 months

### **Problem Statement Author(s)**

Chelsea Treboniak, Critical Ops, (443) 404-1879, [chelsea@criticalops.com](mailto:chelsea@criticalops.com)

### **Others Supporting the Problem Statement**

AMR10, TRB Standing Committee on Critical Transportation Infrastructure Protection, Laurie Radow, Chair, [lradow2@gmail.com](mailto:lradow2@gmail.com)

### **Potential Panel Members**

- Liisa Ecola, RAND Corporation/AMR10, Critical Infrastructure Protection committee, research coordinator, 703-413-1100 x5433, [lecola@rand.org](mailto:lecola@rand.org)

- Patrick Cowley, Utah Department of Transportation, Director of the Transportation Performance Management Division, 801-648-5459, patrickcowley@utah.gov

### **Person Submitting the Problem Statement**

David Stevens  
UDOT Research Project Manager  
801-589-8340  
davidstevens@utah.gov  
Utah DOT

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### **NCHRP Review of A-12**

Reviewed By:  
Andrew C. Lemer  
alemer@nas.edu

Comments:

A feasibility study for creating a knowledge base on transportation and community resilience would necessarily include some definition of what the “knowledge base” would comprise, how it would be developed, maintained, and made available to users, who those users might be, as well as an assessment of the benefits and costs of development and operation. Whether such a study could be accomplished for the budget proposed seems questionable, but a “guidebook” presenting a strategy for undertaking development of the knowledge base would have to go beyond the feasibility study, addressing such matters as building support for the idea and meeting long-term resource needs. The scope of this research should be more narrowly focused.

Review Date:  
12/8/2020

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### **FHWA Evaluation of A-12**

Reviewed By: HEPN/Becky Lupes

Comments:

This project would develop a framework for developing a “dynamic” “knowledge base” of resilience literature summaries. It would be helpful for the proposers to define “CRP.” It is unclear from the proposal who would do the work of summarizing the literature and

keeping the “knowledge base” current and where it might be housed. Would such a niche database have the volume of input required to keep it current? It would be helpful for the proposal to describe how this knowledge base would differ in content, functionality, and use of the TRID database. The proposed cost for the project (\$300,000) seems high given the research proposes to develop a guidebook on how to create such a Knowledge Base, but would not implement it.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for A-12**

Submitted By:  
King Gee  
AASHTO Staff  
Knowledge Management

Priority #: 6

Comments: This project will provide a vision for just-in-time information to support resiliency and could serve as a model for other disciplines. Is research needed or would development of a guide such as the Extreme Event Preparedness & Response for Operations LibGuide effective? It would be valuable to include a research objective on business analysis to identify business requirements for the target audience and vocabularies that will guide search and navigation of the resource over time. Findability and discovery of data and information should also be considered in this project as well as the format for delivery. The lengthy PDF format about the methods used in to deliver a project may be a daunting barrier to use. Would user content in searchable html format be more feasible for use? We already know practices that could improve access to and use of material but lack organizational intent, strategy, and resources to execute these practices.

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## **Submitter Response for 2022-A-12**

**From:** [email: davidstevens@utah.gov]

**Comments:**

We appreciate the feedback provided by the FHWA and NCHRP evaluators. Chelsea Treboniak, author of the problem statement, provided the following revised Research Objective as a suggested modification for the problem statement and to address some of the evaluation comments:

“A feasibility study will culminate in a framework for building a Cooperative Research Program (CRP) Resiliency Knowledge Base. The analysis will consider relevant factors, including economic, technical, implementation, and management of the knowledge base. The data collection will formulate a holistic network of individuals, suitability of topic areas relative to a resilience knowledge base, and cataloged resources of resilience information products in the transportation sector.”

**Contact Info:**

Following are the author and the submitter of the problem statement and the evaluation response:

Chelsea Treboniak, Critical Ops, [chelsea@criticalops.com](mailto:chelsea@criticalops.com)

David Stevens, Utah Department of Transportation, [davidstevens@utah.gov](mailto:davidstevens@utah.gov)

Review Date:

1/29/2021

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# **Research Field B**

TRANSPORTATION PLANNING

American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation

FY2022 NCHRP PROBLEM STATEMENT OUTLINE

**Problem Number: 2022-B-01**

**Problem Title**

Freight Analysis Tool for Analyzing and Communicating Uncertainty to Decision makers

**Background**

In the world of freight, two specific *disruptions* are unfolding—first related to the freight planning and operations under uncertainty and second, the mismatch between shifting supply chains and freight infrastructure.

During the pandemic, decision makers and policymakers had questions about the impact of policies/regulations on the efficient and safe freight movement in a multimodal system. Most of these questions went unanswered because the current tools are not nimble enough to address the *complexities*<sup>3</sup> posed by the pandemic and/or other disruptions (weather-related events and man-made), i.e., uncertainty.

Even before the pandemic, State and local agencies were already struggling with existing freight operations and planning tools that were *insufficient* in quickly responding to uncertainties and adapting to new information, such as efficiently rerouting trucks through urban areas with an understanding of commodities and their movement.

Further, there are serious questions about the *mismatch* between shifting supply-chains and investment in freight infrastructure to maximize the Nation's economic competitiveness. For instance, at the national level, modern container ships at seaports can carry 21,000 TEUs, while full channel dimensions at the Nation's busiest ports are available less than 35 percent of the time<sup>4</sup>. Such discrepancy is observed at many other ports of entries (land or sea), jurisdictional borders (including states and cities), and with both international and domestic supply chains and modes.

COVID-19 has increased diversification of supply-chains and accelerated the growth of E-commerce that has started a war for distribution centers and small delivery hubs to cater same-day delivery near urban and suburban areas—leading to more stress on inadequate and non-freight centric infrastructure (such as ramps, at-grade crossings, signals, etc.).

Lastly, there is a lack of visualization tools to communicate uncertainty and its impact across several freight stakeholder levels for constructive dialogue with the public, decision makers, legislature, logistic providers, shippers, truckers, real-estate developers, etc.

<sup>3</sup> Complexities such as revised hours of service, changing demand and supply, the definition of essentials, border and bridge closures, height or weight restrictions, parking areas, alternative routes, and social equity.

<sup>4</sup> National Freight Strategic Plan <https://www.transportation.gov/freight/NFSP>

### *What is the problem?*

The problems are:

- Lack of Multi-resolution Freight Planning Tools to Analyze Uncertainties and Their Impact on Freight.
- Lack of Flexible Freight Planning Tools that incorporate changes in the Supply-Chain.
- Lack of Visualization Based and User-Friendly Tools to Communicate Impact of Uncertainties.

### *Whom does it affect, and How it relates to AASHTO's Freight Committee's Strategic Plan?*

The changing landscape of freight planning and operations under uncertainty and lack of effective communication tools affects all freight stakeholders and hinder the capability of state DOTs and government agencies (federal, state, and local) to:

- Develop consistent policies and effectively communicate uncertainty with freight stakeholders
- Engage with MPOs, RPOs, and other planning organizations
- Harmonize freight-related regulations
- Promote efficient multijurisdictional and international freight movement
- Minimize freight community impacts
- Reduce mismatch between supply-chain and planned infrastructure.

### *How will the research solve the problem?*

Research is needed to first study why existing quick planning tools cannot address uncertainties (both current and future scenarios), narrow down critical questions asked by agencies and the private freight industry across the US, highlight best practices or transferable solutions developed by state and local agencies. Next, develop a framework and later a simple tool that can integrate the new data and methods (included behavioral models developed during a pandemic, machine learning [ML] and artificial intelligence [AI]) with existing tools (analytical and visual) used by state DOTs and MPOs to quickly address these questions. The lack of simple tools has exacerbated these problems with no tools to answer the current and future freight planning and logistics questions — this research will attempt to find, develop and document solutions.

### **Literature Search Summary**

In preparing this submission, two literature searches were conducted. The first search was of all existing published research as recorded on the Transportation Research International Documentation website (<http://trid.trb.org>). A second search of current research projects was conducted on the Research in Progress website (<http://rip.trb.org/>).

The most relevant *literature* is listed<sup>5</sup>. The project that comes closest to incorporating uncertainty into freight planning is NCHRP 750 (Project 20-83(1)). This

<sup>5</sup> NCHRP Report 750, Strategic Issues Facing Transportation, Volume 1: Scenario Planning for Freight Transportation Infrastructure Investment, 2013

FHWA, Quick Response Freight Methods: Third Edition, 2019

SHRP 2 Vision Eval: Rapid Policy Analysis Tool (RPAT), 2019

earliest project introduced scenario planning as a tool that can be used with other planning methods to improve long-range transportation infrastructure planning quality.

Since, then there has been a lot of improvement in terms of the type of available real-time data (GPS, Sensors, ELD, etc.), surveys and freight flow data (CFS 2017, FAF 4, VIUS, BEA), quick response tools (see listed literature<sup>3</sup>), visualization tools (including Tableau and graph-based) and new models (behavior and tour based freight models) and advance methods (AI and ML). However, none of the tools form a bridge between scenario planning for uncertainty, quick response tools, new data, methods, and visualization tools.

Moreover, some of these baseline surveys do not account for pandemics and natural (hurricanes, snow, etc.) and man-made disasters the freight industry has experienced. The proposed research should first document all these in detail and then build upon all these developments.

## Research Objective

The research objective is to bridge the divide between uncertainty and current analytical and visualization freight tools. The desired outcome is a generalized framework and two specific tools for addressing and communicating uncertainties in freight planning and operations. The tools should (i) be built on the proposed generic framework (ii) should leverage existing tools, new data sources, and methods (iii) should have a visualization component. Major tasks necessary for the successful conduct of the research are (but not limited to):

- **State-of-the-Practice Review:** Interview state DOTs and explore current tools, future uncertainties, and top questions. Perform an in-depth review of developments in scenario planning and freight planning tools. Explore mechanisms of modeling uncertainty in the context of existing swift response freight planning and operation tools. Study and document the mismatch between emerging supply chains and freight infrastructure and possible solutions. Review data sources, sample representations, and availability.
- **Development of the Framework:** The lessons from the review should generate a generic framework that can be accounted for various types of uncertainty, questions, tools (visualization and analytical), data, and quickly measure their impact on freight. The key is to investigate new models, tools, data, methods, visualizations, and advances in computing, including ML, AI, to visually communicate to the audience.
- **Development and Implementation of Tools:** With the concurrence of research panelists and state DOTs the type and features of the tool should be narrowed

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NCHRP Report 897 Tools to Facilitate Implementation of Effective Metropolitan Freight Transportation Strategies, 2018

SHRP 2 Capacity Project C43, Innovations in Freight Demand Modeling and Data Improvement, 2014

NCFRP Report 8, Freight-Demand Modeling to Support Public-Sector Decision Making, 2010

NCHRP Report 606, Forecasting Statewide Freight Toolkit, 2008

NCHRP Report 388, A Guidebook for Forecasting Freight Transportation Demand, 1997



down (routing tool, investment tool etc.). At least two visualization-based tools should be developed to address the uncertainty scenarios identified in interviews with state DOTs. The tools should be designed with the objective of implementation by various state DOTs and MPOs. The tool has to be user-friendly and scalable to the extent possible.

- **Report:** Document findings, framework, developed tools, and manual for using tools and recommendations.

### **Urgency and Potential Benefits**

Over the past decade, the number and the average cost of major disaster events have increased significantly<sup>2</sup>. Expert epidemiologists are already predicting frequent emergence or reemergence of pandemics<sup>6</sup>. Technological innovations and adoptions are growing at an exponential pace. E-commerce is accelerating, and supply chains are frequently changing. All these developments add uncertainty in freight planning and operations, which tends to be static due to the proprietary information and complex nature of freight. Moreover, effectively communicating the impact of these uncertainties to freight stakeholders adds to this existing challenge.

In recent years, state DOTs have spent millions of dollars on new freight tools and new data sources to address freight planning problems. However, rarely do we have real-time answers to the questions asked by decision makers during uncertainty. This proposed statement is the first attempt to address the gap between real-time scenario planning, analyzing, and communicating results for pro-active responses. The negative impacts or consequences of not conducting this research will leave us in an analysis-paralysis situation with future disasters and pandemics. The key benefits of implementing the results will be to enable informed discussion of national, multi-state, state, regional and local freight policy and system investment priorities. This proposed work is consistent with AASHTO's special committee purpose of forward-looking view of freight issues, information dissemination, and encouraging research.

### **Implementation Considerations and Supporters**

The office or division of freight planning and logistics and groups that perform supply chain analysis within the state DOTs will likely benefit the most from this project. The office will have to coordinate with planning partners and other agencies to apply the research.

It is expected that the AASHTO Special Committee on Freight will promote the research results among its members, which includes all state DOTs. Individual state DOTs will coordinate and support disseminating the research results to their local and statewide partners (like MPOs). This research should be disseminated in training workshops on identifying uncertainties, complexities and implementing tools to analyze and present results in a visualization.

The authors of this problem statement circulated the draft statement for review and comment from state DOTs, and following officials have indicated support:

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<sup>6</sup> <https://www.cell.com/action/showPdf?pii=S0092-8674%2820%2931012-6>

Thomas McQueen, AT015 Committee Research Vice Chair, AASHTO Special Committee on Freight, Assistant Administrator, Office of Planning, Georgia Department of Transportation, 404.631.1785, tmcqueen@dot.ga.gov  
Dan Pallme, AASHTO Special Committee on Freight, Assistant Chief of Environment and Planning / Freight and Logistics Director, Tennessee Department of Transportation, 615.741.4031, Daniel.Pallme@tn.gov  
Dana Magliola, Sr. Supply Chain Analyst, North Carolina Department of Transportation, 919.707.0909, dmagliola@ncdot.gov  
Caroline Mays, AASHTO Special Committee on Freight Vice Chair, Director, Freight, Trade, and Connectivity Section, Texas Department of Transportation, 512-936-0904, caroline.mays@txdot.gov

### **Recommended Research Funding and Research Period**

A preliminary estimate to fund the research is in the range of \$350,000 and \$500,000. The estimate to facilitate key research products' communication and implementation is between \$10,000 and \$25,000. The research should be conducted and completed within one and a half (1.5) years.

### **Problem Statement Author(s)**

Ryan Endorf, Office of the Secretary of Transportation (OST), ryan.endorf@dot.gov, 202 366 4835  
Charles H.W. Edwards, AT015 Committee Research Chair, Professor of Practice, Department of City and Regional Planning, University of North Carolina at Chapel Hill, chwedwards@gmail.com, 919 215 0605  
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### **Others Supporting the Problem Statement**

AASHTO Special Committee on Freight, Caroline Kieltyka, Program Manager for Freight, 202.624.8489, ckieltyka@aashto.org  
AASHTO Committee on Planning, Matt Hardy, Program Director for Planning and Performance Management, (202) 624-3625, mhardy@aashto.org

### **Potential Panel Members**

Thomas McQueen, AT015 Committee Research Vice Chair, AASHTO Special Committee on Freight, Assistant Administrator, Office of Planning, Georgia Department of Transportation, 404.631.1785, tmcqueen@dot.ga.gov

Dan Pallme, AASHTO Special Committee on Freight, Assistant Chief of Environment and Planning / Freight and Logistics Director, Tennessee Department of Transportation, 615.741.4031, Daniel.Pallme@tn.gov

Dana Magliola, Sr. Supply Chain Analyst, North Carolina Department of Transportation, 919.707.0909, dmagliola@ncdot.gov

Caroline Mays, AASHTO Special Committee on Freight Vice Chair, Director, Freight, Trade, and Connectivity Section, Texas Department of Transportation, 512-936-0904, caroline.mays@txdot.gov

### **Person Submitting the Problem Statement**

Thomas McQueen, AT015 Committee Research Vice Chair, AASHTO Special Committee on Freight, Assistant Administrator, Office of Planning, Georgia Department of Transportation, 404.631.1785, tmcqueen@dot.ga.gov

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### **NCHRP Review of B-01**

#### Reviewed By:

William C. Rogers  
wrogers@nas.edu

#### Comments:

This is a very worthwhile project, but the time estimate is too optimistic and the cost too low. Recommend 30 months and \$500,000.

#### Review Date:

11/23/2020

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### **FHWA Evaluation of B-01**

#### Reviewed By: HOFM/Chandra Bondzie

#### Comments:

Research into new analysis tools is very much timely and needed. HOFM is also embarking on improvements to data visualization that examine similar problems if on different scales. Given the scope of work, would recommend the \$500,000 for funding the project rather than the lower amounts mentioned.

#### Review Date:

12/18/2020

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## Submitter Response for 2022-B-01

**From:** [email: tmcqueen@dot.ga.gov ]

FHWA Comment:

Research into new analysis tools is very much timely and needed. HOFM is also embarking on improvements to data visualization that examine similar problems if on different scales. Given the scope of work, would recommend the \$500,000 for funding the project rather than the lower amounts mentioned.

Comment Response: The proposal may be modified to 30 months and \$500,000.

NCHRP Comment: This is a very worthwhile project, but the time estimate is too optimistic and the cost too low. Recommend 30 months and \$500,000.

Comment Response: The proposal may be modified to 30 months and \$500,000.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement Outline**

**Problem Number: 2022-B-02**

**Problem Title: Valuation of Transportation Equity in Active Transportation and Safety Investments**

**Background**

Historic methods of transportation decision-making led to the design and construction of transportation facilities oriented towards the use of motorized vehicles, without full consideration of all road users. Redlining practices led to placement of roads and highways that severed or boxed in neighborhoods with majority Black, Indigenous, people of color (BIPOC) populations, concentrating and deepening both poverty and environmental health impacts from transportation-related pollutants. Roadway designs and operations emphasized higher speed throughput of drivers often without facilities for safe walking and bicycling, creating the context for greater exposure to serious injury and fatal crash involvement of active transportation modes in these communities. Driver behavior and potential biases, as well as land use and transportation infrastructure, have exacerbated the disparity in outcomes from a social equity perspective. Gaining a deeper understanding of the causes of and solutions to the disproportionate burden on historically marginalized groups requires a multi-sectoral and multi-step approach.

With data driven safety, it is important to understand how data can be used in performance analysis to inform tradeoff decisions during planning, the project development process, maintenance, and operations. The premise with this research is that, without the ability to analyze and evaluate social equity considerations, there will be limited ability for use of this critically important information throughout planning, project development, maintenance, and operational processes within transportation agencies. The results and products of this research would be incorporated into, for example, as the NEPA process, systemic safety analysis, prioritization of investments, evaluation of the existing system, and improving current mobility performance metrics. Tools to incorporate a systemic, risk-based approach to safety prioritization with a focus on promoting socially equitable outcomes would bring jurisdictions along in a twofold industry evolution: away from chasing hot spots to proactively promoting pedestrian safety, and with a renewed focus on equity. Such a tool would help to ensure traditionally underserved communities, who are disproportionately involved in collisions, benefit from safety investments. This tool could build off of the foundation provided by both NCHRP Report 893 - Systemic Pedestrian Safety Analysis and NCHRP Report 803 – Pedestrian and Bicycle Transportation Along Existing Roads – ActiveTrans Priority Tool Guidebook.

**Literature Search Summary**

Limited research exists on applications of social equity in roadway safety processes, procedures, and analysis activities. While the number of research projects have increased, few if any addresses the specific need to incorporate equity into data assessments, analysis, and performance-based tradeoff decision making. There does

not appear to be research immediately available on the use of quantifying the benefits of equity for the purposes of safety performance analysis.

- Understanding Pedestrian Crash Injury and Social Equity Disparities in Oregon. Oregon Department of Transportation, 2020, Active Research.
- A systematic overview of transportation equity in terms of accessibility, traffic emissions, and safety outcomes: From conventional to emerging technologies. Transportation Research Interdisciplinary Perspectives, Volume 4, Issue 0, 2020.
- Developing a Data-Driven Safety Assessment Framework for RITI Communities in Washington State Center for Safety Equity in Transportation, 2019.
- Equity Analysis of Proactively- vs. Reactively-Identified Traffic Safety Issues. Transportation Research Record: Journal of the Transportation Research Board, Volume 2673, Issue 7, 2019, pp 596-606.
- Pedestrian and Bicycle Crash Risk and Equity: Implications for Street Improvement Projects, University of Minnesota, 2019, 53p  
[http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2804\\_007-2016](http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2804_007-2016)
- 007–2016 Fatal Traffic Crashes in Alaska, Hawaii, Idaho, and Washington and Characteristics of Traffic Fatalities Involving Hawaiians and CSET Minorities, 2019, 94p 2019-02-2.

## **Objective**

The objective of this research is to advance the use of social equity considerations in planning, programming, design and operation of transportation systems. This research will develop data driven tools and guidelines for use by practitioners in safety decision making and in supporting Safe System principles, considering modal priorities and in performance tracking to reduce the potential for fatal and serious injury crashes. This research recognizes that past decisions have created system inequities for BIPOC populations and intends to address the overrepresentation of these communities in severe crash outcomes. This research also recognizes that by addressing these system inequities all road users benefit as system gaps are overcome. The tools may include models, checklists, worksheets and processes that will assist practitioners in how to consider and account for social equity in safety projects, as well as project related to mobility, preservation and operations. The knowledge created as part of this effort will also inform data driven tools such as the Highway Safety Manual and will include updates to appropriate chapters of the HSM to include equity in safety.

The successful completion of this project, at a minimum, will consist of the following tasks:

### **Phase I:**

- Task 1 – *Review safety equity literature and state-of-the-art practice on the use of equity consideration in decision making and prioritization.*
- Task 2 – *Identify source data needs to assess safety equity in decision making and development of models*
- Task 3 – *Prepare a Phase II work plan* indicating a methodological framework for developing tools and an approach for the use of social equity considerations in safety modeling and decision making.

- Task 4 – *Prepare an interim report* documenting the literature review, datasets, and proposed work plan.

### **Phase II:**

- Task 5 – *Execute Work Plan* developed in Task 4 and approved by the NCHRP panel.
- Task 6 – *Complete a detailed application and pilot application of safety equity decision making*
- Task 7 – *Develop a user-friendly guideline* to facilitate the use of equity in safety in planning, programming, design, maintenance, and operations. This guide will also include details on how the data and analysis results can be used by agencies to deliver Safe System and modal priority outcomes.
- Task 8 – *Prepare final deliverables and recommendations* documenting the results of pilot assessments and analysis, the availability and frequency of source data, and how this information can be used from planning through operations. The deliverable would also include steps for local and state agencies looking to implement and consider equity to achieve a Safe System and modal priority outcomes. This task will also develop a section suitable for inclusion in the AASHTO Highway Safety Manual.

### **Urgency and Potential Benefits**

The AASHTO Committee on Safety has identified this research as a high priority. The ability to serve all communities, particularly those who need adequate transportation systems to perform daily task is critical. The ability to provide an approach will provide value, not only in safety programs, but mobility projects and in environmental impact statements where environmental justice considerations are required. Past system approaches that redline through communities of color and lower incomes created significant gaps in the transportation system for these communities. Not only do gaps exist, but people of color and lower incomes are overrepresented in crashes at all levels: the research attempts to address this problem. The new guidelines and tools will be used in data driven safety analysis as well as in performance-based approaches to planning, project development, maintenance, and operations. This research will help local and state agencies optimize existing resources to reduce roadway fatalities and support Safe Systems outcomes and the broader sustainable benefits of modal priority. In addition, this research would benefit Toward Zero Deaths, Vision Zero, and Road to Zero Efforts in the US.

### **Implementation**

Transportation agencies continue to struggle with providing transportation systems that adequately serve communities who need them the most because of their reliance on public transportation, walking, biking, and rolling. This research will develop methods and tools for decision that can be used in practice for bridging these system gaps and bring equity considerations into safety decision making throughout planning, project development, maintenance, and operations of the transportation system. Results of this research could be included in national-level resources such as the Highway Safety Manual, and other tools that support data driven safety analysis.

## **Recommended Research Funding and Research Period**

Recommended Funding: \$650,000

Research Period: 24 months

### **Person(s) Developing the Problem Statement**

John Milton, *Washington State DOT*

Barb Chamberlain, *Washington State DOT*

Ida van Schalkwyk, *Washington State DOT*

Torsha Bhattacharya, *Rails to Trails Conservancy*

Mike Alston, *Kittelson and Associates*

### **Others Supporting Problem Statement**

AASHTO Council on Active Transportation, AASHTO Committee on Safety, TRB's Pedestrian and Bicycle Transportation Committees.

### **Potential Panel Members**

#### **Submitted By**

Name: Phillip Burgoyne-Allen

Phone: (202) 624-3692

Email: pballen@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Council on Active Transportation

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#### Reviewed By:

Leslie C. Harwood

LHarwood@nas.edu

#### Comments:

This is a topic of considerable interest to DOT. The problem covered by this potential project may be moderated through research and the guidance and tools that this project is expected to produce will assist practitioners in addressing the issue of social inequity in transportation planning, programming, design, and operation; however, there is a need to clarify that this project is focusing on safety equity (as the tasks imply) in decision-making and prioritization. The scope and budget are reasonable and the project should need no more than 24 months to complete.

#### Review Date:

1/5/2021

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## **FHWA Evaluation of B-02**



Reviewed By: HSA/Karen Scurry

Comments:

With the current attention on equity and the introduction of the Safe System approach, which promotes a safe system for all road users and responsibility is shared, this RNS is timely. This research is consistent with the recommendations in the FHWA Integrating Safe System in HSIP report and also came up during the regional safety engineer roundtable meetings. There are some projects that have used census data such as household income below poverty level, 0 vehicle households, but think there is more that can be done. It would also be beneficial to make a connection between safety equity with other work on transportation equity that is being institutionalized in planning, programming, design, maintenance, and operations (e.g. environmental justice).

Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for B-02**

Submitted By:

Kelly Hardy

AASHTO Staff

Committee on Safety

Priority #: N/A

Comments: Matching this RNS with any looking at estimating/predicting non-motorized exposure should be linked. This project would be beneficial in identifying data and methods to identify safety needs using equity, but most states are likely to lack data relating to this issue. Rating: 3.3

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## **Submitter Response for 2022-B-02**

**From:** [email: pballen@ashto.org]

**Comments:** We (CAT) concur with FHWA and NCHRP that this proposal is timely and relevant, valuable for practitioners and the field, and meaningfully focused on equity. We appreciate their feedback on considering additional data sources and clarifying the proposal's focus. This was the only problem statement CAT submitted this year, and it is our top priority. Thank you for your consideration.

**Contact Info:** Phillip Burgoyne-Allen, AASHTO, pballen@ashto.org

Review Date: 02/08/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-03**

**Problem Title**

Building Risk-Management Momentum in Agencies

**Background**

Formal risk management is becoming a best practice in the private sector. Many federal agencies now have functional risk-management programs as well. Yet State DOTs have been slow to implement the business practice of risk management.

The current challenges of disruptive changes to DOT operations due the COVID-19 pandemic and resulting decreases in revenues for transportation funding further emphasize the need for proactive risk management in order to identify response strategies that will manage potential risks to strategic objectives. Disruptive technologies, a changing workforce, and the ongoing requirement to develop and maintain risk-based asset management plans drive the relevance and requirement of adoption of formal risk management within transportation agencies.

**The Problem:** State transportation departments (DOTs) have not widely adopted formal risk management.

A few agencies do have effective formal risk-management programs in one or several areas of their business, but only a few have implemented risk management agency-wide. Other agencies have piloted risk management for one purpose or another but then did not implement it fully or sustain it. Many others have not yet attempted formal risk management.

- Why has formal risk management not gained the necessary momentum in state DOTs?
- What are the barriers to adoption and sustained implementation of formal risk management in state DOTs?
- How can those barriers be overcome to ensure long-term implementation and benefits?
- How has the private sector implemented risk management and how can we translate findings and best practices to State DOTs?

**Literature Search Summary**

This project builds upon previous research projects and guides that acknowledge potential barriers to implementation. Some research even suggest approaches to overcome some of those barriers.

Previous and ongoing research studies that serve as background for this project include:

- NCHRP 08-93: Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation
- NCHRP 08-36, Task 121: Successful Implementation of Enterprise Risk Management in State Transportation Agencies
- NCHRP 20-44(02): Implementation of the AASHTO Guide for Enterprise Risk Management
- NCHRP 08-113: Integrating Effective Transportation Performance, Risk, and Asset Management Practices

### **Research Objective**

The objectives of this research are to:

- Identify and evaluate potential barriers to adoption and sustained implementation of formal risk-management practices and a risk-informed culture in state DOTs.
- Identify best practices of risk management implementation from the private sector.
- Identify effective approaches to overcome those barriers and enable broad adoption of formal risk-management by state DOTs, ultimately driving sufficient risk-management “momentum” and associated benefits.

Previous research efforts and guides included written reports but did not lead to wide adoption. Hence, this research effort needs to develop an innovative approach to help, including some traditional methods like CEO and risk practitioner workshops and peer exchanges as well as proven best practices from the private sector. This innovative approach should be piloted in up to three state DOTs.

### **Urgency and Potential Benefits**

State DOTs face many significant and increasing uncertainties and emerging risks, such as challenges related to limited funding, aging infrastructure, rapid introduction of disruptive and transformational technologies, and increasing customer expectations. State DOTs need effective ways to address these risks in decision-making and ultimately improve their ability to achieve objectives. Formal risk management is proven in private industry to help do this, especially when treated as an integral part of strategic planning and performance management.

### **Implementation Considerations and Supporters**

The target audience for this project is state DOT risk-management champions, whether self-designated or officially appointed. These individuals are likely already “sold” on the benefits of formal risk management, but have been unable to convince executives or other senior decision-makers to sustainably implement formal risk management. An additional key audience is State transportation agency CEOs and senior decision-makers to realize the benefits of good risk management and to dedicate appropriate resources to drive implementation.

Two AASHTO Committees in particular (the Committee on Performance-Based Management and the Committee on Transportation System Security and Resilience) have embraced the importance of formal risk management. Representatives from state DOTs active in the Subcommittee on Risk Management also recently expressed interest in gaining risk-management momentum. In addition, risk management cuts across all areas of a state DOT's business and just about any AASHTO Committee and any state DOT could realize benefits from these research results.

### **Recommended Research Funding and Research Period**

Recommended funding: \$350,000. This includes \$250,000 for a full-time investigator (or two half-time investigators) for a year, plus agency and logistical costs for up to three pilot applications in state DOTs.

Recommended research period: 18-24 months. This includes up to three pilot applications of the final product in a state DOT.

### **Problem Statement Author(s)**

The following individuals contributed to development of this problem statement:

- Travis McGrath, PhD, PE, previously with Idaho Transportation Department;
- Mónica Alemán-Smoot, MPA, JD, Texas Department of Transportation, (512) 305-9506, Monica.AlemanSmoot@txdot.gov;
- Anne-Marie McDonnell, Connecticut Department of Transportation, (860) 533-9611, annemarie.mcdonnell@ct.gov;
- Nathan Lee, Utah Department of Transportation, (801) 965-4082, nlee@utah.gov;
- Jean Wallace, Minnesota Department of Transportation, (651) 366-3181, jean.wallace@state.mn.us.

### **Others Supporting the Problem Statement**

- AASHTO Committee on Performance-based Management, Tim Henkel, Chair
- AASHTO Subcommittee on Risk Management, Jean Wallace, Chair

### **Potential Panel Members**

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Performance-based Management and the Subcommittee on Risk Management. Below are those indicating their desire to serve:

- Anne-Marie McDonnell, Connecticut Department of Transportation, (860) 533-9611, annemarie.mcdonnell@ct.gov
- Nathan Lee, Utah Department of Transportation, (801) 965-4082, nlee@utah.gov
- Mónica Alemán-Smoot, MPA, JD, Texas Department of Transportation, (512) 305-

9506, Monica.AlemanSmoot@txdot.gov.

- Jean Wallace, PE, PMP, Minnesota DOT, Co-Chair, AASHTO Subcommittee on Risk Management, (651) 366-3181, Jean.Wallace@state.mn.us

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Matthew Hardy
- 202-624-3625
- mhardy@ashto.org
- Affiliation:  
AASHTO staff on behalf of the AASHTO Committee on Performance-based Management, Tim Henkel, Chair.

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### **NCHRP Review of B-03**

#### Reviewed By:

Andrew C. Lemer  
alemer@nas.edu

#### Comments:

This problem statement asserts that DOTs have not widely adopted formal risk management and greater momentum is needed in adopting risk management practices. Considering the literature cited and, for example, the text of Problem Number 2022-A-04, the reader is left wondering, what are the criteria underlying these assertions. The problem statement needs better definition and justification than are currently presented.

#### Review Date:

12/8/2020

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### **FHWA Evaluation of B-03**

#### Reviewed By: HEPP/Harlan Miller

#### Comments:

Problem statements B-3 (Risk Management) and B-7 (Uncertainty in Long-range Planning) are timely and needed. These two projects could be consolidated into one research project (Risk Management and Uncertainty) as they are interrelated and would be best done together as they serve a common theme and need.

Review Date:  
12/18/2020

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### **Submitter Response for 2022-B-03**

**From:** [email: mhardy@ashto.org]

**Comments:**

In response to the comment from the FHWA: We appreciate the recognition of uncertainty and risk management in both B-03 and B-07, and we understand the recommendation to combine these two need statements. The intent of B-03 is meant to specifically address growing the maturity, deployment and utilization of risk management broadly within State DOTs. This work is intended to align and support AASHTO's Transportation Performance Management (TPM) rather long-range planning. We recommend that B-03 continues as a stand-alone research need statement.

In response to the comment from NCHRP: we offer the observations of the AASHTO Subcommittee on Risk Management to support the need for this research. While State DOTs continue to make progress in applying risk management, we still are not seeing widespread integration of risk-based decision-making at the project, program, and enterprise levels. The AASHTO ERM Guide created the processes, and the 20-44(02) implementation project made progress in piloting implementation of the guide. However, it is noted that we lag behind the private sector and even other transportation agencies across the globe. The intent of this research is to better understand barriers to fully integrating risk management and identifying best practices and approaches to overcoming those institutional barriers to risk management adoption and risk-based decision-making.

**Contact Info:**

Matt Hardy on behalf of the Committee on Performance-Based Management

Review Date:

1/29/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022–B-04**

**Problem Title:** Strategies for Advancing Equity in Transportation Planning by Increasing Diversity, Equity, and Inclusiveness in The Transportation Planning Profession

**Background:**

Title VI of the Civil Rights Act requires every transportation agency that manages Federal funds to ensure that its plans, programs, policies, services, and investments benefit everyone in its jurisdiction equitably. Understanding the actual and potential negative impacts of transportation decisions on minority populations, low-income households, women, and other historically underrepresented populations and taking meaningful action to resolve inequities are critical functions of transportation agencies.

Transportation planners are central to the work of changing the trajectory of environmental injustice. The transportation plan documents the urgent needs of the community and lays out the blueprint for transportation investments and policies. These plans are based upon the data gathering, modeling, analysis, and public engagement conducted by planners working in or for State DOTs, MPOs, and transit agencies. Planners make fundamental choices about which questions are important to ask, how to ask them, and what to do with the answers, and structure the planning process accordingly. If they are unaware of, misunderstand, or dismiss the questions that are important to underrepresented populations, the plan is less likely to address those concerns, and, at worst, could set the stage for investments and policies that harm these communities. If the planning team members are all from similar backgrounds and hold similar perspectives, it may be difficult for them to spot the presence of their own cultural biases, and to counter the potential negative effects of those biases on the development of a plan that meaningfully advances equitable transportation goals.

The transportation planning and analysis field has been slow to incorporate racial/cultural and gender-related concerns into its methods meaningfully, and to identify potential biases and disparities within the practices of travel data collection, analysis, engagement, and plan development. Meanwhile, women and Black, Indigenous, People of Color (BIPOC) have been historically, and continue to be, underrepresented in the field. They are less likely to study fields leading to transportation planning careers, less likely to be promoted to leadership roles, and subject to racism, sexism, and exclusion in the workplace. The extent and distribution of that underrepresentation within the planning field have not been consistently and clearly documented, and there is not a clear understanding on how it manifests itself and permeates the workforce. In order to address inequities in transportation decisionmaking, the industry needs a clear understanding of the extent to which women and BIPOC are excluded from meaningful



roles in transportation planning, the ways in which this imbalance impacts the quality of equitable planning, analysis, and decision-making, and potential strategies for improving diversity, inclusiveness and equity within the transportation planning profession.

### **Literature Search Summary:**

Little has been done to quantify and understand any lack of representation in the transportation planning workforce. Some recent studies have specifically looking at the representation of women in transportation, such as the recently published report on women in the transit industry<sup>7</sup>. The LA Metro Women and Girls Governing Council (WGGC) have made strides to have a gender-balanced work, accelerate change for women, develop comprehensive strategies to address gender inequity, including examining their role as an employer<sup>8</sup>. The WGGC also recently published a groundbreaking report on Understanding How Women Travel<sup>9</sup> that provides some useful background on inequities in the transport system. Still, not much is known about the makeup of the transportation planning workforce, especially in terms of gender identity, race, and the intersection of those basic characteristics.

Cambridge Systematics, Inc. (CS), a solely transportation planning consulting firm, recently undertook a full assessment of their firm's diversity, equity, and inclusion culture, starting with a comprehensive data collection effort. Evaluation of CS employment data since 2005 compared to the US population revealed significant underrepresentation of non-white non-Asian people of color, with the differences being even more significant for those in management or leadership positions. While this is just one company, there was little to no data for comparison against the industry as a whole. An informal survey of travel demand modelers through a Travel Model Improvement Program forum was compared to data on CS's modelers and revealed similar characteristics. For travel demand modeling in particular, women as well as non-white non-Asian people of color are underrepresented in the industry<sup>10</sup>. While this analysis certainly suggests a lack of diverse representation, it is based on a small sample size and does not provide a comprehensive picture of the transportation planning industry.

### **Research Objective:**

The objective of this research is to fully understand the scope and causes of the problem of lack of diversity, equity, and inclusion within the transportation planning and analysis field, and to make clear and actionable recommendations to employers, leaders, professionals, and academics for effective strategies to achieve meaningfully greater diversity throughout the industry. The desired outcomes of this project include:

- Defining the extent to which women and BIPOC are underrepresented within the transportation planning field.

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<sup>7</sup> National Academies of Sciences, Engineering, and Medicine 2020. Attracting, Retaining, and Advancing Women in Transit. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25741>.

<sup>8</sup> <https://www.metro.net/projects/wggc/>

<sup>9</sup> LA Metro. Understanding How Women Travel. [http://libraryarchives.metro.net/DB\\_Attachments/2019-0294/UnderstandingHowWomenTravel\\_FullReport\\_FINAL.pdf](http://libraryarchives.metro.net/DB_Attachments/2019-0294/UnderstandingHowWomenTravel_FullReport_FINAL.pdf)

<sup>10</sup> Zephyr Panel on Race and Gender Lenses in Modeling and Data Collection. 2020. <https://zephyrtransport.org/events/2020-07-22-panel-race-gender-lenses/>

- Identifying the potential impacts of underrepresentation of women and BIPOC within the professional ranks of planners and analysts responsible for conducting transportation plans on the ability of agencies to develop plans and programs that address historic inequities in their jurisdictions.
- Identifying potential causes and correlations associated with the underrepresentation of women and BIPOC in the transportation planning field.
- Understanding the trajectory of the industry by examining trends in agency workforces and in the pipeline of transportation professionals earning credentials through higher education and professional development programs;
- Identifying potential strategies and measures of success for improving the representation of women and BIPOC within the transportation planning profession, and associated strategies for improving the process of equitable transportation planning and decision making; and
- Proposing applications of these strategies and measures of success within public and private sector transportation planning agencies, institutes of higher education, and professional development organizations.

Major tasks or activities could include:

- Quantify and analyze the diversity of the transportation planning industry, segmented by dimensions such as person characteristics (gender identity, race, ethnicity, etc.), employer characteristics (public, private, academic), location/geography, tenure, seniority, and areas of focus within transportation planning.
- Analyze hiring, retention, pay equity, employee satisfaction, and professional development practices by those same diversity dimensions.
- Assess the diversity of the pipeline of transportation professionals at the university level and associated implications for diversity within the professional realm.
- Identify the ways in which increased workforce diversity, equity, and inclusiveness can improve the development of equitable transportation plan analyses, engagement, decision-making on investments and policies, and long-term outcomes.
- Develop actionable recommendations for organizations to assess their levels of diversity, equity, and inclusiveness internally and to take meaningful steps toward advancing workforce development that could improve the ability of the agency to develop more equitable transportation plans and programs.

### **Urgency and Potential Benefits:**

State DOTs are mindful of planning decisions in past generations that were heavily informed by planning efforts and analyses. As just one example of which there are many, the building of urban freeways through vibrant communities of color was heavily informed by forecasting decisions that valued and calculated travel time savings for suburban drivers above considerations of community cohesion and health. A focus on peak hour commute congestion continues to drive inequities in transportation. These forecasters and analysts were nearly all white men.

Transportation planning has never been more relevant and vital to decision-making as new data sources and new transportation modes revolutionize the industry. Key decisions made by state DOTs and other planning agencies in the next decade, informed by today's transportation planning workforce, will impact those decisions. As equity is at the forefront of many planning agencies today, varying perspectives of the workforce can help to lead to a broader representation of the diversity of our communities' perspectives and their transportation needs. Just as transportation planning has had negative impacts on some communities, it can be a vehicle for positive change when the impacts are equitable, and a diverse workforce is one step towards championing those efforts and bringing innovation and diversity of thought. Improving diversity in the industry will help shape the questions that are being asked, the models that are being built, and the tools that are available to address impacts in a more inclusive manner to avoid mistakes of the past and better the transportation planning and data of the future.

### **Implementation Considerations and Supporters:**

These research results will be of primary interest to state DOT planning offices, as well as to MPO planning offices, transit agency planning departments, and the larger consultant and academic community. The findings should be developed to be specific and easily implemented by these stakeholders. The project should identify specific approaches to share and begin implementation of the framework, such as workshops, peer exchanges, and webinars. Organizations that might be interested in the research results and could help support implementation include the AASHTO Committee on Planning, FHWA and FTA capacity building programs for DOTs, MPOs, and transit agencies; the Association of MPOs; the National Association of Regional Councils; the National Association of Development Officials; the American Planning Association Transportation Planning Division; the Institute for Transportation Engineers; Council on Minority Transportation Planning Officials; Zephyr; Women's Transportation Seminar; and TRB Standing Committees AEP10 (Transportation Planning Policy & Process); AEP15 (Transportation Planning Analysis & Application); AME10 (Equity in Transportation); AME20, (Women & Gender in Transportation).

### **Recommended Research Funding and Research Period**

- Research Funding: \$350,000
- Research Period: 18 months

### **Problem Statement Author(s)**

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- Krishnan Viswanathan, Cambridge Systematics, kviswanathan@camsys.com
- Candace Cronin, ICF, Candace.Cronin@icf.com

- Elizabeth Sall, UrbanLabs LLC, [Elizabeth@urbanlabs.io](mailto:Elizabeth@urbanlabs.io)
- Suzanne Childress, Puget Sound Regional Council, [SChildress@psrc.org](mailto:SChildress@psrc.org)

### **Others Supporting the Problem Statement**

- Minnesota DOT, Hally Turner ([Hally.Turner@state.mn.us](mailto:Hally.Turner@state.mn.us))
- Arizona DOT, Keith Killough ([kkillough@azdot.gov](mailto:kkillough@azdot.gov))
- TRB Committee AEP15, Transportation Planning Analysis and Application, Hannah Twaddell ([Hannah.Twaddell@icf.com](mailto:Hannah.Twaddell@icf.com))
- TRB Committee AME20, Women and Gender in Transportation, Dawn Hood ([spanh001@umn.edu](mailto:spanh001@umn.edu))

### **Potential Panel Members**

- Marsha Fiol, Virginia DOT, AASHTO Committee on Planning, [marsha.fiol@vdot.virginia.gov](mailto:marsha.fiol@vdot.virginia.gov)
- Hally Turner, Minnesota DOT, [Hally.Turner@state.mn.us](mailto:Hally.Turner@state.mn.us)
- Beth Alden, Executive Director, Hillsborough County MPO, [aldenb@plancom.org](mailto:aldenb@plancom.org)
- Therese McMillan, Executive Director, Metropolitan Transportation Commission, [tmcmillan@bayareametro.gov](mailto:tmcmillan@bayareametro.gov)
- Sarah Hicks, Transportation Programs Director, AMPO, [shicks@ampo.org](mailto:shicks@ampo.org)
- Tara McDaniel, Chief of Staff, Council of Minority Transportation Officials, [tmcdaniel@comto.org](mailto:tmcdaniel@comto.org)
- April Rai, Deputy Director, Women's Transportation Seminar, [arai@wtsinternational.org](mailto:arai@wtsinternational.org)
- Kenneth Petty and/ or Fleming El-Amin, FHWA Office of Planning, [Kenneth.petty@dot.gov](mailto:Kenneth.petty@dot.gov), [fleming.el-amin@dot.gov](mailto:fleming.el-amin@dot.gov)
- James Garland, FHWA, and/ or Faith Hall, FTA Office of Planning, [james.garland@dot.gov](mailto:james.garland@dot.gov), [fath.hall@dot.gov](mailto:fath.hall@dot.gov)
- Gwen Chisholm-Smith, TCRP Manager, [gsmith@nas.edu](mailto:gsmith@nas.edu)

### **Person Submitting the Problem Statement**

Matthew Hardy

202-624-3625

[mhardy@ashto.org](mailto:mhardy@ashto.org)

AASHTO Program Director for Planning and Performance Management, on behalf of the AASHTO Committee on Planning, [mhardy@ashto.org](mailto:mhardy@ashto.org)

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### **NCHRP Review of B-04**

#### Reviewed By:

Ann M. Hartell

[ahartell@nas.edu](mailto:ahartell@nas.edu)

#### Comments:

Diversity and inclusion in the transportation workforce will no doubt be a topic of interest for transportation agencies for the near- and long-term. The proposed project should build upon the work underway for NCHRP 08-125 "Attracting, Retaining, and Developing the Transportation Workforce: Transportation Planners" (<https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4657>), scheduled for completion in 2021. The problem statement authors might elaborate on the inclusion of analyzing the 'pipeline' of transportation planning talent and how state DOTs could benefit from or respond to that analysis as this is likely considered well outside the purview of most state DOTs. The statement does not mention the use of private sector consultants by public agencies for transportation planning work and whether this research might investigate how private sector partners and consultants might help public agencies accelerate diversity and inclusion in this area of practice. Data on the characteristics proposed for inclusion in the analysis (gender identity, race, ethnicity, pay differentials, workplace discrimination, and similar) will be highly restricted which may severely limit the proposed analysis and the development of robust conclusions.

Review Date:

11/30/2020

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## **FHWA Evaluation of B-04**

Reviewed By: HEP/Fleming El-Amin

Comments:

The problem statement seeks to analyze underrepresentation in the transportation profession with respect to cultural, ethnic, racial, and gender diversity. The proposal aims to increase understanding of the scope and causes of lack of diversity, equity, and inclusion (DEI) within the transportation planning and analysis field and will attempt to quantify the lack of diversity representation in the transportation planning workforce. The problem statement could build on the findings from NCHRP 08-125: Attracting, Retaining, and Developing the Transportation Workforce: Transportation Planners to highlight how advancements in DEI can help build a better workforce to address future transportation planning challenges. The topic is relevant and could produce findings of value and may help improve the transportation workforce in the long term. However, the scope is broad, and measuring levels of DEI in the transportation workforce may prove to be difficult, beyond noting strategies to avoid discriminatory hiring practices. The research objective could include examining the pipeline for future transportation planners, such as exposure to the profession in colleges and universities (i.e. transportation related fields) to understand how diversity recruitment efforts at that level influences underrepresentation in the profession. With that context, the scope could evaluate levels of diversity among some State DOTs, MPOs, transit agencies, and local transportation department with respect recruitment practices, retention efforts, diversity

and inclusion support programs, overall workplace satisfaction, and promotional opportunities.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for B-04**

Submitted By:  
King Gee  
AASHTO Staff  
Knowledge Management

Priority #: 1

Comments: This project poses an interesting knowledge question: how do we reach out to women and BIPOC populations as potential candidates? are interview processes biased toward the current norm in an organization? Are behaviors such as divergent thinking encouraged? How are female and BIPOC employees included into decision processes once hired so their potentially divergent opinions are heard? Psychological safety in the workplace has been extensively researched and it would be beneficial to include this in the study. This research may help identify ways to help employees feel "safe" to express opinions and provide feedback; organizations can foster a culture of trust, personal mastery, respect, learning, and a growth mindset; what organizations can do to quickly increase cultural and relational knowledge capabilities to foster a truly inclusive culture? We suggest including factors that restrict differing points of view (e.g., we've always done it this way, timelines) and existing practices that reinforce bias.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY 2022 NCHRP Research Problem Statement**

**Problem Number: 2022–B-05**

**Problem Title:**

Transportation Planning for Healthcare Access: The Role of Multi-Agency Funding and Multi-Scale Coordination as Revealed by COVID-19 Disruptions

**Background:**

Transportation plays an important role in the advancement of public health goals. Prior research has demonstrated that a lack of viable transportation opportunities can lead to missed healthcare appointments, needed care not being accessible, and delayed medication use, all of which lead to poorer health outcomes. These poorer health outcomes disproportionately impact people of color and lower income individuals, groups who also are more likely to be under/uninsured. Moreover, the unprecedented public health crisis created by COVID-19 has exacerbated these disparities and revealed the negative impacts that gaps in accessibility to healthcare can have. To help solve the problems associated with transportation barriers to healthcare accessibility, research on a national scale is needed to provide transportation and public health stakeholders guidance within the following overarching areas:

- 1.) The documentation of healthcare accessibility gaps: An easily implementable methodology that can be used by planners and decision-makers is needed in order to identify where accessibility gaps are and which aspects of transportation limit healthcare access the most across different geographic areas and demographic groups.
- 2.) Stakeholder coordination: Documenting how transportation and public health stakeholders are implementing guidance from prior research on this topic, as well as barriers and challenges related to implementation, is important in understanding how future recommendations can support the more rapid implementation of best practices.
- 3.) Policy and program development: There is currently limited knowledge on how issues such as telemedicine, alternative transit service models, and other travel demand management tools relate to health and equity outcomes. More research in this area would allow stakeholders to better understand the suite of policy and program options that can be used to address gaps in accessibility to healthcare.

The areas of research identified above have been identified as part of the NCHRP Research Roadmap for Transportation and Public Health published in 2019.

**Literature Search Summary:**

With regard to accessibility measurement, this study will aim to help solve the issue of implementing accessibility-based planning frameworks through guidance on how state DOTs can apply accessibility metrics to help advance public health goals, a need

identified by Ganning (2014). With regard to policy and program development, this study will fill a gap in the literature identified by Syed, Gerber, and Sharp (2014) and the NCHRP Research Roadmap for Transportation and Public Health (2019) to describe the impacts that transportation policy changes can have on public health outcomes. Additionally, the study will build upon prior research showing disparities in access to care and trauma hospitals in both rural and urban areas (Knowlton 2019); the TCRP-funded study, “Community Tools to Improve Transportation for Veterans, Military Service Members, and Their Families” (2013); “Improvement Mobility for Veterans” (2011); and the NCHRP-funded study, “Access to Jobs, Economic Opportunities, and Education in Rural Areas” (NCHRP 08-131).

**Research Objective:**

The objective of this research is to provide officials and service providers with the guidance they need to implement an accessibility-based approach to address barriers to healthcare access. The two desired final products will be 1.) an implementable methodology for the identification of gaps in accessibility to healthcare that can be used during project identification and prioritization processes across all geographic areas, and 2.) action-oriented guidance organized by geographic area providing recommendations for enhanced coordination among transportation and public health officials, as well as evidence-based program and policy options that make healthcare more accessible from a transportation perspective.

The major tasks that the research contractor will likely have to perform include a literature review; a state-of-the-practice assessment; the development of a methodology that can identify gaps in healthcare accessibility; interviews with transportation and public health officials and stakeholders; the development of case studies that reflect conditions and best practices in urban, rural and military communities; an identification of existing policies and programs designed to enhance accessibility to healthcare; an analysis of how the COVID-19 pandemic has revealed transportation barriers to healthcare accessibility; and a review of successful transportation policies and programs that advance public health goals. These tasks will culminate in recommendations for how transportation and public health agencies can address gaps in healthcare accessibility through developing innovative policies and programs.

**Urgency and Potential Benefits:**

The COVID-19 pandemic has highlighted the dire need for enhanced accessibility to health care facilities, especially as more vulnerable populations experience conditions that create disproportionately low access. However, state and local officials have little action-oriented guidance for implementing solutions. Additionally, an exploration of how telemedicine and the digital divide have impacted accessibility to health care is timely and necessary. The benefits of this research include increased meaningful collaboration between transportation and public health stakeholders and a greater likelihood that policies and programs providing greater accessibility to healthcare will be implemented. The beneficiaries of such work include anyone seeking access to healthcare, especially vulnerable populations that currently experience low healthcare access.



**Implementation Considerations and Supporters:**

Within a state DOT, parties responsible for implementation include planning offices, offices overseeing the provision of transit services and roadway projects, and leadership charged with policy development. Existing processes that can be used to support implementation include project evaluation systems and public engagement activities. For policy development, processes supporting implementation include the development of inter-agency agreements, engineering directives, standard operating procedures (SOPs), and other policy instruments. In addition to guidance documents, products that will be developed will include one-pagers designed for different audiences, technical memos on implementation, and brochures with guidance highlights.

List the AASHTO Committee(s) and/or Council(s) – and any other organization – that might be interested in the research results and could help support implementation

- AASHTO's Council on Public Transportation; Charles Carr; Research Chair; 601-359-7025; ccarr@mdot.ms.gov

**Recommended Research Funding and Research Period:**

Research Funding: \$300,000 is needed to accomplish the research objectives and develop materials to facilitate communication and implement key research products.

Research Period: The estimated length of this study is 18 – 24 months.

**Problem Statement Authors:**

- Derek Krevat; MassDOT; 781-927-9023; Derek.Krevat@dot.state.ma.us
- Bryan Pounds; MassDOT; 724-880-2489; Bryan.Pounds@dot.state.ma.us
- Corey Hull; Southern Georgia Regional Commission; chull@sgrc.us
- Tameka Macon; FHWA; 202-366-1183; tameka.macon@dot.gov

**Others Supporting the Problem Statement:**

- AASHTO Committee on Planning
- MassDOT; Bryan Pounds; 724-880-2489; Bryan.Pounds@dot.state.ma.us
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- National Center for Mobility Management; Chris Zeilinger; chris.zeilinger@gmail.com
- FHWA; Tameka Macon; tameka.macon@dot.gov
- Georgia Council on Aging; Kathy Floyd; 404-657-5342; kathy.floyd@gcoa.ga.gov
- TRB Rural Public and Intercity Bus Transportation Committee (AP055); Jonathan Brooks; jonathanbrooks@linkhouston.org

**Potential Panel Members:**

- Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Planning. Below are initial suggestions:

- Pivot Strategies; Flora Castillo; flora@pivotstrategies.io
- West Virginia State University; Lauri Andress; 713-553-8192; laandress@hsc.wvu.edu
- Upper Great Plains Transportation Institute; North Dakota State University; Jill Hough; jill.hough@ndsu.edu

**Person Submitting the Problem Statement:**

Provide contact information for the individual submitting this problem statement.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning,  
Kristina Swallow, Chair.

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**NCHRP Review of B-05**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

Comments:

The topic, which relates equity, transit, healthcare access, and highway transportation, will be of interest to transportation agencies that wish to study implications of future business disruptions and how they may best coordinate with healthcare professionals and stakeholders from multiple transportation modes to ensure healthcare accessibility. Shared funding from healthcare, transit could supplement NCHRP funds to ensure all perspectives can be addressed in this study.

Review Date:

12/21/2020

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**FHWA Evaluation of B-05**

Reviewed By: HEP/Tameka Macon

Comments:

This is a proposal that was written to consider how to look at barriers to health care access. It is necessary and contributes to the practice by looking at gaps that can be used in looking at project identification. This would be handy during TIP project prioritization and the development of guidance that would be organized geographically and would provide recommendations for coordination between health, transportation officials, and various stakeholders that support better access to healthcare. One challenge that will be a focus is COVID-19 and how the pandemic has been a barrier in some geographical areas and a focus on case studies and success stories and how agencies developed innovative practices. This is an important element of transportation supporting better health outcomes. Its strength is in identifying public engagement and inter-agency partnerships as mechanisms for success. Consideration of the Private Health Care Sector and how their role/investments can be identified and utilized to fill some of the gaps would help make this a stronger proposal. Some focus of the research should highlight successful programs where the health industry partnered with transit agencies to coordinate access and mobility options, while providing ADA accessible and patient friendly facilities located with the end user in mind. The research should provide recommendations for how transportation and public health agencies can address gaps in healthcare accessibility through developing innovative policies and programs that include the private sector providers. Recommend incorporating elements of B-11 with this proposal.

Review Date:

12/18/2020

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## **Submitter Response for 2022-B-05**

**From:** [email: mhardy@aaashto.org]

### **Comments:**

Submitting these reply comments on behalf of the Committee on Planning

NCHRP Review--Thank you for your review and support for this topic.

FHWA Review--Thank you for your review. We agree that assessing how COVID-19 has impacted healthcare access will be a challenge, especially since the public health and transportation response to the pandemic is rapidly evolving. The proposal does include "analysis of how the COVID-19 pandemic has revealed transportation barriers to healthcare accessibility" as an objective. The suggestion to study how private health care providers can partner with public transportation providers and agencies to enhance access to health-related destinations is a good one. The authors of this document have experience with partnerships between public and private entities (particularly, the health sector) in their own agencies to incorporate health impacts and accessibility in TIP

evaluation. Highlighting current and/or new successful programs and public/private partnerships will be considered by the research team.

**Contact Info:**

Matt Hardy, AASHTO mhardy@aaashto.org

Review Date: 2/3/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY 2022 NCHRP Research Problem Statement**

**Problem Number: 2022–B-06**

**Problem Title**

Guidance on Improving Truck Traffic Estimates in “Design Traffic” Forecasts.

**Background**

The current practice on determining “Design Traffic” forecasts to assess roadway design elements, stands in contrast with “Planning Level” forecasts (for identifying possible deficiencies) that also form input to determining roadway design elements. For instance, engineers utilize “design traffic” forecasts including total traffic volumes, turning-movement volumes, directional factors and truck percentages to determine specifics such as pavement type/depth, and length of turning lanes. NCHRP 765 goes into detail regarding “design traffic” but refers to it as “project-level traffic”<sup>11</sup>; this is in contrast to “planning level” traffic resulting from travel demand models as discussed in NCHRP 716<sup>12</sup>.

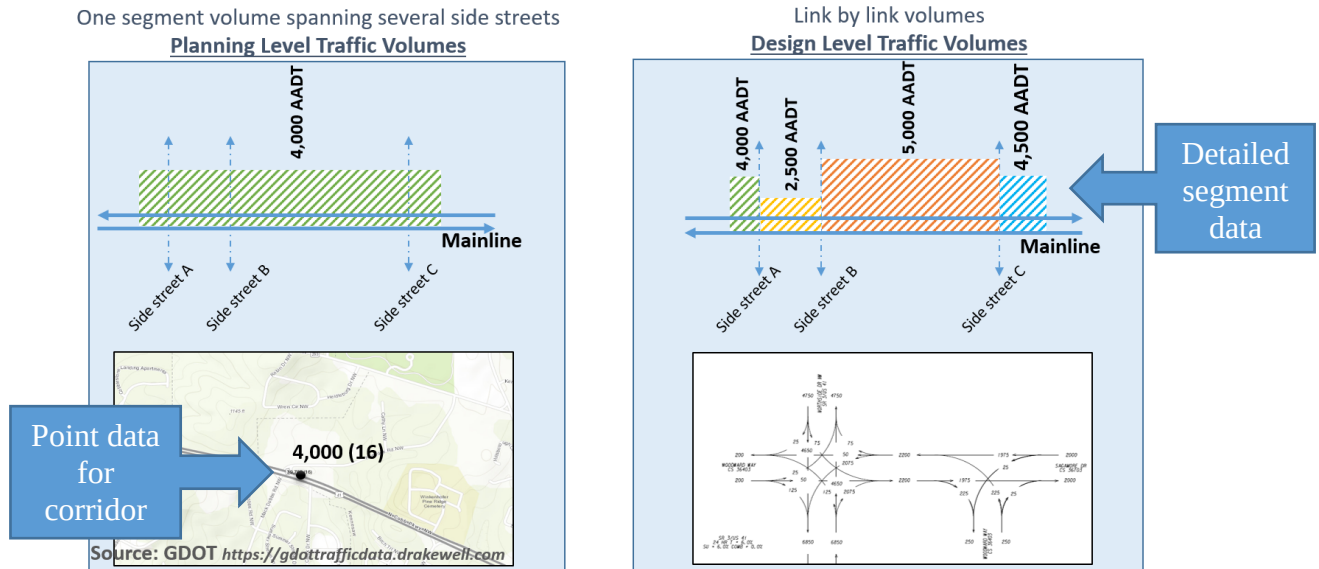
The following diagram illustrates the difference in the level of detail between macro (planning) and micro (design) traffic estimates. As the diagram illustrates, the level of detail required to create a design of the roadway and/or improvements is significantly higher than for a corridor plan.

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<sup>11</sup> [www.trb.org/Publications/Blurbs/170900.aspx](http://www.trb.org/Publications/Blurbs/170900.aspx)

<sup>12</sup> [www.trb.org/Publications/Blurbs/167055.aspx](http://www.trb.org/Publications/Blurbs/167055.aspx)

# MACRO (PLANNING) VS. MICRO (DESIGN) TRAFFIC



For “planning traffic” forecasts, the standard methodology is to develop overall traffic using historical traffic counts, existing and future land use, road network changes, population and employment estimates. These steps are accomplished using travel demand models, whose outputs are available to *guide* a practitioner who is developing “design level” traffic; however, the practitioner must be aware of limitations of the model outputs because its link data is often not at a precise enough level to make sound engineering level decisions. In addition, the model does not provide any of the vital turning-movement data at intersections that an engineer needs.

In addition, a model’s truck traffic forecast is generally a secondary step that is represented as truck percentages after the overall traffic is determined. When projecting future truck volumes under the “design traffic” forecast, often, the same truck percentages identified under the existing conditions are applied to future Annual Average Daily Traffic and Design Hourly Volumes to forecast future truck volumes.

There are some recent examples of technology being used to collect more robust truck volumes, but they may not be available at the rate needed. One example is CalTans’ use of loop sensors to detect, count and classify trucks<sup>13</sup>.

This research is intended to explore the best practices of “design level” forecasting truck volumes in the roadway project development process.

## Literature Search Summary

In preparing this submission, two literature searches were conducted. The first search was of all existing published research as recorded on the Transportation Research

<sup>13</sup> <http://onlinepubs.trb.org/onlinepubs/conferences/2017/FreightData/TokPPT.pdf>

International Documentation (TRID) website (<http://trid.trb.org>). A second search of current research projects was conducted on the Research in Progress (RIP) website (<http://rip.trb.org/>).

In consideration of the significant changes which have occurred since early 2020, the search of the TRID database was limited to all documents issued since 2010. Of the documents reviewed, none addressed the topic of this proposed research. The documents found in the TRID search focused on ‘macro’ issues. A review of research in progress found only three (3) projects none of which are applicable to this research statement.

### **Research Objective**

The 2020 “INVEST in America Act” directs DOTs to develop tools and databases for better informed passenger and freight planning. It is a unique opportunity to study the difference between truck and passenger travel growth trends. This research will assist better project evaluation, prioritization and implementation, traffic estimation, and design of roadway improvements. This research is intended to explore the best practices of “design level” forecasting truck volumes in the roadway project development process.

The proposed research area will include:

- **State-of-the-Practice:** Identify and review truck volumes forecasting methodology in design traffic forecasts from peer state DOT using surveys, questionnaires, or other formats of communication.
- **Identify Input Parameters:** Propose a list of input parameters to consider when forecasting truck traffic, including but not limited to:
  - Existing and future land use on freight-related activity centers, ports, urban and rural freight corridors, etc.
  - National, state, or regional freight and logistic planning activities, i.e. State Transportation/Freight Plans.
  - Historic truck traffic growth pattern, in addition to historic total traffic growth
  - Freight forecasts in state or regional travel demand modeling
  - Regional or state-level economic or industry forecasts
  - Impacts of new technologies such as automated and connected vehicles
  - Impacts of natural and human-made supply chain disruptions
  - Land Use Plans (current and future) and zoning changes
- **Document Warrants/Thresholds for In-depth Study:** Identify infrastructure project types that have warrants/thresholds based on truck volumes that will require additional, detailed truck volume forecasts (such as turning movements).
- **Guidelines:** Develop a set of guidelines which describe the methodology on improving truck volumes forecasts to be incorporated into the design traffic forecasts
- **Report:** Prepare a concise objective statement describing desired outcome(s), major tasks or activities the research contractor will likely have to perform and that the estimated funding is justified and sufficient, and expected final product(s).

### **Urgency and Potential Benefits**

Numerous research papers are suggesting that the complexion of vehicular movements will be significantly altered as a result of the current disruption and the highly probable future disruptions. As a result, the traditional processes to estimate truck movements, especially in the future need to be challenged and revised.

Improvements in truck volume forecasts in Design Traffic Forecasting will enhance state and regional freight system planning, improve the project-level analysis on truck traffic management, and better accommodate the rapid growth in truck volumes due to a variety of reasons including online shopping. Traffic and design planners in state departments of transportation and MPOs will benefit from the outcome of the research and the resulting guidelines.

### **Implementation Considerations and Supporters**

The research and planning tool will be employed the groups charged with planning new corridors, increasing the capacity of existing routes, and the allocation of resources for the maintenance of routes and corridors. The likely focal point within a state DOT will be the office dedicated in whole or in part to freight and logistics issues. That office will coordinate with other parts of the agency as well as planning partners to apply the results of the research.

Implementation of the research will commence with the publication of the results of the research on the TRB website and in the form of a NCHRP report. It is expected that the AASHTO Special Committee on Freight will promote the research results among its members which includes all of the state DOTs. Individual state departments of transportation will coordinate and support the dissemination of the research results to their local and statewide partners.

The results and findings of the research should be widely disseminated. This process will take different forms including webinar presentations, training workshops organized by the AASHTO Special Committee on Freight, the Eastern Transportation Coalition, the I-10 Corridor Coalition and other similar groups, as well as pilot projects both two or more states to validate the usefulness of the new approach to freight planning.

AASHTO Special Committee on Freight will be most interested in the research findings. As part of their mission, the Committee will coordinate the release of the research results to other committees and standing councils of AASHTO and the members of AASHTO.

### **Recommended Research Funding and Research Period**

A preliminary estimate to fund the research is in the range of \$350,000 and \$500,000. This estimate includes time for the research team, the collection and examination of new data sources, and the creation of a planning process based on the research. A preliminary estimate to facilitate the communication and implementation of key research products is between \$10,000 and \$25,000. This effort will be based on the creating and delivery of webinars by the research team and the AASHTO Special Committee on



Freight. Given the expected long-term impact of the current disruption, the research should be conducted and completed as quickly as possible. As a result, the research should be completed within one (1) year.

### **Problem Statement Author(s)**

This problem statement has been formulated by the AASHTO Committee on Planning's Freight Planning Task Force.

- Thomas McQueen, AASHTO Committee on Planning Freight Planning Task Force Chair, Assistant Administrator, Office of Planning, Georgia Department of Transportation, 404.631.1785, tmcqueen@dot.ga.gov
- Michael Vanderhoof, AASHTO Committee on Planning Freight Planning Task Force Vice Chair, Planning Services Section Chief, Illinois Department of Transportation, 217.782.8080, michael.vanderhood@illinois.gov

### **Others Supporting the Problem Statement**

- AASHTO Committee on Planning
- Georgia DOT, Mr. Tom McQueen, 404.631.1785, tmcqueen@dot.ga.gov
- Nevada DOT, Ms. Sondra Rosenberg, 775.888.7440, SRosenberg@dot.nv.gov
- Missouri DOT, Ms. Cheryl Ball, 573.526.5578, Cheryl.Ball@MoDOT.MO.gov
- North Carolina DOT, Mr. Dana Magliola, 919.707.0909, damagiola@ncdot.gov
- Tennessee DOT, Mr. Dan Pallme, 615.741.4031, Daniel.Pallme@tn.gov
- Texas DOT, Mr. Casey Wells, Texas DOT, 512.936.0950, Casey.Wells@TxDOT.Gov

### **Potential Panel Members**

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Planning. Below are initial suggestions:

- Georgia DOT, Mr. Tom McQueen, 404.631.1785, tmcqueen@dot.ga.gov
- Nevada DOT, Ms. Sondra Rosenberg, 775.888.7440, SRosenberg@dot.nv.gov
- Missouri DOT, Ms. Cheryl Ball, 573.526.5578, Cheryl.Ball@MoDOT.MO.gov
- North Carolina DOT, Mr. Dana Magliola, 919.707.0909, damagiola@ncdot.gov
- Tennessee DOT, Mr. Dan Pallme, 615.741.4031, Daniel.Pallme@tn.gov
- Texas DOT, Mr. Casey Wells, Texas DOT, 512.936.0950, Casey.Wells@TxDOT.Gov

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

Matthew Hardy

202-624-3625  
mhardy@ashto.org  
Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning,  
Kristina Swallow, Chair.

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## **NCHRP Review of B-06**

Reviewed By:  
Lawrence D. Goldstein  
lgoldstein@nas.edu

Comments:

This appears to be a well-developed problem statement, logically presented. Should designate an actual research budget.

Review Date:  
12/14/2020

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## **FHWA Evaluation of B-06**

Reviewed By: HEP/Jeremy Raw, HPL/Tianjia Tang, HOFM/Birat Pandey

Comments:

HEP, Jeremy Raw -This proposal identifies an important problem (preparing adequately detailed forecasts of truck movements to support facility design). However, it comes up short in several respects. The proposal fails to explain how project design will be improved with better truck forecasts. Obviously “blowing the forecast” could lead to under- of over-designed facilities. But what is needed to fix that problem are better forecasting tools, not better design tools. The problem that needs to be addressed is not what the title of this project calls for, and the real problem will not be addressed efficiently by the proposed research. The literature review is cursory and the proposal alludes vaguely to “travel demand modeling” but not “freight demand modeling”. No evidence in the literature review to support the claim that there is any reason to “challenge and revise” traditional truck forecasting methods (other than by representing them better in regional models). There is no discussion of existing forecasting tools such as the Quick Response Freight Methods. The proposal suggests the only method of forecasting is to use existing truck percentages and extrapolation. They report on a CalTrans method for doing classification counts as if it were a novelty, yet most states have vehicle classification capability on many of their ATRs and the capability is

increasing. The set of “factors” that the research offers to develop to support design can only properly be handled through improved forecasting methods (essentially, planning models). The proposal does not seem to understand the difference between forecasting models (which attempt to understand “how much traffic” in relation to “why” the traffic is on the road) and design models (which translate such efforts into local estimates for use in “right-sizing” or “right-shaping” specific facilities). The proposal dismisses NCHRP 765, yet that report contains a variety of methods suitable for estimating design-oriented traffic (equally applicable to passenger vehicles and freight vehicles). It is quite reasonable in view of the QRFM and NCHRP 765 to develop design estimates of truck volume provided a suitable planning forecast is available. The resources proposed for this project will be wasted if they are not focused effectively on better (planning level) forecasting. The proposal does not clearly distinguish the types of trucks it wishes to consider, which consist of two components: (1) the purpose (e.g. long haul, regional distribution, local delivery) and (2) the vehicle class (which is more important for design, and which will include big trucks used on the facility for any purpose). Alluding to changes in local truck movements due to online shopping etc. is gratuitous: clearly, an entirely different set of forecasting data, assumptions and practices are needed to evaluate future demand for local freight movement compared to long-haul freight movement, but this proposal is insensitive to that need. Overall, I would consider this a very weak proposal since it does not do enough to assess and respond to the state of practice. Because it hinges on improving forecasting methodologies (and the data on which those methodologies are based), it should be considered dependent on project B-08 (reviewed separately) and reworked as an update/supplement to QRFM and other freight forecasting methods (not ruling out that there might be some new methods comparable to what is NCHRP 765 to move efficiently from the planning forecasts to design).

HPL, Tianjia Tang -This is a very critical subject and needs detailed attention on how to carry out the best practices. A uniform and practical guidance will be significant help to field people as design traffic affects a host of design and environmental issues.

HOFM, Birat Pandey - Problem statement, work scope, approach and deliverable are well defined. This research can assist transportation agencies project development efforts by highlighting challenges and finding on application of corridor level traffic forecast for location specific traffic estimates for roadway design activity. Suggesting for a special consideration to establish a project panel that includes planners, transportation modelers, roadway design engineers and traffic engineers.

Review Date:  
12/18/2020

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 3

Comments: N/A

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## **Submitter Response for 2022-B-06**

**From:** [email: mhardy@aaashto.org]

### **Comments:**

#### Response to FHWA/Jeremy Raw

Comment: The proposal fails to explain how project design will be improved with better truck forecasts.

Comment Response: The proposal states that appropriate truck forecasts will lead to more accurate roadway project design metrics such as pavement design (ex. materials type/depth) and number/length of turn lanes. Improved truck forecasts captured at a local or regional level are much more likely to precisely estimate truck movement volumes than "overarching" truck estimates universally applied through "Planning-level" models commonly utilized in transportation planning tasks.

More precise project volumes will support the goal to right-sized project designs, which translates into better use of financial resources - whether the source is federal or non-federal funds. More accurate forecasts will also benefit freight transport companies by reflecting their requirements thus contributing to higher levels of efficiency and improved resilience and sustainability.

Comment: Obviously "blowing the forecast" could lead to under- or over-designed facilities. But what is needed to fix that problem are better forecasting tools, not better design tools.

Comment Response: Forecasting tools are diverse across the country, with multiple methods for calculating. While traditional 4-step travel demand (gravity) modeling still exists in many jurisdictions, several larger metro areas have moved on to activity-based modeling (ABM) that can forecast truck volumes through cell phone, license plate, or other real-time data methods.

Per USDOT's Quick Response Freight Manual (QRFM), there are five methods for forecasting freight vehicle trips, with commodity models being listed as the most

dynamic. Additionally, NCHRP 765 cites the FHWA Freight Analysis Framework table as adequate, along with the commodity model, to develop freight vehicle values for 4-step travel demand models.

Alternatively, the QRFM mentions simple growth factors, hybrid approaches, and economic activity models as ways to appropriately forecast freight volumes. With these methods from the QRFM and NCHRP 765, as well as the move to incorporate real-time vehicle information into updated ABMs, we suggest that the issue is not the planning level forecasting tools but the adoption of values from these planning level models into the "design level" forecast values used by engineers to design road improvement projects.

As suggested in the research statement, there is ample research conducted in planning level forecasting tools (such as the sources you cited, NCHRP 765 and QRFM), but there are few on the "design level" traffic forecasting topic. Therefore, we believe the best path forward for estimating "design level" traffic volume forecasts for freight is to research what has previously been done here, and how it can be applied to other agencies.

Comment: The literature review is cursory, and the proposal alludes vaguely to "travel demand modeling" but not "freight demand modeling".

Comment Response: In many states and regions, the freight modeling is 'embedded' in the travel demand models as part of its "planning level" traffic forecasting procedures. It is suggested that these "Planning Level" forecasts are not adequate enough to supply the more robust "Design Traffic" forecasts needed by 'consumers' such as road design engineers, who need that detailed data to help inform several key design aspect decisions of road-related improvement projects, especially if the project serves a freight-intensive activity. Thus, any allusions to "travel demand modeling" would be freight-based regardless since that is the purpose of this research. The unique characteristics of freight truck operations can vary significantly within a discretely defined corridor due adjacent land uses and the type of roadway facility, for example. Procedures which reflect these situations and factors are needed to ensure that the ultimate design of the facility reflects an optimal solution.

Comment: No evidence in the literature review to support the claim that there is any reason to "challenge and revise" traditional truck forecasting methods (other than by representing them better in regional models).

Comment Response: There may be confusion here as to what was being challenged and revised. The proposal is focused on challenges to "Design Traffic" level of forecasting that is used during a roadway transportation improvement's design process, not traditional truck forecasting tools and techniques that provide "planning level" forecasts; the output of which may be referenced when initiating the development of the more detailed "Design Traffic" forecasts.

Comment: There is no discussion of existing forecasting tools such as the Quick Response Freight Methods.

Comment Response: The Quick Response Freight Methods (QRFM) report was updated in 2019 and referenced five different methods for forecasting freight vehicle trips: Simple Growth Factor, Incorporating Freight into 4-Step travel demand models, Commodity Models, Hybrid Approaches, and Economic Activity Models. The Freight-Based Commodity Component is listed as identifying the freight modal network, developing commodity groups, related groups to industrial sectors, finding base year commodity flows, forecasting growth in industrial sectors, factoring commodity flows, developing modal cost for commodities, splitting commodities into modes (which can be mode split models, tables, or expert opinion), finding daily vehicles from load weights, and days of operations and assigning vehicles to modal networks.

The QRFM is a method for performing "Planning Level" forecasts, but not the "Design Level" forecasts on which this research is focused.

Comment: The set of "factors" that the research offers to develop to support design can only properly be handled through improved a forecasting methods (essentially, planning models).

Comment Response: The QRFM and NCHRP 765 already dictate several strategies for improving forecasting models for freight. NCHRP 765 also contains additional methods, such as the FHWA Freight Analysis Framework and other documentation that makes this statement unlikely. FHWA FAF data provides state-level data. When designing a specific intersection, interchange of corridor, the state-level data does not reflect the unique characteristics.

Comment: It is quite reasonable in view of the QRFM and NCHRP 765 to develop design estimates of truck volume provided a suitable planning forecast is available.

Comment Response: The section on "Design Traffic" level in the NCHRP 765 amounts to one section, Chapter 9, Section 1, of the document. The remainder of the document is focused on "Planning Level" forecasting, with several sections documenting how to improve its corresponding forecasting of freight.

Chapter 9, Section 1 discusses the use of extrapolation, the use of static truck percentages, historical truck counts, and using Equivalent Single Axle Load (ESAL) data for truck pavement design.

The QRFM alludes to "Planning Level" forecasting. Both documents fail to discuss turning-movement data, or other design-level traffic forecasting needs. They are both focused on large-scale, "planning level" forecasting methodologies. This further shows that there is little need for the proposal to focus on how to improve "Planning Level" forecasting of freight; rather it focuses on why there is a need for improved "Design

Level" forecasting of truck volumes that are vital inputs used by engineers designing road improvement projects.

Comment: The proposal does not clearly distinguish the types of trucks it wishes to consider, which consist of two components: (1) the purpose (e.g. long haul, regional distribution, local delivery) and (2) the vehicle class (which is more important for design, and which will include big trucks used on the facility for any purpose).

Comment Response: Vehicle class for freight is FHWA Class 4-7 (single unit trucks) and FHWA Class 8-15 (combination trucks). These classes can be integrated into the research proposal to determine how each class can affect "Design Level" forecasting.

Comment: Alluding to changes in local truck movements due to online shopping etc. is gratuitous: clearly, an entirely different set of forecasting data, assumptions and practices are needed to evaluate future demand for local freight movement compared to long-haul freight movement, but this proposal is insensitive to that need.

Comment Response: Focusing on long-range versus "last mile" freight can be integrated into the study proposal. However, this is more detailed and is not the central focus of the research. The research seeks to find ways to forecast all modes of freight at the design-level, not just one class or type.

Response to FHWA/Birat Pandey

Comment: Suggesting for a special consideration to establish a project panel that includes planners, transportation modelers, roadway design engineers and traffic engineers.

Comment Response: These elements can certainly be integrated into the overall proposal and research if budget allows. The panel should also include transport operators, i.e. as in a statewide freight advisory committee, to ensure that the perspective of users of facilities are represented.

Response to NCHRP

Comment Response: The research budget is currently estimated between \$350 and \$500k and works with a schedule of 18 months.

Contact Info:

Matt Hardy on behalf of the Committee on Planning

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number:** 2022–B-07

**Problem Title:** Guidebook/Toolbox for Agencies to Incorporate Uncertainty into Long-Range Transportation Planning

**Background**

State departments of transportation (DOT), metropolitan planning organizations (MPO), and other planning agencies increasingly face the challenge of developing meaningful plans and making thoughtful investment decisions during a time of uncertainty. These uncertainties include a confluence of trends including changes in demographics, the economy and workforce, land use and development patterns, and other social, cultural, and geopolitical trends; the impact of rapidly changing technologies including automated, connected, electric, and shared vehicles; a growing number of risks ranging from extreme weather and climate change to cybersecurity concerns; and continued uncertainty about future funding for transportation.

The COVID-19 pandemic in 2020 introduced additional uncertainties related to increased working from home, distance learning, and other virtual interaction; increased home delivery of goods and services; and shifts in travel and mode choice. There is significant uncertainty regarding the short-term duration and recovery from the pandemic and the long-term impacts of COVID-19 on travel behavior.

Recent research (see section 3 below) has helped agencies understand potential trends and disruptions and helped develop scenario planning and risk analysis tools to assess the potential impacts of these changes. Additional research and guidance is needed to help state DOTs, MPOs, regional transportation planning organizations (RTPOs), and other planning agencies incorporate these uncertainties into statewide and metropolitan long-range transportation plans (LRTP), statewide and metropolitan transportation improvement programs (STIP/TIP), and other planning documents. Agencies often face challenges related to introducing greater flexibility into existing planning and programming processes, particularly where existing processes rely on specific types of data, forecasts, and modeling tools; must remain consistent with local land use decisions; must demonstrate fiscal constraint; and must demonstrate progress toward transportation performance management targets.

The intent of this research project is to identify examples of how agencies are incorporating uncertainty into their planning and investment decisions; develop a framework for how DOTs, MPOs, and other planning agencies can address uncertainty in their plans; and provide guidance and a toolbox for use by DOTs, MPOs, and other planning agencies consistent with this framework. The framework and guidance should



be flexible to address difference scales or contexts for specific types of agencies. Furthermore, this research supports the strategic plan of the AASHTO Committee on Planning:

- Goal 2.0 Provide Innovative Planning Technical Products and Professional Services
- Goal 3.3 Provide Forward-Looking Ideas and Thoughts that Identify Likely Future Policy Issues
- Goal 3.6 Foster Peer Exchanges Among State DOT Planning Groups the Focus on Key Planning Challenges

### **Literature Search Summary**

Prior NCHRP research, including the *Report 750* series, *Foresight: Informing Transportation's Future*, has documented many of these long-range trends and uncertainties. Prior research, including *Report 798: The Role of Planning in a 21st Century State Department of Transportation—Supporting Strategic Decision-making*, has documented the changing management and customer expectations facing state DOT planning staff today. This research has offered valuable tools for state DOTs and other planning agencies and could be enhanced to address emerging uncertainties including the impacts of COVID-19.

Prior research also has documented emerging tools and techniques related to topics like scenario planning and risk management. FHWA has developed a *Scenario Planning Guidebook* and a *Guidebook on Supporting Performance-Based Planning and Programming through Scenario Planning*. NCHRP reports have helped identify and develop tools to support scenario planning (including *NCHRP 08-36, Task 117, Sketch Tools for Regional Sustainability Planning*; and *NCHRP 08-36, Task 145, Scenario Planning Lite*) and documented multi-agency approaches to planning on related issues (including *NCHRP 08-36, Task 142 Guidebook for Multi-Agency Collaboration for Sustainability and Resilience*). There also are many examples of state DOT and MPO scenario planning initiatives around the nation, but limited documentation on the lessons learned including how scenario planning impacted investment decisions and other plan elements.

A series of current research projects are focusing on incorporating risk into asset and performance management (including *NCHRP 08-113, Integrating Effective Transportation Performance, Risk, and Asset Management Practices*; *NCHRP 08-118, Risk Assessment Techniques for Transportation Asset Management*, and *NCHRP 08-127, Emerging Issues: Impact of New Disruptive Technologies on the Performance of DOTs*). The results of these ongoing projects can be used to inform this project, and in particular help build the “toolbox.” Furthermore, the AASHTO Committee on Planning is initiating a “snapshot” of state DOT planning response to COVID-19, which can inform this research.

A majority of prior research has focused on the mechanics of scenario planning, risk assessment, and other techniques, leaving gaps in policymaking, implementation, and internal and multi-agency coordination needed to implement long-range plans and adapt investment decisions to rapidly changing conditions. Additional research is needed on

how to incorporate uncertainty, disruption, and risk into long-range transportation plans and transportation investment programs. The purpose of this project is to examine how state DOTs, MPOs, and other planning agencies are adapting their planning and programming processes to account for potential uncertainties, disruptions, and risks.

### **Research Objective**

The objective of this research is to provide guidance for agencies on how to adapt planning processes to account for potential uncertainties, disruptions, and risks. This guidance should focus on incorporating uncertainty into long-range transportation plans, and, through these plans, inform investment decisions as documented in transportation improvement programs at multiple scales. The guidance is intended to augment prior or ongoing research regarding incorporating risk into asset management and other performance-based planning processes. The guidance should reflect the unique characteristics of DOTs, MPOs, and other planning agencies, and provide approaches that would be appropriate to incorporate into different types of planning processes with consideration for the level of resources available.

Potential research questions include:

1. How are the questions decision-makers are asking of planners changing as agencies address emerging trends and disruptions and greater uncertainties?
2. What approaches are agencies using to incorporate uncertainty into planning processes and document (e.g., scenario planning, risk analysis, and robust decision making)?
  - a. Are DOTs, MPOs, and other planning agencies changing their baselines and forecasts to reflect actual or anticipated changes in travel demand and modal choices due to COVID-19 and other disruptions?
3. How are these approaches impacting planning products and decisions? These could include:
  - a. Long-range transportation plans (including impacts on both vision/policy-based and fiscally constrained plans)
  - b. Integration with performance targets and performance-based plans
  - c. Investment decision making/programming including integration with medium- and short-term plans and transportation improvement programs
4. Are agencies changing planning products and timelines to account for uncertainty?
5. What barriers do agencies face when trying to implement these changes?
6. Are agencies changing the way they engage and communicate with partners and the public to account for uncertainty?

Potential research tasks include:

1. Review existing research related to planning in uncertainty, including research related to other public infrastructure and investment planning as well as private sector planning that might be relevant to transportation.

2. Conduct a synthesis of current transportation agency practices related to planning in uncertainty, including examples of effective processes. This might include a broad-based scan or survey, followed by a series of detailed case studies to document approaches, impacts, and lessons learned.
3. Develop a framework for incorporating uncertainty into planning decisions. This framework should reflect the needs of different types of agencies (DOT/MPO/RTPO/others) and planning products (LRTP, medium/short-range plans, STIP/TIP, etc.). It also should consider the workforce, technical, and financial capacity of agencies to adapt these approaches.
4. Validate the framework and identify specific implementation approaches through a workshop involving planners from multiple DOTs, MPOs, and other agencies.
5. Develop a guidebook or toolkit for agencies to incorporate uncertainty into long-range transportation planning. The guidebook or toolkit should focus on advancing the framework developed through the research through practical activities agencies can adapt and integrate.
6. Develop a communications and implementation plan to advance the framework and guidebook.

The final product could be in the form of a guidebook and toolbox prepared to assist planners from state DOTs, MPOs, and other planning agencies. Specific elements of the guidance would be identified by the project panel and research team. It is anticipated that the research will identify and document specific data, tools, and models that agencies are using, but the focus should be on the overall planning and decision-making process.

### **Urgency and Potential Benefits**

Uncertainties related to changing demographics, economics, technology, climate, travel behavior, funding, and other topics are common to virtually every DOT, MPO, and planning agency. COVID-19 has added a new set of uncertainties that are common to all agencies. Given the need to regularly update LRTPs and S/TIPs, as well as to continue to track progress toward federal transportation performance requirements, every DOT and MPO will need to address these uncertainties in its planning process during the next few years. Developing a common framework and tools will be an important contribution to the planning practice at this critical time.

### **Implementation Considerations and Supporters**

These research results will be of primary interest to state DOT planning offices, as well as offices responsible for performance and asset management, public engagement, and research. The guidebook and toolkit should be developed to be easily implemented by these offices, such as easy to use self-assessments, checklists, and methods and examples of effective practices that could be adapted.

The guidebook and toolbox could be disseminated through the AASHTO Committee on Planning, relevant TRB committees, and other partner organizations such as AMPO, NARC, and NADO. The project should identify specific approaches to share and begin implementation of the framework, such as workshops, peer exchanges, webinars, and other briefings. The project should leverage existing AASHTO, TRB, and other partner

meetings to maximize participation of planning professionals in workshops and peer exchanges to gather input and disseminate results of the research.

The research design should consider pilot tests of the framework with different types of agencies.

AASHTO Committees and other organizations interested in supporting the implementation of the results:

- AASHTO Committee on Planning
- AASHTO Committee on Performance-Based Management
- Association of Metropolitan Planning Organizations
- National Association of Regional Councils
- National Association of Development Organizations
- Federal Highway Administration

### **Recommended Research Funding and Research Period**

Research funding: \$600,000

Research period: 24 months to include research and implementation phases. Given the importance of this research, it is suggested that the project be structured to provide early and frequent deliverables to engage and assist planners, leading up to the final report. For example, the literature review, synthesis of existing practice, and framework could be prepared and shared during the first 12 months of the project, providing initial information to AASHTO, TRB, and agency planners while the full guidebook/toolbox is developed and pilot/demonstration projects are conducted. The project should maximize use of existing meetings and webinars to gather information on and share initial results of this project.

### **Problem Statement Author(s)**

- AEP 10 and AEP 15 Members
  - John Kaliski, Cambridge Systematics, jkaliski@camsys.com
  - Hannah Twaddell, ICF Consulting, Hannah.twaddell@icf.com
  - Elise Barrella, DfX Consulting LLC, elise@dforxconsulting.com
- AASHTO Committee on Planning Members
  - Jerri Bohard, Oregon DOT, Jerri.L.BOARD@odot.state.or.us
  - Marc Williams, Texas DOT, marc.williams@txdot.gov
  - Bradley Sharlow, Michigan DOT, sharlowb@michigan.gov

### **Others Supporting the Problem Statement**

- AASHTO Committee on Planning
- TRB AEP10 Standing Committee on Transportation Planning Policy and Processes
- TRB AEP15 Standing Committee on Transportation Planning Analysis and Application

### **Potential Panel Members**

- Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Planning. Below are initial suggestions:
  - Jerri Bohard, Oregon DOT, Jerri.L.BOHard@odot.state.or.us
  - Marc Williams, Texas DOT, marc.williams@txdot.gov
  - Bradley Sharlow, Michigan DOT, sharlowb@michigan.gov

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning,  
Kristina Swallow, Chair.

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### **NCHRP Review of B-07**

#### Reviewed By:

Lawrence D. Goldstein

lgoldstein@nas.edu

#### Comments:

The critical issue for this problem statement is an effective review of current related projects and an integration of outcomes in the work plan for the new study. This is a subject that has received considerable interest and quality research, but there is a need to review what has been accomplished and build on those accomplishments in a synthesis, a gap identification, and an effective plan for organizational implementation.

#### Review Date:

12/14/2020

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### **FHWA Evaluation of B-07**

Reviewed By: HEPP/Harlan Miller

#### Comments:

Problem statements B-3 (Risk Management) and B-7 (Uncertainty in Long-range Planning) are timely and needed. These two projects could be consolidated into one research project (Risk Management and Uncertainty) as they are interrelated and would be best done together as they serve a common theme and need.

Review Date:  
12/18/2020

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**Submitter Response for 2022-B-07**

**From:** [email: mhardy@aaashto.org]

**Comments:**

We agree with NCHRP's comments. The existing research plan already calls for a synthesis of existing research (Task 1) and agency practice (Task 2) and the text could be more explicit that the synthesis should help identify potential gaps in research or practice. The research plan also includes a task on implementation (Task 6) which again could be more explicit that it is not only about advancing the guidebook/toolbox but more generally advancing implementation of good research and practice in this area.

**Contact Info:**

Matt Hardy on behalf of the Committee on Planning

Review Date: 2/5/2021

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**American Association of State Highway and Transportation Officials  
AASHTO Committee on Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022–B-08**

**Problem Title**

Improving Freight Origin & Destination (OD) Data to Advance the Capabilities of Freight Forecasting Models.

**Background**

Historically, state freight forecasting methodologies have varied widely based on the agency's needs, expertise, data availability, and complexities of the freight network. The lack of a consistent methodology creates impediments within the national freight network as the state's plans are discontinuous across state lines. This situation leads to higher operating costs for the freight transport operators, contributing to the loss of margin and higher costs to beneficial cargo owners.

The proposed research will create a common approach employed by all state departments of transportation and affiliated partner agencies to develop forecasts of freight movements for all modes. This consistent approach will provide a foundation upon which bilateral and multi-lateral planning processes can be formulated to address common areas of concern and interest independent of state boundaries. An example of such an approach is the freight study and plan, which focused on the greater Charlotte region, including sections of the states of North Carolina and South Carolina. That study and the ensuing planning and implementation process have addressed common interest areas in a coordinated and collaborative, and financially efficient manner.

The proposed research corresponds to the AASHTO Special Committee on Freight's forward-looking view of freight issues and disseminating information and encouragement of research necessary to achieve identified policy goals. The Special Committee operates as a forum to exchange information regarding freight transportation issues of national concern, including:

- the relationship between the movement of goods and the natural and built environments, social equity, public health, and the economy;
- the roles of the private and public sectors;
- the interconnectivity and resiliency of freight and passenger transportation modes and systems; and
- interface requirements between airports, highways, ports, railroads, transit systems, and waterways important for freight movement.

**Literature Search Summary**

In preparing this submission, two literature searches were conducted. The first search was of all existing published research recorded on the Transportation Research International Documentation (TRID) website (<http://trid.trb.org>). A second search of

current research projects was conducted on the Research in Progress (RIP) website (<http://rip.trb.org/>).

Considering the significant changes that have occurred since early 2020, the search of the TRID database was limited to all documents issued since 2010. Of the documents reviewed, none addressed the topic of this proposed research.

### **Research Objective**

It is vital for state DOTs and urban and rural planning agencies to have accurate freight forecasting at not just the tonnage level, but also by mode, commodity type, and land usage supporting these activities. As ongoing land development and re-development contribute to congestion in major cities, forecasting freight demand can help identify and inform the best locations for intermodal and warehouse facilities to curb congestion. Additionally, accurate forecasting can ensure funding is optimally allocated on vital freight corridors.

The objective of this research is to examine how freight O&D, commodity type, and land use data can enhance freight forecasting capabilities. This will lead to better freight policy decisions, gaps in freight infrastructure, and provide a model for investing in freight moving forward. Research tasks should include, but not be limited to, the following:

- Scan Advanced Data Sources: Review freight O&D, commodity type, and land use data sources that are available through State and Federal resources, as well as private venues. Identify the limitations (including sample size or lack of representative sample) for O&D data.
- Data Integration and Cost-Benefit Analysis: Analyze data types to understand how they can be integrated into current freight forecasting methodologies and preview the costs for doing so (can this be done for free through government data or require purchasing private data). Recommend ways to complement, fuse, or leverage the different datasets to overcome the limitations.
- Comparison of Freight Forecasts: Develop and compare freight forecasts for up to two pilot states using available data, and data identified and purchased as part of the research project, against existing freight forecasts to identify differences in outputs and determine which model provides the most accurate representations of the current freight network. Create a matrix that compares various model types utilizing only O&D, commodity type, and land use data with freight forecasts or a combination of two or more sources.
- Development Guidelines: Identify steps for developing freight forecasts using both methodologies that can be replicated by local, regional, and state agencies for freight forecasting using O&D, commodity type, and land use data.
- Report: Develop a report summarizing the research effort and findings, lessons learned, and assumed outcomes that can benefit those following this methodology.

The report will produce a combination of data sources and methodologies for improving freight forecasting with each additional data source, enabling state DOTs to adopt their



methods based on available government data for their jurisdiction and available budget for privately acquired data. This research will be vital in helping them identify appropriate freight investments in the short and long-term through more accurate freight forecasting.

### **Urgency and Potential Benefits**

The SARS-CoV-2 (COVID-19) pandemic has highlighted the importance of freight transport as part of supply chains. The immediate impact of the pandemic has also radically changed commuting and personal travel patterns. With the expected long-term increase in remote employment (most new jobs posted on the Indeed website are for permanent remote employment positions), planners who deal with road improvements and maintenance must pivot to understand the “new normal”. Reliance on tools that were created in the previous era of concentration, central business districts, and typical commuting patterns are of limited value.

The expanded reliance on e-Commerce to fulfill both corporate and individual needs is also creating changes in freight transport patterns. Amazon’s recent announcement of 1,000 new delivery stations across the United States (S. Soper, “Amazon Plans to Put 1,000 Warehouses in Suburban Neighborhoods”, September 16, 2020, Bloomberg News) heralds a potentially major change to small package delivery patterns.

Freight demand has grown significantly across the United States, along with population and economic growth. While trucks move the majority of freight goods on roadways— an increase in demand has also impacted rail and port (seaports and airports) facilities. Hence, for a reliable, resilient, and sustainable freight flow, it is critical to accurately forecast freight demand on infrastructure to identify key areas for investing tax dollars in the short and long-term.

Many states have historically utilized data such as TRANSEARCH flow data and applied growth rates using the FHWA Freight Analysis Framework product to inform a truck trip table in a travel demand model. In recent years, new data products have been released to help identify truck O&D and/or create truck trip tables used in travel demand models. Many of these data are focused on samples only from large fleets and/or use of probe data run post-processed with algorithms, some of which are proprietary and focused on general traffic. A majority of the trucks on the road are operated by independent operators or part of small fleets and not technically equipped; this can be especially evident around marine ports.

The benefits of research based on this problem statement include:

- A freight planning tool which reflects the new era. The new tool will be based on forward looking analysis of freight transport instead of the application of estimates based on a retroactive perspective.
- A common understanding of general patterns of freight transport, across all the primary modes, which is adaptable to the unique characteristics of each community and state.
- Improved coordinated planning across state and community boundaries.

- An increased focus on the key operational and maintenance issues for both infrastructure providers and users of reliability, resiliency and sustainability.
- Accommodation of new technologies appropriate to infrastructure providers and users alike.

### **Implementation Considerations and Supporters**

The research and planning tool will be employed the groups charged with planning new corridors, increasing the capacity of existing routes, and the allocation of resources for the maintenance of routes and corridors.

The likely focal point within a state department of transportation will be the office dedicated in whole or in part to freight and logistics issues. That office will coordinate with other parts of the agency as well as planning partners to apply the results of the research.

Implementation of the research will commence with the publication of the results of the research on the TRB website and in the form of a NCHRP report. It is expected that the AASHTO Special Committee on Freight will promote the research results among its members which includes all of the state departments of transportation. Individual state departments of transportation will coordinate and support the dissemination of the research results to their local and statewide partners.

The results and findings of the research should be widely disseminated. This process will take different forms including webinar presentations, training workshops organized by the AASHTON Special Committee on Freight, the Eastern Transportation Coalition, the I-10 Corridor Coalition and other similar groups, as well as pilot projects both two or more states to validate the usefulness of the new approach to freight planning.

AASHTO Special Committee on Freight will be most interested in the research findings. As part of their mission, the Committee will coordinate the release of the research results to other committees and standing councils of AASHTO and the members of AASHTO.

### **Recommended Research Funding and Research Period**

#### Research Funding: \$525,000

A preliminary estimate to fund the research of approximately \$525,000. This estimate includes time for the research team, the collection and examination of new data sources, and the creation of a planning process based on the research. A preliminary estimate to facilitate the communication and implementation of key research products is between \$10,000 and \$25,000. This effort will be based on the creating and delivery of webinars by the research team and the AASHTO Committee on Planning and the Special Committee on Freight.

#### Research Period: 12 months

**Problem Statement Author(s)**

This problem statement has been formulated by the AASHTO Committee on Planning's Freight Planning Task Force.

- Thomas McQueen, AASHTO Committee on Planning Freight Planning Task Force Chair, Assistant Administrator, Office of Planning, Georgia Department of Transportation, 404.631.1785, tmcqueen@dot.ga.gov
- Michael Vanderhoof, AASHTO Committee on Planning Freight Planning Task Force Vice Chair, Planning Services Section Chief, Illinois Department of Transportation, 217.782.8080, michael.vanderhood@illinois.gov

**Others Supporting the Problem Statement**

- AASHTO Committee on Planning, Mr. Matthew Hardy, 202.624.3625, mhardy@ashto.org
- AASHTO Special Committee on Freight, Ms. Caroline Kieltyka, 202.624.8489, ckieltyka@ashto.org
- Georgia DOT, Mr. Tom McQueen, 404.631.1785, tmcqueen@dot.ga.gov
- Nevada DOT, Ms. Sondra Rosenberg, 775.888.7440, SRosenberg@dot.nv.gov
- Missouri DOT, Ms. Cheryl Ball, 573.526.5578, Cheryl.Ball@MoDOT.MO.gov
- North Carolina DOT, Mr. Dana Magliola, 919.707.0909, damagiola@ncdot.gov
- Tennessee DOT, Mr. Dan Pallme, 615.741.4031, Daniel.Pallme@tn.gov
- Texas DOT, Mr. Casey Wells, Texas DOT, 512.936.0950, Casey.Wells@TxDOT.Gov

**Potential Panel Members**

Please contact Matt Hardy, AASHTO Program Director for Planning and Performance Management, for a list of recommended panel members representing the AASHTO Committee on Planning. Below are initial suggestions:

- Mr. Tom McQueen, 404.631.1785, tmcqueen@dot.ga.gov
- Nevada DOT, Ms. Sondra Rosenberg, 775.888.7440, SRosenberg@dot.nv.gov
- Missouri DOT, Ms. Cheryl Ball, 573.526.5578, Cheryl.Ball@MoDOT.MO.gov
- North Carolina DOT, Mr. Dana Magliola, 919.707.0909, damagiola@ncdot.gov
- Tennessee DOT, Mr. Dan Pallme, 615.741.4031, Daniel.Pallme@tn.gov

**Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

Matthew Hardy

202-624-3625

mhardy@ashto.org

Affiliation: AASHTO staff on behalf of the AASHTO Committee on Planning, Kristina Swallow, Chair.

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## **NCHRP Review of B-08**

### Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

### Comments:

This is a worthwhile study as integrating freight origin/destination data into improving and evolving forecast models is critical. Logistical support building on increased sources of data is an evolving process, and a contribution to improving the tools and techniques is essential. Coordination with earlier studies and ongoing studies is crucial to the success of this proposed study; in particular, the recently completed 08-110 study on accuracy of traffic forecasts and the current study 20-125 on incorporating resilience into transportation networks provide important input to this proposed study.

### Review Date:

12/14/2020

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## **FHWA Evaluation of B-08**

Reviewed By: HOFM/Birat Pandey, HEP/Jeremy Raw

### Comments:

HOFM/Birat Pandey - Both research problem statement and scope are vague. Unclear how proposed research approach and finding will benefit the end users of this research. HEP/Jeremy Raw - The proposal is presented as seeking a consistent methodology for preparing freight forecasts (presumably for long haul freight) to allow coordinated long-distance facilities from state to state. That desire for a recommended methodology document is reasonable. However, the proposal also describes development of a “tool”, which is discussed as if it were somehow different from a “forecasting model”. The project does not allow sufficient time or budget to reasonably accomplish that goal. The literature review for the proposal is inadequate. At a minimum, for the stated goal of creating an adequate cross-state methodology, it is essential to consider building on existing resources and tools such as the Quick Response Freight Methodology and FHWA’s Freight Analysis Framework, as well as extensive existing research and good working examples of regional and statewide freight forecasting models. If the proposal were reinterpreted to more narrowly address its title and focused on assessing new resources for improved freight data to support forecasting methods and models

(including FAF), using origin/destination data in particular, it would be a stronger proposal. That wouldn't necessarily rule out suggesting some new methods – but it would be premature to develop those (and could not be effectively accomplished with the proposed budget and time frame). A more comprehensive “phased” series of interrelated proposals would be preferred (e.g. a blanket project with tasks), aiming at developing better freight data and forecasting tools that was explicitly focused on building on existing techniques (some of which are good) and adding in new data sources and updated modeling techniques.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for B-08**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 2

Comments: N/A

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### **Submitter Response for 2022-B-08**

**From:** [email: mhardy@aaashto.org]

#### **Comments:**

#### Response Comments to FHWA/Jeremy raw

Comment: Unclear how proposed research approach and finding will benefit the end users of this research.

Comment Response: The purpose of the research will be to identify and assess new resources for improved freight data for forecasting methods and models and create guidelines for having a standard method of forecasting freight across state borders.

Comment: That desire for a recommended methodology document is reasonable. However, the proposal also describes development of a "tool", which is discussed as if it were somehow different from a "forecasting model".

Comment Response: We agree that the tool will be outside the scope and budget for this research material and thus would agree to remove this aspect from this research proposal.

Comment: At a minimum, for the stated goal of creating an adequate cross-state methodology, it is essential to consider building on existing resources and tools such as the Quick Response Freight Methodology and FHWA's Freight Analysis Framework, as well as extensive existing research and good working examples of regional and statewide freight forecasting models. If the proposal were reinterpreted to more narrowly address its title and focused on assessing new resources for improved freight data to support forecasting methods and models (including FAF), using origin/destination data in particular, it would be a stronger proposal.

Comment Response: We agree that the proposal should be clarified to better focus on the data. This research topic proposal can be revised to focus on the origin-destination data and other available freight data for better informing freight forecasting methodologies and models.

#### Response to NCHRP

Comment Response: This research will ensure that both of these studies listed will be referenced during the study.

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**American Association of State Highway and Transportation Officials  
AASHTO Committee on Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-09**

**Problem Title**

Extreme Weather and Climate: Managed Relocation as an Adaptation Strategy

**Background**

Climate change impacts increasingly affect transportation systems in the U.S. Transportation agencies across the country already face substantial impacts from extreme weather and other climate events, with future projections suggesting that this trend will continue. Impacts to transportation infrastructure from such events can be direct and rapid (e.g., flooding, wind, wildfires) or indirect and slow (e.g., sea level rise, land erosion, subsidence, pavement degradation). These impacts can also cause immediate or longer-term changes in the way people use local infrastructure and where people choose to permanently locate or relocate.

State and local governments often have short-term economic incentives to allow development in known high risk areas, requiring often huge and ongoing investment from transportation agencies to repeatedly repair or maintain such assets. Such development can also exacerbate risks in neighboring areas if they displace natural protections such as wetlands or greenspace. State DOTs will ultimately have significant financial and operational responsibility with respect to these assets as their exposures increase.

Managed relocation needs to be a strategy available to transportation planners, but the understanding of legal, policy, and political barriers, and implementation frameworks are only beginning to be considered. There is a need for research that develops information about managed relocation strategies in a way that supports state DOT decision making regarding transportation systems. A successful managed relocation plan can decrease risk to the entire system, save valuable resources that may be better allocated elsewhere, and protect lives and livelihoods. However, state DOT's often do not have the experience, tools, or frameworks needed to approach these issues in a way that leads to successful outcomes.

This research project will develop a framework and guidance for state DOTs to explore and implement managed relocation actions. There is no "once size fits all" approach, in part because the legal and political issues will differ by state, but a framework and guidance could provide substantial support as state DOTs begin to determine the best approach to specific, ongoing extreme weather and climate risks in a particular area. In particular, the project will identify legal barriers and opportunities in selected states as examples that can support other state DOTs that are beginning to examine their own laws and regulations.

## **Literature Search Summary**

Managed relocation is a nascent field with very little research. A literature search of the Transport Research International Documentation (TRID) database revealed only five studies related to the topic. Transportation-focused research has also concentrated on roads to the exclusion of other modes.

There are a growing number of media reports suggesting that managed relocation is a needed, and in some cases the best, adaptation strategy. However, there is a dearth of available frameworks or guidance documents to assist state DOTs with *how* such a strategy should begin to be considered, much less implemented.

## **Research Objective**

The research will develop a practice-ready managed relocation framework and guidance targeted to state DOT's to enable an informed approach to discussions and to facilitate decision-making. The expected final product is a framework and guidance document that draws from experiences and outcomes across the U.S. The framework would help state DOTs consider managed relocation as a viable resiliency strategy that can have positive, long term community benefits.

Tasks include the following:

1. Collect and synthesize managed relocation case studies from the U.S. and abroad and a review of state laws and regulations in selected states that impact DOTs managed relocation decision making.
2. Identify patterns of specific challenges and potential solutions likely to be relevant to state DOTs.
3. Identify relevant research regarding human decision-making in managed relocation considerations.
4. Convene an expert working group to synthesize the research, case studies, and pattern identification, and develop a framework and guidance document that can apply nationally.
5. Pilot test the framework with a select group of state DOTs in areas experiencing managed relocation needs.
6. Incorporate results of pilot test and revise final framework and guidance.
7. Prepare guidance document or manual that will include a practice-ready framework.

## **Urgency and Potential Benefits**

All state DOTs regularly face the impacts of extreme weather and other climate events, but those events are worsening in some areas, a trend that is expected to continue. Transportation infrastructure is often expensive and long-lived, and the practice of designing, building, and maintaining based only on current or past climate exposure does not adequately protect those substantial investments by state DOTs. Indeed, investments being made now should long outlast the expected changes in extreme weather. Incorporating managed relocation into the toolbox could more efficiently use and direct limited transportation resources. Failing to include this option may result in the need for even larger ongoing investments to protect infrastructure impacted by climate change,



infrastructure that may not have been built in a particular place or a particular way had managed relocation been a considered strategy. Managed relocation is not merely “relocating,” infrastructure, it includes evaluation of alternative routes, structures, and other considerations to more efficiently use transportation funding while preserving critical access to people, freight, and emergency services.

### **Implementation Considerations and Supporters**

The research product would be implemented by senior managers and operations staff within state DOTs. As noted, pilot testing within selected DOTs is appropriate, and training workshops and presentations can be held in person or in a synchronous format on-line. Potentially interested AASHTO Committees and Councils include: Committee on Transportation System Security and Resilience; Committee of Environment and Sustainability; Subcommittee on Air Quality, Climate Change & Energy; Committee on Maintenance; Committee on Planning; and Committee on Performance Based Management.

### **Recommended Research Funding and Research Period**

Research Funding: \$ 500,000

Research Period: 24 months

### **Problem Statement Author(s)**

Tim Sexton, Minnesota DOT, Chair, CTSSR Subcommittee on Research

Mark Abkowitz, Chair, TRB Committee on Extreme Weather and Climate Change Adaptation

Leah A. Dundon, Member, TRB Committee on Extreme Weather and Climate Change Adaptation

### **Others Supporting the Problem Statement**

Committee on Transportation System Security and Resilience

### **Potential Panel Members**

Members from the Committee on Transportation System Security and Resilience

Members and Friends of the TRB Committee on Extreme Weather and Climate Change Adaptation

### **Person Submitting the Problem Statement**

Tim Sexton, (651) 366-3622, [timothy.sexton@state.mn.us](mailto:timothy.sexton@state.mn.us)

Affiliation: Minnesota DOT, AASHTO Committee on Transportation System Security and Resilience

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## **NCHRP Review of B-09**

Reviewed By:  
Andrew C. Lemer  
alemer@nas.edu

Comments:

As a strategy for reducing societal risk associated with weather events or climatic trends, “managed relocation” would seem to apply primarily to location of human activities and land use. To the extent that transportation investment serves current or anticipated future patterns of human activity and land use, it is unclear how managed relocation could be considered a strategy for transportation planners. It seems to me unlikely that transportation facilities would be moved in advance of decisions about development patterns. In any case, the research is likely to be politically sensitive, to impinge on the domains of government agencies beyond transportation agencies, and to require value judgements inconsistent with the typical scope of NCHRP concerns. If the topic is judged to be suited to expenditure of NCHRP funds, the work might be undertaken as a policy study or carefully constrained to analysis of situations where managed relocation might be a feasible strategy, for example considering increasingly flood-prone riverfront and coastal communities.

Review Date:  
12/8/2020

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## **FHWA Evaluation of B-09**

Reviewed By: HEPN/Heather Holsinger

Comments:

This is an important topic for additional research. A FHWA/TRB/AASHTO conference held in late 2019 included multiple sessions on this topic. These sessions were well attended and the interest level from State DOTs was high. As the proposal states, we anticipate this topic will be increasingly of interest to State DOTs, particularly coastal states, and the communities they serve.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-B-09**

**From:** [email: timothy.sexton@state.mn.us;pzelinski@ashto.org]

**Comments:**

- The issues are challenging and require more than a decision that a repeatedly flooded road will no longer be maintained; it requires a complex understanding of place attachment, the community in which the transportation system exists, the interconnectedness of the infrastructure at issue with other systems and people, and whether laws and regulations authorize a state DOT to make managed relocation decisions.
- The entrenchment of expensive and long-lived transportation infrastructure in areas that are increasingly exposed to extreme weather events are challenging, making it seemingly impossible to “move” these major structures out of harm’s way. Guidance is needed for how to determine and measure transportation performance thresholds at which retreat strategies should be implemented, one that allows for sequenced and phased planning and budgeting of retreat over long time scales.
- There may be limits of local government authority and their corresponding duties under the law. In some areas, local governments may have a legal obligation to continue to maintain a road once it is there. These localities may face lawsuits from residents unable to access their property if a road is abandoned, as effecting an unconstitutional “taking” of their property without just compensation. There is a need for state and federal government coordination and for state intervention in some cases, because local governments only have the authority granted to them by the state.
- This issue is taking hold in various locations and involving multiple modes: 1) In November 2020, the State of California approved moving a stretch of Highway 1 inland...planning effort took over a decade; 2) Illinois has deployed expanded floodplains, relocated communities and removed flood-prone transportation infrastructure; 3) MN has divested from a facility because of frequent slope failures and increased investment in an alternate route, 4) two cities in Canada are evaluating retreat options for a portion of a rail line that is now increasingly vulnerable to weather-induced events.
- There are social justice issues related to migration (e.g., economically disadvantaged people are unable to migrate and are left “stuck” and their standard of living becomes reduced even further).
- When, where and how permanent retreat should occur also requires a thorough understanding of the interconnectivity of transportation with other critical infrastructure systems (e.g., energy, communication, public health, housing, etc.).

**Contact Info:**

timothy.sexton@state.mn.us, mark.abkowitz@Vanderbilt.Edu, PZelinski@ashto.org

Review Date: January 19, 2021

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-10**

**Problem Title**

Identifying, understanding, and managing risks from multiple interacting crises and cascading failures in the context of improving transportation system resilience.

**Background**

Various short-term weather driven natural disasters in 2020 (e.g. wildfires, hurricanes, floods, heat, strong wind) in the context of the current Covid19 pandemic and long-term climate change provide examples of multiple interacting crises straining transportation systems and potentially leading to interacting and cascading inter-modal and supporting infrastructure failures (e.g. electric grid, telecom, water supply). The impacts of these multiple crises and system failures will be felt at all levels of government (Federal, state, regional, and local) and ripple nationally throughout populations. Research is needed to identify, understand, and provide recommendations for how to manage resulting risks, especially how to determine points of criticality among and between modal assets and supporting systems, feedback loops from local to state to regional scales; and entry points for interventions to reduce key vulnerabilities, prepare in advance to prevent and mitigate failure cascades, and increase overall systems resilience.

Strategic plan: 2.3

- *Work with AASHTO committees and partners to develop and implement effective research efforts addressing national priorities*

Strategic plan: 3.2

- *Pursue opportunities to improve system performance by accommodating and encouraging innovative technologies in construction, maintenance, operations, and management processes*

Strategic plan: 3.4

- *Recognize and support the development of a full range of transportation solutions that meet the needs of a diverse set of states and communities*

Strategic plan: 4.2

- *Develop strong transportation narratives and tools that have broad impact on the transportation dialogue*

THE RESILIENT AND SUSTAINABLE TRANSPORTATION SYSTEMS  
STEERING COMMITTEE ACTION PLAN (2017 – 2019) (The Committee on  
Transportation System Security and Resilience (CTSSR))

- *“The purpose of the Steering Committee is to strategically coordinate national efforts, identify best practices, and work to fill research gaps to promote resilient transportation systems across the country...[including] preparing for, and responding and adapting infrastructure for extreme weather events, and other shocks and stresses to the transportation system...[and] is dedicated to influencing emerging policies, guiding and developing technical expertise and tools for state DOTs to perform risk based identification of potential impacts, planning for system adaptation needs, and preparing for the response and recovery of impacted transportation systems.*
- *[Function] 4. Provide State DOTs with the resources, including models, tools, analysis techniques, methodologies and professional development to implement a multimodal, multidisciplinary approach to transportation system resilience and sustainability.*
- *Strategic Goal 2. Provide Innovative Technical and Professional Services and Products*
  - o *Strategy 2.3:*
    - *Identify and support high priority research*
    - *Identify research gaps in climate adaptation and resiliency*
    - *Work with AASHTO committees and partners to develop and implement effective research efforts addressing national priorities related to climate adaptation and extreme weather resiliency*

## **Literature Search Summary**

A cursory search finds a limited amount of literature, especially in the area of transportation. TRID shows about 10 related articles. Some research groups and Federal grant programs are pursuing this topic, particularly focused on systems and risk modelling (e.g. the Resilient Infrastructure as Seas Rise (RISeR) project, supported by the National Science Foundation (NSF) Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP).

## **Research Objective**

Research objective is to identify, understand, and provide recommendations for how transportation systems can increase capacity to manage and respond to extreme weather and climate crises occurring simultaneously or in conjunction with other crises (e.g. Covid19); determine points of criticality among and between modal assets and supporting systems (e.g. electric grid, communications); feedback loops from local to state to regional scales of impacts and crisis that may cause cascading failures; and entry points for interventions to reduce key vulnerabilities via policy and operations.

- a. The desired outcome(s) and expected final product(s).

- increased consideration and interaction of AASHTO and TRB Committees on this topic – including annual Policy Forum topic, and possibly new ad hoc group, or standing committee
- compendium of current research and best practices, especially applying systems risk management from other sectors (e.g. electric grid), and applied systems research modelling
- illustrative analysis and case studies from representative regions, states, and agencies
- test bed for tool development
- development of experimental prototype decision support tools
- a. Major tasks or activities the research contractor will likely have to perform in order to successfully conduct the research.
  - Describe the tasks or activities in enough detail to demonstrate that the objective can be fully achieved and that the estimated funding is justified and sufficient.
  - Literature review and compilation
  - Series of interdisciplinary Committee Workshops and interviews across modes to compile expert judgement, including experts from outside the transportation community who manage interdependent systems on which transportation relies (e.g. electric grid), public health (e.g. Covid and Covid response expertise), perform disaster preparedness and recovery, and model complex adaptive systems
  - Report compendium production, including developing research-based case studies
  - Decision support development and training
- b. How the research results should be presented.
  - Possible forms include, but are not limited to, guidance or guidelines, a test method, equipment, a tool, specifications, a manual, a new or revised process, etc.
  - Reports, guidance, best practices, decisions support tools, trainings, webinars, and workshops

## **Urgency and Potential Benefits**

Given the interdependencies and complexities of current transportation systems and modes nationwide, coupled with Covid19 safety limits on response with constrained resources, and the arrival of climate tipping points driving extreme weather events, the time is now to explore this topic for all DOTs.

Failure to explore this topic means that DOTs will be less prepared for these emerging crises, to prevent cascading failures that inevitable will arise, and opportunities will be missed to improve overall systems resilience.

Besides proving the value of current investments in preparedness leading to avoided future costs, and the benefits of improving decision making for system risk management, increasing overall systems resilience has advantages both measurable and intangible.

## Implementation Considerations and Supporters

Although valuable across multiple modes and business units, planners, asset managers, risk managers, and policy decision-makers likely will benefit the most. However, it is essential to involve operations and maintenance personnel to bridge short and long-term management scales in developing agency-wide policies.

States with emerging resilience positions and programs will be best able to pursue and take advantage of this research, so building this capacity across all DOTs potentially should be part of the backdrop to the research process.

Various DOTs including, but not limited to California, Colorado, Texas, Florida, North Carolina, Virginia, Maryland, Pennsylvania, New York, and Massachusetts are pursuing resilience planning and preparedness statewide or in their transportation agencies. State-level transportation organizations like AASHTO also are beginning to emphasize the importance of systems resilience. Additionally, system resilience, especially in the face of climate change is becoming a priority for numerous organizations including built infrastructure, electric grid, telecom, water, and transportation, among others who are “asking the climate question”.

Likely products could include systems models supporting general and ad hoc decision support tools. Dissemination and training on these tools could follow, although TBD by ad hoc group.

**NOTE: this proposal could be complementary to another submitted this round under CTSSR: “Measuring Impacts and Performance of State DOT Resilience Efforts” (from Jeff Meek and Jennifer Carver of MNDOT)**

### POSSIBLE AASHTO COMMITTEES (\*= key committees to consider)

- \*Committee on Transportation Systems Security and Resilience (CTSSR)
- Committee on Performance Based Management
- \*Committee on Risk Management? (not listed but mentioned)
- Committee on Transportation System Operations (CTSO)
  - >Working Group on Freight Operations
  - >Subcommittee on Performance Management and Data
  - >\*Community of Practice on Road Weather Management
- Committee on Planning
  - >Subcommittee on Research
  - >\*Task Force on Freight Planning
  - >\*Task Force on Multimodal

- Committee on Maintenance
  - >\*Maintenance Operations – Focuses on highway maintenance operations issues including work zone safety, snow and ice control, and emergency response (but also Pavement, Bridge, Roadway)
- \*Committee on Environment and Sustainability
  - >Subcommittee on Environmental Process
  - >Subcommittee on Natural Resources
  - >Subcommittee on Research
  - >\*Center for Environmental Excellence
  - >\*Resilient and Sustainable Transportation Systems
- Committee on Design
  - >\*Subcommittee on Environmental Design
  - >\*Subcommittee Hydrology and Hydraulics
- Committee on Bridges and Structures
  - >Technical Committees
  - T-9 Bridge Preservation
  - T-11 Research Membership (Tom Ostrom, CA DOT?)
  - T-13 \*Culverts
  - T-15 Substructures and Retaining Walls
  - T-18 Bridge Management, Evaluation, and Rehabilitation
  - T-20 \*Tunnels
- \*Water Transportation Council
- \*Rail Council
- Active Transportation Council
- \*Aviation Council
- \*Special Committee on Freight
- >\*Highway Transport

#### **POSSIBLE TRANSPORTATION RESEARCH BOARD (TRB) COMMITTEES**

- Standing Committee on Extreme Weather and Climate Change Adaptation (Mark Abkowitz)
- Standing Committee on Disaster Response, Emergency Evacuations, and Business Continuity
- Standing Committee on Critical Transportation Infrastructure Protection
- Standing Committee on Road Weather (Paul Pisano)

#### **POTENTIAL ORGANIZATIONS – contacts available on request**



- US Army Corps of Engineers, Engineering Research and Development Center (ERDC), Vicksburg, MS
- Department of Homeland Security, Cybersecurity and Infrastructure Security Agency (CISA)
- National Institute of Standards and Technology (NIST) - Center for Risk-Based Community Resilience Planning
- National Science Foundation - Natural Hazards Clearinghouse
- FEMA?
- Pacific Northwest National Lab (PNNL)
  - Control of Complex Systems Initiative
  - Environmental Assessment and Engineering (EA&E)
  - The Risk and Decision Sciences Group (R&DS)
- Natural Hazards Center, University of Colorado, Boulder
  - EAGER: Interdisciplinary and Social Science Extreme Events Research
  - Network for Social Science Extreme Events Research (SSEER) and
  - Network for Interdisciplinary Science and Engineering Extreme Events Research (ISEEER).
- Network Dynamics and Simulation Science Laboratory, Virginia Bioinformatics Institute, Virginia Tech, Blacksburg, VA
- NEMAC-FERNLEAF, Asheville, NC
- Center for Climate Adaptation Science and Solutions (CCASS) at the University of Arizona, Tucson, AZ
- Climate Adaptation Partners, New York, NY
- University of Texas – Arlington, Civil Engineering Dept
- RAND Corporation, Santa Monica, CA
  - Homeland Security Operational Analysis Center
  - RAND Social and Economic Well-Being

#### **Recommended Research Funding and Research Period**

- \$10,000: Literature review and compilation
- \$60,000 (remote): series of interdisciplinary Committee workshops and interviews across modes to compile expert judgement, including experts from outside the transportation community who manage interdependent systems on which transportation relies (e.g. electric grid), perform disaster preparedness and recovery, or model complex adaptive systems
- \$25,000: Report compendium production
- \$75,000: developing research-based case studies, including modelling
- \$100,000: proto-type decision support tool development (scalable)
- \$30,000: training

**TOTAL = \$300,000**

TBD by ad hoc group: estimate 2 years

**Problem Statement Author(s)**

- TBD by ad hoc group participation/proposal development process

**Others Supporting the Problem Statement**

- Tim Sexton, CTSSR, MNDOT <timothy.sexton@state.mn.us>
- Jeff Meek, CTSSR, MNDOT <Jeffrey.Meek@state.mn.us>
- Jim Pappas, CTSSR, DelDOT <James.Pappas@delaware.gov>
- TBD by ad hoc group participation/proposal development process

**Potential Panel Members**

- TBD by ad hoc group participation/proposal development process

**Person Submitting the Problem Statement**

- Name of individual: Josh Foster
- Phone number: M) 443-960-3249
- Email address: jfoster@mdot.state.md.us
- Affiliation (limited to):[state] DOT: Maryland Department of Transportation, Office of Environment HQ AASHTO nomination pending for Committee on Transportation System Security and Resilience

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**NCHRP Review of B-10**

Reviewed By:

Stephan A. Parker  
saparker@nas.edu

Comments:

This is an important and timely topic. The federal government has spent millions of dollars on modeling critical infrastructure interdependencies. This project, if funded, could hold events and develop communications materials to familiarize the transportation community with those models. Venues for such sharing already exist in the TRB Resilience Section and in the AASHTO Committee on Transportation System Security and Resilience.

Most applicable for state DOT application on managing risks is a recently completed report under NCHRP Project 08-107, A Guidebook for Emergency Contracting

Procedures for Administration of a Regional Emergency. The objective of this research is to develop a contracting strategies guidebook for concurrent regional emergencies. The primary audience is state DOTs administering multiple projects over a region involving multiple routes.

Identifying, understanding, and managing risks under this topic are addressed in other NCHRP research in progress:

- 08-129 Incorporating Resilience Concepts and Strategies in Transportation Planning
- 20-116 An Emergency Management Playbook for State Transportation Agencies
- 20-125 Strategies for Incorporating Resilience into Transportation Networks
- 23-09 Scoping Study to Develop the Basis for a Highway Standard to Conduct an All-Hazards Risk and Resilience Analysis
- 20-127 Business Case and Communications Strategies for State DOT Resilience Efforts
- 20-128 Emergency Response: Organizational and Operational Models Used by State DOTs

Identifying, understanding, and managing risks under this topic are addressed in NCHRP research in development:

- 08-146 Integrating Resiliency into Transportation System Operations
- 15-61A Updates to the Design Practices Guide for Applying Climate Change Information to Hydrologic and Coastal Design of Transportation Infrastructure
- 15-80 Design Guidance and Standards for Resilience
- 20-102(16) Preparing TIM Responders for Connected Vehicles and Automated Vehicles

Review Date:

12/18/2020

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## **FHWA Evaluation of B-10**

Reviewed By: HOP, HEPN/Becky Lupes

Comments:

HOP - Repeats some of the area covered by problem statement B-30 that was selected last year. It may make sense to wait for that research to progress.

HEPN/Becky Lupes - This is a timely and useful study.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-B-10**

**From:** [email: jfoster@mdot.state.md.us;pzelinski@aashto.org]

### **Comments:**

My problem statement indeed has similar characteristics to other studies mentioned in the review comments with objectives of bringing together resilience considerations: to systems operations and planning, emergency and risk management, climate and (all) hazards resilience, and integrating research into practice, while also including climate and hydrology, asset management, project design and delivery, and recovery.

However, my problem statement is different in that it includes:

- both extreme weather/natural hazards AND (largely) is climate change focused (more than other studies or at least with more of an interest in applying climate impacts knowledge to long-term planning;
  - considerations of managing multiple simultaneous crisis and cascading failures;
  - planning AND operations (although other studies do too) rather than one or the other.
- My problem statement also includes maintenance issues as separate from operational issues;
- takes a holistic and focused systems modelling approach—bringing in new tools and models, and proposes engaging non-transportation advance systems modelling communities;
  - more intermodally focus than other studies (e.g. oriented only to highway systems);
  - includes dependent systems (e.g. electricity, telecom, water) that are critical top supporting transportation systems.

I believe my problem statement complements and builds on these other active or anticipated resilience studies as well as pulling together a different and needed focus on multiple interacting crises and cascading failures (MICCF), intermodal and dependent systems, and with more of a long-term climate perspective, cutting across, or slicing these problems in a unique way.

Finally, Secretary Gregory Slater, Maryland Department of Transportation, noted the importance of this issue (MICCF) in his resilience panel presentation to the AASHTO Policy Forum on November 12, 2020.

Therefore, I would like my problem statement to move forward for consideration. Thanks for your reviews, support, and assistance!

Best regards,

Josh Foster, MD DOT

**Contact Info:**

Josh Foster  
Senior Manager, Climate Risk Management and Resilience  
Office of Environment, The Secretary's Office  
Maryland Department of Transportation Headquarters  
7201 Corporate Center Drive, Hanover, MD 21076  
jfoster@mdot.state.md.us M) 443-960-3249

Review Date: 2/5/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-11**

**Problem Title: Benefit Analysis of Private Health Sector Investments in Public/Human Transportation**

**Background**

People who are unable to transport themselves and require recurring medical trips for chronic conditions such as diabetes or cancer face numerous challenges to receiving much-needed care. Individuals without a support network often rely on public transportation to access medical services, but then face transit service limitations, prohibitive costs, or potentially the complete lack of access to public transportation. Moreover, those with access to public transportation may be without options in response to other challenges, like service delays, interruptions, or closures. While health care transportation (commonly called Non-Emergency Medical Transportation or NEMT) is a benefit of some public insurance plans, the uninsured, under insured, or those who have insurance without this transportation benefit continue to struggle.

For a medical provider, success is only attainable if individuals are able to access their health care facilities for service. When a provider reduces services or the service does not meet its projected levels, a provider can relocate to improve access. While beneficial to the provider, relocations often cause further stress on transportation-disadvantaged individuals already struggling to access services.

Federal, state, and local funding is available for transportation in many areas, and the Coordinating Council on Access and Mobility (called CCAM) is addressing NEMT from a federal policy and funding perspective. However, available funding may be insufficient to meet all the transportation needs, particularly if public transit does not currently exist. If private and nonprofit funding from the health care industry, including hospitals, is available to subsidize transportation, opportunities exist to increase availability of NEMT while also providing an even greater monetary benefit to the health care industry. This research aims to incentivize private health investment in NEMT, and serve as the foundation for future research to examine the effects of such an investment. By showing the returned value of investment in NEMT, the overall healthcare sector will be unable to deny its value. Ultimately, by improving access to health care services through NEMT, not only will public health improve but the impacts to local, regional and statewide economies will be significant by maintaining and potentially increasing population growth in some areas most in need, another benefit for hospitals and health care providers.

**Literature Search Summary**

During this literature search, the following citations with summaries were discovered in relation to best practices on private health sector investments in transportation:

- Exploring Data and Metrics of Value at the Intersection of Health Care and Transportation: Proceedings of a Workshop. Summary – The objective of this research was to explore partnerships, data, and measurement at the intersection between health care and transportation.
- Guidebook and Research Plan to Help Communities Improve Transportation to Health Care Services. [Project]. Transit Cooperative Research Program, Federal Transit Administration. Start Date: Oct. 01, 2017. Summary – The objectives of this research are to: (1) Develop a guidebook to help communities improve transportation to health care. The guidebook should serve three important audiences—the healthcare sector, the transportation sector, and other stakeholders—and help them lay the foundation for building effective relationships to improve customer-focused mobility services.
- Healthcare transportation services: Policy shifts and the influence of shared mobility. Transportation Research Board 98th Annual Meeting. Summary – The objective of this research is to catalogue innovative healthcare mobility services, such as shared mobility with transportation network companies.
- Transportation to Dialysis Centers: Health/Transportation Policy Intersection. [Project]. Transit Cooperative Research Program, Federal Transit Administration. Start date: 3 Dec. 2016. Summary – The objective of this research is to quantify the current and projected demand and associated costs of transportation for kidney dialysis and identify current effective practices and new strategies for funding and providing transportation for dialysis.
- How the Health Insurance Portability and Accountability Act (HIPAA) and Other Privacy Laws Affect Public Transportation Operations. Summary – The objective of this research is to examine privacy legal issues in transportation as a result of the Health Insurance Portability and Accountability Act (HIPAA) and other privacy laws, which may limit public transportation provider ability to coordinate NEMT for individuals with Medicaid.

NEMT is necessary for health care, affecting providers and patients. This proposed research would expand upon existing research and provide an actionable solution with multi-faceted benefits, including improved NEMT services for patients resulting from the healthcare industry's increased investment in NEMT.

### **Research Objective**

The objective of this research is to analyze the benefit to the healthcare industry resulting from small, supportive private investments in NEMT. This research will explore the effects of healthcare investments in communities with existing public transit, human services transportation, and other NEMT; the intent is to subsidize the expense of existing NEMT services to provide expansions rather than create new services where funding may not currently exist. This research needs to include several cost-benefit analyses of healthcare investment in transportation, specifically, one analysis each in a rural, small urban, and urbanized area in at least three states with varying geography, demographics, and economies. The research should include: a report of findings, a tool

for measuring the direct and indirect benefits of transportation subsidies by healthcare providers, and a recommended process for presenting the findings to the healthcare industry to incentivize investment.

### **Urgency and Potential Benefits**

Federal, state, and local funding is insufficient to meet the NEMT needs across the country. Transportation will continue to be an issue, and challenges to accessing healthcare will continue to increase as the population ages. Medical and other large-scale emergency events that increase the public need to access transportation will further strain the system. There may be many solutions to the transportation funding challenge, but until they are explored and vetted, there will be no definitive way to determine where investments can afford sufficient benefit. By not furthering this research now, the transportation challenges will persist while the available funding will remain deficient.

### **Implementation Considerations and Supporters**

Program managers for transit at state departments of transportations (DOTs) will use this research when working with transportation operators, other state agencies that fund transportation, and state committees responsible for overseeing and implementing activities in the Coordinated Human Service Mobility Plans. Because available transportation funding is limited and does not meet the need in every area, state DOTs will benefit from involving all partners in efforts to increase private NEMT investment. Once available, this information will be valuable for public meetings and made available for presentations, trainings, and peer exchanges; in brochures, websites, and guidance documents for transit providers; for large healthcare systems with multiple locations in a state or region; and for transportation providers to use within their communities to solicit funding from healthcare providers.

### **Recommended Research Funding and Research Period**

Recommended Funding: \$300,000

Research Period: 18 months: 12 months of research and six months of communication and implementation

### **Problem Statement Author(s)**

Brittany Voll, Virginia Department of Rail and Public Transportation, (804) 786-4637, [brittany.voll@drpt.virginia.gov](mailto:brittany.voll@drpt.virginia.gov)

Ian Ritz, Transit Section Chief, Wisconsin Department of Transportation, (608) 266-0189, [ian.ritz@dot.wi.gov](mailto:ian.ritz@dot.wi.gov)

### **Others Supporting the Problem Statement**

AASHTO's Council on Public Transportation

AASHTO's Multi-State Transit Technical Assistance Program

### **Potential Panel Members**



Brittany Voll, Virginia Department of Rail and Public Transportation, (804) 786-4637,  
brittany.voll@drpt.virginia.gov  
Ian Ritz, Transit Section Chief, Wisconsin Department of Transportation, (608) 266-0189,  
ian.ritz@dot.wi.gov  
Charles Carr, Research Chair, AASHTO's Council on Public Transportation; Mississippi  
Department of Transportation, (601) 359-7025, ccarr@mdot.state.ms.us

### **Person(s) Submitting the Problem Statement**

AASHTO's Council on Public Transportation

Contacts: Shayne Gill  
Program Director for Multimodal Transportation  
AASHTO  
(202) 624-3630/(202) 486-7742  
sgill@aashto.org

Richard Price  
Associate Program Manager, Transit Policy and Technical Assistance  
AASHTO  
(202) 624-5813/(202) 427-5600  
rprice@aashto.org

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### **NCHRP Evaluation of B-11**

Reviewed By: Dianne S. Schwager

#### Comment:

This research will have significant value to communities of all sizes throughout the U.S. It builds on prior research projects and workshops conducted by TRB and NASEM that have addressed the intersection of transportation and healthcare, in particular for elderly, low-income, and infirmed people. Non-emergency Medical Transportation (NEMT) plays a critical role in providing access to healthcare for many people. Adding resources to these services through private investments may result in improved health outcomes and greater efficiency and effectiveness of the transportation services. The research problem statement proposes examination in different environments, i.e., rural, small urban, and and urbanized areas, which is critical since the availability of both healthcare facilities and transportation options varies in these different environments. The results of this research will provide greater insight regarding the potential benefits of private investments in NEMT and much-needed tools to improve decision-making that will benefit healthcare outcomes and transportation services.

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### **FHWA Evaluation of B-11**

Reviewed By: HEP/Fleming El-Amin

Comments:

This research problem has been submitted for consideration a couple of times over the past few years and it has gotten much stronger since they've incorporated feedback by FHWA. There is an obvious roll of transportation to get people to health care – both private and public, but there is a slightly less obvious roll of the transportation industry to convince the private health sector to fund transportation to their services. The research should address how increased mobility and public transit service to a concentration of healthcare providers will benefit the entire community. However, the concepts introduced in this problem statement could be an element or piece of the puzzle. Recommend this research is integrated with the objectives of proposal B-05 Transportation Planning for Health Care Access.

Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for B-11**

Submitted By:  
Phillip Burgoyne-Allen  
AASHTO Staff  
Council on Active Transportation

Priority #: 4

Comments: Addresses the needs of those left behind/vulnerable by their insurance provider or their lack of insurance. Appeals to the healthcare providers by reminding that their best outcomes are only possible when patients come to appointments. This is a great rationale for the research as it appeals to both the underinsured and uninsured as well as the healthcare industry.

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**Submitter Response for 2022-B-11**

**Comments:** Response to Reviewer Comments in attached file. (Below)

**Contact Info:**

Richard Price  
Associate Program Manager, Transit Policy and Technical Assistance  
American Association of State Highway and Transportation Officials (AASHTO)  
555 12th Street NW Suite 1000

Washington, DC 20004  
 Work: (202) 624-5813  
 Cell: (202) 427-5600

**Review Date:** 2/3/2020

| <b>Problem 2022-B-11: Benefit Analysis of Private Health Sector Investments in Public/Human Transportation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| <b>Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Response to Reviewer's Comments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <p><b>Reviewed By: HEP/Fleming El-Amin -</b><br/>         This research problem has been submitted for consideration a couple of times over the past few years and it has gotten much stronger since they've incorporated feedback by FHWA. There is an obvious roll of transportation to get people to health care – both private and public, but there is a slightly less obvious roll of the transportation industry to convince the private health sector to fund transportation to their services. The research should address how increased mobility and public transit service to a concentration of healthcare providers will benefit the entire community. However, the concepts introduced in this problem statement could be an element or piece of the puzzle. Recommend this research is integrated with the objectives of proposal B-05 Transportation Planning for Health Care Access.</p> | <p><b>Response to HEP/Fleming El-Amin -</b><br/>         The recommendation to address how increased mobility and public transit service to healthcare services would be a result of this proposed research, as it is intended to result in a tool for measuring the direct and indirect benefits of transportation subsidies by healthcare providers. Direct and indirect benefits could include beneficial public health outcomes in a community.</p> <p>The B-05 research proposal could provide complementary information to this research; however, the proposed research focuses and results are different such that combining them may result in degradation of either proposal.</p> <p>NEMT is a discrete and significant program nationwide and merits its own consideration in the context of public transportation. Furthermore, B-11 proposes immediately actionable research for use at a community or state level to garner healthcare support for existing transportation to expand or provide services for underserved populations.</p> <p>Thanks again for your comments on this research proposal. Please know that this problem statement ranked #2 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program.</p> |

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| <p><b>NCHRP comment</b> - This research will have significant value to communities of all sizes throughout the U.S. It builds on prior research projects and workshops conducted by TRB and NASEM that have addressed the intersection of transportation and healthcare, in particular for elderly, low-income, and infirmed people. Non-emergency Medical Transportation (NEMT) plays a critical role in providing access to healthcare for many people. Adding resources to these services through private investments may result in improved health outcomes and greater efficiency and effectiveness of the transportation services. The research problem statement proposes examination in different environments, i.e., rural, small urban, and urbanized areas, which is critical since the availability of both healthcare facilities and transportation options varies in these different environments. The results of this research will provide greater insight regarding the potential benefits of private investments in NEMT and much-needed tools to improve decision-making that will benefit healthcare outcomes and transportation services.</p> | <p><b>Response to NCHRP comment</b> - We agree that this research will have significant value and hope that it builds upon past research by addressing the gaps in existing research. More importantly, we hope this research provides opportunities to improve healthcare transportation and ultimately improving transportation services overall, resulting in improved community health.</p> <p>Thanks again for your comments on this research proposal. Please know that this problem statement ranked #2 in priority for members of AASHTO's Council on Public Transportation and Multi-State Transit Technical Assistance Program.</p> |
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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-12**

**Problem Title**

Successful Approaches in Preparing Convincing Section 106 Effect Determinations

**Background**

Concluding Section 106 (of the National Historic Preservation Act of 1966) has ramifications on other environmental requirements in transportation project development including NEPA, Section 4(f) analyses, and environmental permits. The outcome of the Section 106 consultation process is an effect determination, i.e., what effect will a federal action have on historic properties (eligible for or listed in the National Register of Historic Places). Federal regulation (36 CFR 800) makes a distinction between undertakings that adversely affect historic properties and those that do not (i.e., no-effect and no-adverse-effect findings). The basis for this distinction is whether a federal action will alter or diminish those properties that make a property eligible for listing in the National Register of Historic Places. In other words, not every alteration or change constitutes an adverse effect from a Section 106 perspective. Making that argument, however, requires both a detailed understanding of regulatory definitions and skill in arguing the case. This research would identify and document examples of "making the case" for no-effect and especially no-adverse effect determinations, both of which are the most favorable Section 106 findings for DOTs with direct positive applications in both NEPA and 4(f) analyses.

Section 106 consultation is a keystone element of transportation project development among all state DOTs and their federal agency partners such as FHWA and the U.S. Army Corps of Engineers. Improving the skill of Section 106 practitioners in making convincing effect determinations will make environmental analysis and permitting less burdensome and more efficient.

While Section 106 training is available to state DOT cultural resources practitioners, it often covers the general requirements of law and regulation, focuses on the nuances of writing Memoranda of Agreement, or specialized topics like tribal consultation. A focus on the content and skill needed in making convincing effect determinations would supplement existing training on a topic that rarely deserves focused attention.

This research is directly responsive to Goal No. 1 of AASHTO's Standing Committee on the Environment and Sustainability (CES): "provide technical support to members to increase their capacity to efficiently and reliably deliver environmentally sound transportation programs and services", especially to "provide various forums and facilitate member information peer exchange of successful practices ...".

## **Literature Search Summary**

Research and training is available on a range of cultural resources topics in transportation including the evaluation of historic properties, the National Register of Historic Places, traditional cultural properties and the preparation of agreement documents, among others. However, no research has been conducted to identify successful approaches in making convincing Section 106 effect determinations, a crucial decision with far-ranging impact on environmental analysis and project development.

## **Research Objective**

The objective of this research is to identify successful practices in making Section 106 no-effect and no-adverse-effect determinations. This will be accomplished by identifying examples of successful practices among state DOTs and synthesizing those findings in a manner that is implementable among cultural resources practitioners.

Major tasks include:

- a. Define the regulatory basis and definition for effect, especially pertaining to alteration vs. diminishment of historic characteristics, tests of integrity, and any situations where a certain effect determination is prescribed.
- . Identify and collect examples of successful no-effect and no-adverse-effect determinations developed by state DOTs and concurred with by the DOT's respective State Historic Preservation Officer (SHPO) relative to the following types of historic properties:
  - i. historic buildings and bridges
  - ii. historic districts
  - iii. significant archaeological sites
  - iv. historic battlefields
  - v. traditional cultural properties
- a. Interview selected DOT cultural resources practitioners for recommendations about making convincing effect determinations.
- b. Synthesize the aspects of the examples especially pertaining to the basis of the no-effect or no-adverse-effect finding. What are the aspects of fact, application of regulatory definitions, and logic that made these determinations convincing to the SHPO?
- c. The results of the research should be presented both as a publication of the National Academies and as the basis for a webinar or training program to disseminate the results to DOTs.

## **Urgency and Potential Benefits**

Some of the most skilled Section 106 practitioners are reaching the end of their careers and newer employees may not possess the equivalent knowledge, skill and ability that their more senior peers have in making convincing effect determinations. Further, many Section 106 practitioners at both state DOTs and their SHPO partners have imprecise, colloquial understanding of the regulatory definitions involved in making effect

determinations. This research is urgent for purposes of succession planning among state DOTs and for improving the accuracy and quality of a key environmental decision in project development.

### **Implementation Considerations and Supporters**

This research would primarily be implemented by state DOT environmental programs, including cultural resources, NEPA, 4(f) and permit staff, implemented through review and adoption of research results and participation in a webinar prepared for this project. Training workshops and peer exchanges among practitioners would also be effective in implementing the identified successful practices among state DOTs.

Other organizations that might be interested in the research results and could help support implementation include:

- Federal Highway Administration
- Federal Transit Administration
- Federal Railway Administration
- Advisory Council on Historic Preservation
- State Historic Preservation Officers

### **Recommended Research Funding and Research Period**

Research Funding: \$150,000

Research Period: 18 months

### **Problem Statement Author(s)**

- Antony F. Opperman  
Virginia Department of Transportation, Environmental Division  
Mobile: 757-254-9045  
Email: a.opperman@vdot.virginia.gov

### **Others Supporting the Problem Statement**

List organizations, including AASHTO Committees or Councils, which support this problem statement, and provide contact information.

- AASHTO Standing Committee on Environment and Sustainability (CES)
- TRB Standing Committee on Historic and Archaeological Preservation in Transportation (AME60)

### **Potential Panel Members**

- To be determined, though potential panel members should include cultural resources practitioners from state DOTs, SHPO project review representatives, FHWA's Historic Preservation Officer, and representation from the Advisory Council on Historic Preservation.

### **Person Submitting the Problem Statement**

- Timothy M. Hill  
Phone: (614) 644-0377  
Email: Tim.Hill@dot.ohio.gov  
Affiliation: AASHTO Standing Committee on Environment and Sustainability
- 

## **NCHRP Review of B-12**

### Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

### Comments:

The proposed research addresses an area of cultural resource practice encountered by many state DOTs and their partners/stakeholders. A readily accessible, up-to-date review of no-effect/no-adverse-effect determinations would be a useful resource for practitioners. To be effective, the project needs to rely on a strong research design that will support conclusions that can be generalized to future cases. The problem statement authors might elaborate on the issue of generalizability, given the wide divergence in practice and contexts across the country. The proposed budget is adequate for a focused documentation of recent practice. The development of training materials would require additional resources and/or be carried out through other programs than NCHRP.

### Review Date:

11/30/2020

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## **FHWA Evaluation of B-12**

### Reviewed By: HEPE-30/David Clarke

### Comments:

The tone of this project needs some work. It reads as, DOTs need to find ways to convince SHPOs to agree with them. This is useful in the sense that recommendations could be in how to better consult with SHPOs, how to provide complete documentation, how to fully document character-defining features, the 7 aspects of integrity, and significance, how to incorporate design changes to avoid adverse effects, how to explore design exceptions, etc. Robust SHPO involvement would be expected, otherwise this product will be one-sided and perceived as potentially anti-SHPO. Overall, the statement should be more balanced because it's not just SHPOs that are the "problem" it's also DOTs and consultants that need to think creatively.



Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-13**

**Problem Title**

**Analysis of Changes in Near-Road Air Pollutant Levels Resulting from Decreased Traffic due to Coronavirus Pandemic Stay-at-Home Policies**

**Background**

Understanding background contributions to near-road air quality is a critical element in hot-spot analyses, which can be required in conformity demonstrations for transportation projects in air quality maintenance and nonattainment areas. In addition, better characterization of the roadway contribution to near-road air quality can inform future policies, programs, and projects to ensure they effectively address air quality and that we are addressing existing air quality issues without creating new or worsening existing problems.

In the US, when stay home orders were issued to reduce the spread of COVID, traffic across the country dropped significantly – as much as 60 percent over mid-January levels. A number of analysis have shown that NO<sub>x</sub> concentrations dropped during the initial COVID stay home orders, yet pollutant reductions were not proportional to traffic reductions. This non-proportional reduction is likely due, at least in part, to the traffic decrease coming primarily from light duty vehicles, while freight volumes remained close to normal levels.

The first few months of the pandemic provide a unique opportunity to evaluate the roadway contribution to near-road air quality under traffic conditions that normally would be impossible to generate. In addition, changes in fleet characteristics can also provide insight into the contributions of different vehicle classes.

**Literature Search Summary**

This research builds on several recent studies seeking to better understand the traffic contribution to near-road air pollution levels. Analysis in Texas showed that near-road PM<sub>2.5</sub> concentrations were dominated by regional background levels and indicated a strong correlation between the near-road PM<sub>2.5</sub> levels and background concentrations. The Near-Road Air Quality Pooled Fund study looked at multiple methods of calculating background concentrations and investigated confounding factors (such as nearby noise walls). Similar to the Texas analysis, the Near-Road Pooled Fund showed that the roadway contributed no more than about 2.0 µg/m<sup>3</sup> of the near-road PM<sub>2.5</sub> concentrations, and often less.

The body of literature evaluating air quality during the most severe COVID lockdowns is growing. Satellite imagery shows NO<sub>x</sub> reductions in the range of 20 to 40 percent in various parts of the world. A literature search in TRID identified a handful of articles that evaluate the effect of the COVID stay home orders on air quality. While these studies show that PM<sub>2.5</sub> and NO<sub>x</sub> levels decreased during the stay home orders and look at coincident changes in traffic, the analyses do not parse the traffic and air quality data in ways that contribute to our overall understanding of the roadway contribution to near-road air quality.

### **Research Objective**

The dramatic and sustained drop in traffic during the early stay home orders, along with the change in the fleet mix, provide a unique opportunity to look at the relationship between traffic and near-road pollutant concentrations. The objective of this research is to use this early pandemic traffic drop and the associated monitored air quality data to better understand the traffic contribution to near-road air pollutant levels through statistical analysis and case study emissions evaluations.

### **Desired Outcome and Product**

The desired outcome of this research is additional insights into the roadway contribution to near-road air pollution. These insights will be documented, along with the methods, in a report, and as applicable, in a peer-reviewed journal article.

### **Major tasks**

- Identify areas with near road monitors that had significant reductions in traffic early in the spring of 2020, during the initial COVID stay home orders
  - Compare COVID window traffic to pre-COVID traffic
  - Differentiate traffic volume changes between light-duty and truck fleet activity, if data are available (most assessments to date show sharper decline in LDVs vs. trucks)
- Compare COVID window air pollution concentrations to similar periods with near-road monitoring (2014 to present)
  - Look at all pollutants, criteria pollutants and toxics
  - Evaluate whether meteorological conditions are a factor in any concentration changes observed
- Assuming a concentration drop was observed from previous years, assess to what degree that drop is outside the bounds of what would be expected simply due to fleet turnover
- Evaluate national data for relationships between traffic drop and concentration changes
- Evaluate case studies (1-4, depends on funding level and potential case studies identified in preliminary analysis) to further investigate contributions to near road pollutant concentrations, e.g., where roads have varying fleet mixes (e.g., a truck route case vs. a light duty route case)

### **Urgency and Potential Benefits**

The results of this research will support project delivery efforts, provide insight into potential future scenarios with lower on-road emissions, and support efforts to mitigate air quality effects to near-road communities, which are often disproportionately impacted.

The results would support efforts by FHWA and State DOTs to efficiently deliver projects in nonattainment and maintenance areas. Transportation agencies continue to spend substantial time and resources demonstrating project level effects on air quality. By contributing to the body of work that is developing around the roadway contribution to near road air quality, this work will support on-going efforts to develop efficient and effective analysis approaches for transportation projects.

The period of the most stringent COVID stay home orders provides a unique peek into a future where emissions from the roadway are lower than today, similar to what may come with widespread electric vehicle use. Analyzing air quality data from this period will provide insights to better understand future near-road air pollution concentrations. This knowledge of lower on-road emissions on the near-road concentrations can help shape mitigation efforts now and in the future to reduce the impacts of emissions from major roadways, which often fall on disproportionately affected communities.

### **Implementation Considerations and Supporters**

This research will inform the work of state DOT air quality specialists as they work to analyze project air quality. The work will also support the efforts of FHWA and EPA to develop additional methods for air quality analysis and future requirements.

AASHTO Committee on Sustainability and Environment, Air Quality, Climate Change, and Energy Subcommittee supports this research statement and will be a venue for sharing the work with state DOT staff.

### **Recommended Research Funding and Research Period**

- Funding: \$150,000 to \$300,000
- Period: 12-18 months

### **Problem Statement Author(s)**

- Karin Landsberg, Washington State Department of Transportation, 360-705-7491, [karin.landsberg@wsdot.wa.gov](mailto:karin.landsberg@wsdot.wa.gov)
- Justin Bishop, Arup, 44 20 7755 5766, [justin.bishop@arup.com](mailto:justin.bishop@arup.com)
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- Anil Namdeo, Northumbria University New Castle, [anil.namdeo@northumbria.ac.uk](mailto:anil.namdeo@northumbria.ac.uk)
- Bo Yang, Cornell, 607-882-0029, [by57@cornell.edu](mailto:by57@cornell.edu)

### **Others Supporting the Problem Statement**

- AASHTO Air Quality Climate Change and Energy Subcommittee, Colleen Turner, 410-865-2773, [cturner@mdot.maryland.gov](mailto:cturner@mdot.maryland.gov)

### **Potential Panel Members**

- Karin Landsberg, Washington State Department of Transportation, 360-705-7491, [karin.landsberg@wsdot.wa.gov](mailto:karin.landsberg@wsdot.wa.gov)
- Christopher Voigt, Virginia DOT, Vice-Chair, AASHTO AQCCES, (804) 371-6764, [christopher.voigt@vdot.virginia.gov](mailto:christopher.voigt@vdot.virginia.gov)
- Natalie Liljenwall, Oregon Department of Transportation, 503-798-0080, [natalie.liljenwall@odot.state.or.us](mailto:natalie.liljenwall@odot.state.or.us)

### **Person Submitting the Problem Statement**

- AASHTO Committee on Environment and Sustainability  
Tim Hill, CES Vice Chair, Ohio Department of Transportation  
[Tim.hill@dot.ohio.gov](mailto:Tim.hill@dot.ohio.gov), (614) 644-0377

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### **NCHRP Review of B-13**

Reviewed By:  
Ann M. Hartell  
[ahartell@nas.edu](mailto:ahartell@nas.edu)

#### Comments:

The proposed research seeks to take advantage of the large scale, natural experiment that occurred as a result of pandemic-related shutdowns and travel restrictions. The situation offers a rare opportunity to investigate air quality issues, including background pollutant levels vs pollutants generated by traffic. One challenge to the study will be to control for changes in levels of background pollutants; it is likely that industrial and construction sources were affected along with on-road traffic volumes. It would be helpful to elaborate on the implementation pathways for the research outcomes in this highly regulated area of practice. If air quality topics are selected for funding in the NCHRP 23-13 Transportation Research Related to COVID-19 project, the scope for this project should be evaluated to avoid duplication.

Review Date:  
12/2/2020

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### **FHWA Evaluation of B-13**

Reviewed By: HEPN/Cecilia Ho

Comments:

This is an interesting and timely research. However, the authors need to provide more information on data – source, availability, or collection effort.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for B-13**

Submitted By:  
Jenn Billo  
AASHTO Staff  
Committee on Environment and Sustainability

Priority #: 4

Comments: Response to FHWA We agree that this analysis would be very helpful for DOTs. Air quality monitoring data is available from EPA's Air Quality System (AQS). Traffic data could come from sources such as those documented in NCHRP 08-101 or telematics data from companies like INRIX or Streetlight. Response to NCHRP We appreciate and agree with the supportive statements. More information is needed to inform future EPA and FHWA rules and guidance supporting streamlined and efficient transportation project and plan analysis and approval. This research would add to that knowledge base.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-14**

**Case Study Development and Model Testing Following a Major Update to MOVES**

**Background**

A major update to the MOVES emission model used in air quality analyses of transportation improvement projects for purposes of both the National Environmental Policy Act (NEPA) and the Environmental Protection Agency (EPA) conformity rule is expected in November-December 2020. In addition to changes to the model framework, the update is expected to result in significant changes to emission rates and default activity estimates that could result in significant delays to conformity determinations and NEPA clearances. State DOTs would therefore benefit from model implementation support to thoroughly vet the model and prepare reference case studies for a range of typical project types, both routine and complex, before the expected two-year grace period for use of the model in regulatory analyses expires. The primary deliverable would be the case studies, which would be designed to serve as templates for project-level air quality analyses. Since modelers often learn best from examples of good modeling practices, the case studies would not only facilitate analyses through the use of the templates but also help improve quality control, particularly for modelers (staff and consultants) that are new to the field. Such case studies are not currently available. Software tools and procedures to facilitate and streamline analyses (e.g., MOVES scripts and/or spreadsheets for post-processing) would also be developed as needed and applied in the case studies. Finally, sensitivity testing of the model would be conducted to identify any potential issues, e.g., with model estimates for higher road grades and speeds, which were observed in previous versions of the model but never resolved.

The proposed study directly responds to the AASHTO Committee on Environment and Sustainability (CES) Air Quality, Climate Change and Energy Subcommittee (AQCCES) Research Roadmap (2015) priority for *Analysis Tools*, including *Model Improvements* and *Streamlining*. It is also consistent with the AASHTO CES Strategic Plan (2018), specifically *Goal 2.3 Leverage Research Programs - Encourage the application of new and innovative research findings and methods*.

**Literature Search Summary**

The proposed study involves testing of a regulatory model update pending release by the end of 2020. As case studies cannot be conducted with the updated model in advance of its release, including any such as this that would focus on meeting the specific needs of state DOTs, the literature does not directly address the objectives of this proposed study. One related precedent however is available. NCHRP 25-38 (2014) helped inform state DOTs on the best approaches for developing model inputs for the first release of the

MOVES model. However, it did not address the broader implementation issues for project-level analyses that are the focus of this study, namely, the development of case studies; the creation of tools to facilitate and streamline analyses; and sensitivity testing to identify potential issues. One related study, recently completed, may be a useful reference: NCHRP 20-05/51-18 (2020) reviewed current practices of state DOTs in project-level air quality modeling, which would help in identifying best modeling practices.

### **Research Objective**

The primary objective is to facilitate implementation by state DOTs of the MOVES model update with the development of case studies for typical transportation project types, both routine and complex, that would serve as templates for state DOTs for conducting project-level air quality analyses, support implementation of best practices for modeling, and help improve quality control. A second objective is to develop tools and/or procedures as needed to facilitate and streamline analyses as well as, where applicable, resolve or mitigate any identified issues. For example, a tool (preferably a MOVES script) may be developed for mileage accumulation rate adjustments of fleet-average emission factors/rates that would not only be more accurate but also lower than those generated without these adjustments. This is very important for analyses for fine particulate matter (PM<sub>2.5</sub>) for which margins with the applicable national ambient quality standards can be very small, which places a premium on accuracy for modeled emissions. The third and final objective is to conduct sensitivity testing to not only identify potential issues but also potentially inform priorities for developing modeling inputs.

The primary deliverables are: (1) a report with the case studies, results of the sensitivity tests and associated conclusions and recommendations, and documentation of the tools and procedures developed in the study; (2) modeling input and output files for each case study, including all pre- and post-processing files, and all software tools developed in the study (MOVES scripts, spreadsheet tools, etc.); and (3) presentations and webinar/workshop materials.

Potential model implementation issues would be identified by: (1) surveying AASHTO AQCCES members and their consultants at the start of the proposed study, (2) checking whether known issues with previous version of the model have been resolved in whole or in part with this update, including issues identified in meetings of the MOVES Review Work Group\* and (3) conducting sensitivity testing to identify any new issues.

\* <https://www.epa.gov/sites/production/files/2019-12/documents/03-moves-project-level-analyses-2019-10-09.pdf>

### **Urgency and Potential Benefits**

The problem is urgent as the model update is expected to have a grace period of only two years, after which it must be applied by state DOTs for environmental clearances for all projects. An NCHRP study initiated in 2021 would be completed by the end of the grace period. State DOTs could then apply the case studies/templates and tools to streamline analyses, support implementation of best modeling practices, and improve quality control, as well as prioritize data collection activities based on the results of the sensitivity studies.



In the absence of this proposed study, state DOTs would not have the benefits of cases studies, tools, and testing, and may therefore face unnecessary challenges in implementing the model to support environmental clearances for EPA regulatory (conformity) requirements and NEPA.

### **Implementation Considerations and Supporters**

The study deliverables can be readily implemented with AASHTO AQCCES support. Its members, primarily air quality staff for their respective state DOTs, are the primary market for the deliverables as they work with consultants on modeling and/or are modelers themselves. The consultants for the proposed study would therefore seek input from AQCCES members early in the study process on the proposed scope and any potential issues that they may wish to see addressed in the study. In the course of the study, AQCCES members would also receive presentations on the project deliverables (interim and final) and how they may be applied to benefit state DOTs in streamlining analyses, supporting best modeling practices, and improving quality control. A workshop/webinar would also be held with AQCCES members and their consultants to present the final deliverables in detail and respond to questions.

**Contact:** Christopher Voigt, Virginia DOT, Vice-Chair, AASHTO AQCCES, (804) 371-6764, christopher.voigt@vdot.virginia.gov

### **Recommended Research Funding and Research Period**

Research Funding: The proposed budget is \$300,000, which includes \$280,000 for the proposed research and \$20,000 for implementation activities (presentations and webinar/workshop).

Research Period: The research is expected to take approximately fourteen months for professional staff, comprised of approximately three months for performance and sensitivity testing, ten months for case study and tool development, and one month for implementation support.

### **Problem Statement Author(s)**

- Christopher Voigt, Virginia DOT, Vice-Chair, AASHTO AQCCES, (804) 371-6764, christopher.voigt@vdot.virginia.gov
- Natalie Liljenwall, Oregon DOT, Research Coordinator, AASHTO AQCCES, (503) 986-3456, natalie.liljenwall@odot.state.or.us

### **Others Supporting the Problem Statement**

- AASHTO Air Quality, Climate Change and Energy Subcommittee, Melissa Savage, Director, AASHTO Center for Environmental Excellence, msavage@ashto.org, (202) 624-3638
- AASHTO Air Quality, Climate Change and Energy Subcommittee, Colleen Turner, Maryland DOT, Chair, cturner@mdot.maryland.gov, (410) 865-2773

### **Potential Panel Members**

- Christopher Voigt, Virginia DOT, Vice-Chair, AASHTO AQCCES, (804) 371-6764, christopher.voigt@vdot.virginia.gov
- Natalie Liljenwall, Oregon DOT, Research Coordinator, AASHTO AQCCES, (503) 986-3456, natalie.liljenwall@odot.state.or.us

### **Person Submitting the Problem Statement**

Tim Hill, Ohio DOT, Vice-Chair, AASHTO Committee on Environment and Sustainability, (614) 644-0377, Tim.Hill@dot.ohio.gov

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### **NCHRP Review of B-14**

#### Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

#### Comments:

The proposed project can potentially provide a highly useful resource for state DOTs. As noted in the problem statement, the project should be initiated in the FY2022 cycle to provide timely information to state DOTs and enable a smoother transition to the new version of the model. Additional tools, such as a mileage accumulation tool, need to be reviewed and approved by EPA prior to use for regulatory compliance. Further development of tools for an EPA model is outside the scope of the NCHRP program and premature given the lack of user experience with the new model that could identify priorities for tools and/or templates. The proposed budget of \$300,000 is sufficient for developing a set of use cases, documenting the results of the use case modeling effort (including information about the relative sensitivity of model inputs), and conducting outreach activities to relevant audiences.

#### Review Date:

12/3/2020

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### **FHWA Evaluation of B-14**

Reviewed By: HEPN/Cecilia Ho

#### Comments:

Developing and sharing case studies may be useful, but not the template. Also the research seems to focus on project level applications, but not other levels. Regional level application is of utmost importance for transportation conformity analyses and the research should cover regional levels application. For sensitivity analysis, the research should also include other new functions/assumptions (e.g. the new off-road idling emissions) of MOVES3.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for B-14**

Submitted By:  
Jenn Billo  
AASHTO Staff  
Committee on Environment and Sustainability

Priority #: 3

Comments: Response to FHWA: HEPN/Cecilia Ho UPDATE: The MOVES3 model was released by EPA in November 2020, which was noted as "pending" in the original scope. To clarify, the proposed case studies are intended to be designed to serve as templates; they are not intended as separate deliverables. Modelers would be able to use the respective case studies/templates for a highway segment, interchange, arterial street intersection, parking facility etc. as the starting point for their project-level analyses. This helps to save time and costs for analyses done by state DOTs and at the same time improve quality assurance and control. With respect to the relative priority for project-level and regional analyses, all state DOTs are required to do project-level analyses for NEPA and, for air quality nonattainment and maintenance areas, project-level (hotspot) analyses for EPA conformity. In contrast, relatively few state DOTs conduct regional conformity analyses as these are typically handled by MPOs. We understand FHWA works closely with MPOs, and therefore regional conformity analyses that are done largely by MPOs may be of "utmost importance" to FHWA, but project-level analyses are and will continue to be the highest priority for state DOTs. In this context, it bears keeping in mind that NCHRP funding is state DOT funding, not FHWA funding, and NCHRP funding decisions should be based on state DOT needs and priorities, not FHWA's, where they are not the same. For background, the AASHTO Air Quality, Climate Change and Energy Subcommittee recently conducted a survey (from 1/22/2021 to 1/27/2021) of its members, which are primarily state DOT air quality staff, and included general question "Do you also conduct regional-level analyses using MOVES, e.g., regional conformity analyses?". Only 5 of 19 respondents responded yes, and one of the yes votes was only for rural areas (which are rarely done). (One additional state DOT voted yes but not for regional conformity analyses specifically, stating that "Analysis for projects requiring MSAT, energy, or GHG (agency policy) are

done using MOVES") Anecdotally, less than a handful of state DOTs nationwide conduct regional conformity analyses. As an option if additional funding is made available, case studies for regional conformity analyses could be added to the proposed scope. Finally, depending on funding availability, the proposed sensitivity analysis would cover all key inputs including any that are new. Response to NCHRP Ann Hartell RESPONSE: We agree the proposed deliverables for this project would be highly useful to state DOTs and appreciate the supportive statements in this regard from NCHRP. With respect to the proposed mileage accumulation rate (MAR) tool, the adjustment in question is one that was recommended in email from EPA in response to a question posed to them by a state DOT (VA) in email. They were unable to accommodate this change within the model itself so instead suggested that modelers could develop the tool themselves. Additionally, a spreadsheet version or example was already developed and published in NCHRP 08-101; however, it was limited to heavy duty vehicles. The proposed MAR tool would cover all vehicles, both light and heavy duty. That said, we would of course be happy to work with EPA on the proposed tool if they are interested. Other tools may or may not be needed, and may be as simple as providing standardized pre- and post-processing spreadsheets that modelers currently develop themselves as needed. The use of standardized spreadsheets would not be expected to be an issue with either EPA or FHWA. Finally, the EPA MOVES model includes a feature for users to apply scripts that they have written themselves, so obviously any such scripts developed in an NCHRP study should also be acceptable to EPA. Again, we are happy to have them involved in the study to review any tools that are developed.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number:** 2022-B-15

**Problem Title:** Environmental Effects of Roadway Lighting on Wildlife

**Background**

Roadway lighting has been shown to measurably reduce nighttime fatal and other crashes. However, roadway lighting can negatively impact insects and animals through attraction and disorientation or by disrupting their natural habitats. Artificial nighttime lighting is thought to reduce occupancy of habitat areas adjacent to roadways for some species and may decrease use of wildlife crossing structures. Additionally, nighttime lighting attracts insects and may indirectly lead to increased road mortality for bats and other insectivorous animals.

Transportation agencies are facing growing opposition to the use of nighttime lighting as a countermeasure to improve roadway safety from members of the public concerned with potential consequences of nighttime lighting on the surrounding environment. While it is known that lighting has a negative impact on some species, it is not well understood whether those impacts can be minimized or otherwise mitigated by directional shielding, changing light levels or the type/color of the light source. Therefore, there is a need to investigate the effects of artificial light on wildlife to determine best practices to provide lighting to support driver safety while minimizing negative impacts to surrounding ecosystems.

The expected results of this research will include new information regarding roadway lighting that will allow this important crash countermeasure to be implemented while minimizing impacts on wildlife. The research will support at least four goals of the AASHTO Committee on Design:

- Goal 2: Develop design solutions that meet the purpose and need of a project, address its context, and protect the natural and human environment.
- Goal 4: Improve safety for the traveling public and the workforce.
- Goal 5: Advance the state of the practice.
- Goal 6: Foster collaboration within AASHTO and with other organizations and disciplines.

This research task also supports following goals of the Committee on Environment and Sustainability:

- CES Goal 2: Increase the capacity of members to efficiently and reliably deliver environmentally sound transportation projects, programs and services.

- CES Goal 3: Create the knowledge foundation on which to base state of the art impact analysis and mitigation planning for current and future environmental issues.
- CES Natural Resources Goal 2: Increase the capacity of members to efficiently and reliably deliver environmentally sound transportation projects, programs and services relating to natural resources.

### **Literature Search Summary**

There is some research available on the impacts of roadway lighting on flora. For instance, the effects of roadway lighting on soybeans was studied in Illinois which proved that typical roadway lighting levels will adversely impact this important cash crop unless trespass light is managed properly (Palmer, Gibbons, Bhagavathula, 2018). A recent article by Fraser, Collins, Longcore and Vickers (2020) summarizes literature regarding the effects of artificial nighttime light as well as traffic noise on animal behavior and occupancy. Lighting was also addressed in a chapter in the Handbook of Road Ecology (2015, van der Ree, Smith and Grilo, Eds.). However, there is much to be understood about the mechanisms and ways to minimize or mitigate effects of artificial nighttime lighting on wildlife.

### **Research Objective**

The objective of this research is to develop roadway lighting recommendations that can minimize negative impacts on wildlife species that are sensitive to artificial lighting. The research should consider the scope and magnitude by which outdoor lighting in general and roadway lighting more specifically influences species of animals in an adverse manner (i.e., sea turtles, reduced roadway crossings or use of wildlife structures) and propose solutions to mitigate these impacts. This roadmap will also serve to inform the work of researchers currently working independently by bringing together both ecological and lighting team members to pioneer solutions.

Task 1 will identify groups of wildlife species that are impacted in similar ways by the more common spectrum, light levels, and designs of roadway lighting and evaluate the direct impacts, both positive and negative, to each of these groups. Then suggestions for design and management practices to reduce impacts for each group or impact type will be developed.

Task 2 will examine the impacts of different light spectrums to particular groups of species identified in Task 1. Correlated color temperature (CCT) has been often used in conversation to characterize this impact but CCT is a better metric to define appearance not spectral impact. Actinic spectrum (Longcore et al) shall be used unless a more robust calculation method is available to measure the potential impact of roadway lighting on the various species of fauna.

The information derived from spectral response once assigned to each species group will offer a broad array of potentially conflicting solutions. In other words, the spectrum adjustments needed to mitigate impacts on one may be impossible or impractical to achieve in a normal roadway lighting application. Furthermore, what may resolve impacts for one may intensify the problem for another species. Therefore, the array of possible practical solutions will be identified along with a best fit solution or solutions for

current roadway lighting practice which is based on current roadway lighting techniques and technology.

Task 3 will be to develop a research roadmap to detail the future research needs through which environmental impacts of roadway lighting are fully identified and addressed in order to eliminate adverse effects on wildlife. For this research, a final report will be sufficient as the end product. AASHTO and other national and international lighting organizations (such as the Illuminating Engineering Society, IES) may consider the report in future updates to their guidelines.

### **Urgency and Potential Benefits**

The magnitude of potential impact must be determined before incorrect lighting designs are deployed in a nonrecoverable fashion. Currently DOTs around the country are converting high pressure sodium (HPS) luminaires to light emitting diode (LED) roadway fixtures as HPS is no longer supported by most fixture manufacturers. The correlated color temperature differs between these two light sources and can differ among LED luminaires depending on which LED is selected. Likewise, the spectrum can vary in blue light content depending on the specific LED fixture selected.

A proper understanding of the impacts of LED roadway lighting on fauna can prevent a large deployment of fixtures throughout the country that are not optimally tuned to the needs of the environment. In addition, recommendations for adjusting lighting design at wildlife crossing locations may increase the use of these structures as well.

### **Implementation Considerations and Supporters**

This research would be considered by the entity within each DOT responsible for the DOT's roadway lighting design guidelines, as well as individual roadway lighting design engineers. The information would also be useful to DOT biologists and landscape architects for evaluating impacts of lighting on wildlife and designing pedestrian-oriented areas to be more wildlife friendly.

DOTs may use the proposed research results to update their roadway lighting design guidelines and guidelines for species impact evaluations. In addition, individual project managers, biologists and roadway lighting design engineers may use the research directly to support individual projects.

The AASHTO Joint Technical Committee on Roadway Lighting will use the research results to consider making changes to the AASHTO Roadway Lighting Design Guide, which is referenced by many state DOTs and other agencies responsible for roadway lighting. The AASHTO Committee on Environment and Sustainability will disseminate the results to state DOT biologists to guide suggestions for reducing impacts of lighting on wildlife.

The IES may also use the results of this research to update their guidelines. Webinars and trainings would also be useful for environmental planners and biologists at DOTs to better understand the impacts of different types of lighting designs and possible approaches to mitigation.

AASHTO Committees and other organizations likely interested in the research results and could help support implementation:

- AASHTO Joint Technical Committee on Roadway Lighting, Mark Luszcz, Chair, 302-760-2356, mark.luszcz@delaware.gov.
- AASHTO Committee on Environment and Sustainability, Margaret Anderson-Kelliher, Minnesota DOT.
- Federal Highway Administration, Daniel Buford, 202-366-8168, daniel.buford@dot.gov
- U.S. Fish and Wildlife Service, Catherine Liller, 303-236-4318, catherine\_liller@fws.gov

### **Recommended Research Funding and Research Period**

\$600,000 over 36 months

### **Problem Statement Author(s)**

Mark Seppelt, formerly Illinois DOT, mark@wi-skies.com

Mark Luszcz, DelDOT, Chair, AASHTO Joint Technical Committee on Roadway Lighting, mark.luszcz@delaware.gov

Kris Gade, Arizona DOT, Co-Chair, Natural Resources Committee for AASHTO CES. kgade@azdot.gov

### **Others Supporting the Problem Statement**

AASHTO Joint Technical Committee on Roadway Lighting, Mark Luszcz, Chair, 302-760-2356, mark.luszcz@delaware.gov.

AASHTO Committee on Environment and Sustainability, Margaret Anderson-Kelliher, Minnesota DOT

### **Potential Panel Members**

Susan Zarling, Minnesota DOT

Daryl St. Clair, Pennsylvania DOT

Anna Bosin, Alaska DOT

### **Person Submitting the Problem Statement**

AASHTO Committee on Environment and Sustainability

Tim Hill, CES Vice Chair, Ohio Department of Transportation

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### **NCHRP Review of B-15**

#### Reviewed By:

Ann M. Hartell

ahartell@nas.edu

#### Comments:



This research could produce needed information on a design issue that likely goes un- or under-considered for most highway projects. The problem statement authors note that one reason for urgency is the current conversion underway to LEDs. It might be that this research could focus on the effects of this one type of lighting. Without a series of field trials and monitoring, it will be difficult to create robust and detailed guidelines that address the needs of many species. The proposed convening of ecologists and lighting designers could help identify priorities for targeted studies and/or relevant ongoing research that should be tracked. If the proposed research includes an evaluation of past and on-going research, examples from current practice, and recommended protocols for monitoring that include the effects of lighting, a budget of up to \$450,000 would likely be sufficient.

Review Date:  
11/30/2020

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## **FHWA Evaluation of B-15**

Reviewed By: HRDS/Michelle Arnold, HEPE/Damaris Santiago

Comments:

HRDS/Michelle Arnold - The problem statement will add important information to the previous research effort 5-22 'Providing Guidance on the Implementation of Solid-State Lighting' and ongoing research effort under 5-22A 'Gap and Emerging Technologies in the Application of Solid-State Lighting'. One of the research gaps identified under 5-22A is the lighting impact on flora and fauna and fauna was deemed to be important and deserving of a separate research effort on its own. The project will be useful to State DOTs and useful for updating lighting design guidelines. A couple of considerations to note: Main issues will be defining/prioritizing the species of interest and then following through with an appropriate research design. Proposed funding and length of project should be sufficient to address this. Another consideration is for researchers to consider species' response to light since they will likely have different responses to electromagnetic radiation which differs from the current definition based on human light.

HEPE/Damaris Santiago - The Problem Statement addresses an important issue, effects of roadway lighting on wildlife, and is interdisciplinary. The scope of the research objectives is appropriate. The level of funding seems high for the deliverable of a final report.

Review Date:  
12/18/2020

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-16**

**Problem Title:** Framework for Analyzing and Mitigating Highway-related Noise and Vibration Impacts on Terrestrial Wildlife

**Background**

Currently, there is minimal guidance from federal agencies on how to conduct noise and vibration analyses specific to wildlife, which results in differing approaches to noise analyses that may be inaccurate, non-comparative from state to state (or study to study), or result in unnecessary analyses. The current FHWA Noise Abatement Criteria (NAC) approach is based on striking a balance between desirable and feasible approaches for human receptors, with a focus on hearing, annoyance, sleep, and task interference or disturbance. Interference with speech communication is used as basis for determining the NAC. Such an approach is insufficient in addressing issues with wildlife.

As a result, there is a need for a framework for analyzing the effects of anthropogenic noises and vibrations associated with highway construction and operations on wildlife. Specifically, an approach is needed to use current noise analysis tools to address effects on essential activities for wildlife, including feeding, sheltering, breeding, dispersal and communication. This requires input both from noise specialists and biologists. The goal is to streamline and move toward a more standard approach for these analyses.

Streamlining does not mean waiving or relaxing regulatory requirements or neglecting best available practices. Streamlining identifies a common denominator between the project delivery, environmental effects and applicable regulatory framework. In other words, ways to more efficiently meet requirements, by establishing, and adhering to, more realistic project budgets, schedules, and possible mitigation obligations through interagency cooperation.

This research task supports the Committee on Environment and Sustainability's (CES) initiative to streamline the environmental review process and their promotion of practices that encourage interagency cooperation and coordination in the resolution of environmental issues.

**Literature Search Summary**

A search of the TRID database (<https://trid.trb.org>) resulted in recent documents on the general effects of noise on bats, monarch caterpillars, deer, coyote and bobcats, but these do not address an approach for analyzing noise and vibration impacts on different terrestrial species. A search of the Research in Progress database (<http://rip.trb.org/>) did not produce any additional studies. Caltrans protocols for addressing noise impacts

to birds and bats were identified. The FHWA Synthesis of Noise Effects on Wildlife and other literature from outside the transportation realm (e.g. National Park Service) also provide information on approaches to evaluating impacts to species.

### **Research Objective**

The objective of this project is to *develop focused, streamlined, concise and consistent* practices and methodologies for analyzing and mitigating noise and vibration impacts on terrestrial wildlife species (including those that are listed under ESA), that would be conducive to efficient and regulatory compliant noise analyses performed by state DOTs and their partners. To that effect, it is essential to determine:

- The stressor(s)/noise and vibration descriptors (un-weighted vs. weighted, statistical, other as appropriate, and inter-correlation), and propagation over terrain and other physical variables
- An understanding of how the stressors of project-related noise and vibration might affect responses of different species and individuals within the species, and related life-history influences, and a ***tiered approach*** on how an impact may be identified
- Evaluation of available modeling tools that are provided by federal authorities, such as FHWA TNM 3.0, RCNM 2.0, and Quarry for use for wildlife analysis as well as the representation of subject activities and resources analyzed
- Appropriate techniques on establishing a common noise environment based on the anthropogenic sound landscape
- Risk assessment approach that considers the conservation status of the resources involved
- Reasonable and feasible mitigation measures that can be considered as environmental commitments, if impacts are identified
- Appropriate tiered level of reporting and documentation of decisions and interagency coordination

### **Tasks and Deliverables**

#### **Task 1: Conduct Interviews or Virtual Discussions with DOTs**

Conduct interviews or convene virtual discussions with DOTs in representative ecoregions for information on species consultations, for existing guidance, and assessment of potential savings from streamlined processes. Altogether, 19 states have expressed an interest in this project, including AL, AZ, CO, ID, IL, KY, ME, MT, ND, NH, NV, OH, OK, UT, VA, VT, WV, WY. Additional interviews or inclusion of oil and gas industry representatives and regulatory or resource agencies in the discussions is suggested.

#### **Task 2: Literature Review**

Develop a summary of existing relevant literature; documents developed by/for the oil and gas industry may be of particular interest.

#### **Task 3: Develop Guidance Strategies for Methodologies Used for Analyzing Noise and Vibration Impacts on Various Wildlife Species**

Further to the stipulations made in the Research Objective section, the following deliverables are expected, as a minimum:

- Template protocol and cross-functional flowchart on tiered approach and project-related activity screening
- Instructions on determination of noise and/or vibration sensitive areas and species' sensitivities (species grouped by identical or similar response or interference, cause-effect-severity matrix) and activities represented (nesting, roosting, foraging)
- Instructions on measurement and determination of existing common noise and vibration environment and anthropogenic noise and vibration sources (baseline conditions)
- Instructions on noise modeling techniques for FHWA TNM 3.0, RCNM 2.0, and Quarry, and representation of species and habitats
- Instructions on determining appropriate noise and vibration mitigation strategies and examples of best management practices
- Report template for documentation of decisions and interagency coordination, and biological evaluation programmatic agreements
- On-line training material focused on the implementation of the research

#### **Task 4: Summary of Results/Final Report**

Combine the highlights of the results of Tasks 2 and 3 into a concise summary document targeted at DOT biologists and project managers. Make recommendations on where further research is needed.

#### **Urgency and Potential Benefits**

This project will increase the quality and defensibility of noise and vibration analyses for terrestrial wildlife. In turn, this will assist DOTs to improve and expedite noise and vibration impact analyses as well as better justify instances where road-related noise will not affect wildlife. This will result in time and money savings by standardizing approaches to analysis and mitigation as well as avoiding unnecessary mitigation. Increased consistency in the methodologies used by DOTs will result in studies that are comparable and improve the predictability of the level of effort needed for these analyses.

#### **Implementation Considerations and Supporters**

The results of this research would improve project planning by improving estimates of the level of effort needed to analyze and mitigate noise and vibration impacts and provide a framework for DOT biologists and noise specialists to conduct the analyses. It will provide clear guidelines to DOTs on a standardized approach to assessing these impacts. The summary document will be disseminated to all state DOTs and it is anticipated that additional implementation activities such as webinars and/or training on how to implement the guidance could be offered to state DOT noise and wildlife specialists as a follow on activity to this project.

#### **Recommended Research Funding and Research Period**

Recommended Funding: \$375,000

Research Period: 30 months

#### **Problem Statement Author(s)**

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Kris Gade, Arizona DOT  
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### **Others Supporting the Problem Statement**

- TRB Committee on Transportation-Related Noise and Vibration (AEP80) – Adam Alexander (Chair), 202-309-5835, aalexander@gfnet.com
- TRB Committee on Ecology and Transportation (AEP70) – Daniel Smith (Co-Chair), 352-213-3833, daniel.smith@ucf.edu

### **Potential Panel Members**

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### **Person Submitting the Problem Statement**

AASHTO Committee on Environment and Sustainability  
Tim Hill, CES Vice Chair, Ohio Department of Transportation  
Tim.hill@dot.ohio.gov, (614) 644-0377

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### **NCHRP Review of B-16**

#### Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

#### Comments:

The proposed research addresses an important gap in road ecology practice for state DOTs and their partners. The study design would likely require exploratory modeling of existing data along with other research tasks. Because the proposed project includes considerable technical work and the development of training materials in addition to typical NCHRP report materials, increasing the budget to \$450,000 is appropriate.

Review Date:  
12/2/2020

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### **FHWA Evaluation of B-16**

Reviewed By: HEPE-30/Daniel Buford

Comments:

The Problem Statement is relevant and well-crafted. The funding level seems appropriate given the literature review, development of tools and online training, and a final report.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for B-16**

Submitted By:  
Jenn Billo  
AASHTO Staff  
Committee on Environment and Sustainability

Priority #: 7

Comments: The submitters agree with the comments and the suggestion to increase the budget to \$450,000.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022-B-17**

**Problem Title**

**Summary of Existing Stormwater Bioretention Specifications and Approval Processes**

**Background**

Bioretention is one of the most common stormwater control measures (SCMs) used by municipalities, and departments of transportation (DOTs) are increasingly being asked to use bioretention to meet federal NPDES stormwater permit requirements. There are many materials that can be used in bioretention, but while adopting local specifications may seem an easy option, DOTs may have hydraulic, structural, safety, and other performance standards that are not shared by the municipality. As DOTs look to develop their own bioretention specifications, it would be helpful to know what bioretention components other state and municipal DOTs are successfully implementing and what procedures they used to approve them. Some DOTs, like WSDOT, have integrated aspects of bioretention into their roadway embankment, such as vegetated filter strips, compost amended vegetated filter strips, and media filter drains that treat stormwater as part of the roadway embankment. These adaptations may be useful to other DOTs.

Though bioretention media evaluation research is common and easy to access, the current media design standards are not well-documented. This study will consist of a survey of DOTs to establish highway-specific requirements for bioretention implementation and assist in standardizing the terminology of the DOT sector.

**Literature Search Summary**

Bioretention for the treatment of highway runoff is a relatively new practice (Hsieh and Davis 2005) that is still undergoing research and development to optimize media effectiveness versus cost (Dibiasi et al 2009, Imhoff et al 2019, Jones et al 2017, Zhang et al 2019). Some DOT are rapidly developing and updating specifications for biofiltration, while others are needing to adopt specifications for the first time. Current literature focuses on testing improvements to biofiltration mix based on hydraulic and water quality performance (e.g., Li et al 2013). However, developing specifications addresses many other factors that are usually missing from performance evaluations, including roadside safety, availability of roadside products, and cost. While there are general design guidelines available through entities such as ASCE and WEF and design principles have been compiled from comprehensive studies in three states (Davis et al 2012), there are no resources that collect design and specification

information that has been developed, tested, and approved for highway environments across the country. The TRB TRID database was used for this literature review summary.

### **Research Objective**

The objective of this research is to provide a summary of the current DOT practices for bioretention design, construction, and maintenance. Specifications, guidelines, and project information will be collected on the following:

- Siting constraints, including nearby contaminated soil, groundwater, or wetlands, high sediment loads, and steep terrain or erodible soils;
- Physical and chemical characteristics of bioretention soil mix, including content, gradation, nutrients, micronutrients, and source material;
- Allowances for bioretention soil mix variations or substitutions (e.g., biochar amendments);
- Local sourcing requirements for materials;
- Quality control requirements (i.e., project-specific material acceptance criteria prior to placement);
- Bioretention minimum or maximum saturated conductivity;
- Minimum pollutant reduction (e.g., influent/effluent water quality evaluation and approval criteria);
- Specifications for filter fabric or choker course;
- Underdrain usage guidance (e.g., when to use an underdrain), underdrain matrix material (e.g., specifications for crushed rock or permeable base), and underdrain pipe material, elevation, and slope;
- Slope of the bottom of bioretention (i.e., when is there a zero-slope requirement to maximize retained water vs. a minimum slope requirement to encourage drainage);
- Guidance and specifications on the use of impermeable liners;
- Compaction requirements (in and outside of clear recovery zones);
- Outlet control (flow restriction or elevation);
- Plant type, including allowance for trees;
- Use of temporary or permanent irrigation;
- Operation and Maintenance (O&M) inspection and maintenance protocols, feasibility evaluation criteria, and considerations impacting design;
- Cost-benefit guidance for using enhancements for water quality (e.g., more expensive filter media);
- Construction cost of bioretention components;
- Bioretention-related terms and definitions (e.g., raingardens vs. bioretention vs. bioswales, and planting soil vs. bioretention mix vs. filter media).

This study will also document the DOT's approval processes, such as field trials, water quality analyses, O&M evaluations (including development of inspection protocols and analysis of maintainability), and safety reviews. It will note whether approval is granted based solely on municipal, university, or regulatory approvals, and it will survey DOTs on their policies and experiences of receiving responsibility for any bioretention installed



by local authorities on DOT-maintained ROW. Results will be organized by region and climate. It will require some effort to identify the appropriate contacts at a DOT because the information may live in different offices, such as those that develop specifications for design, construction, and maintenance.

This study will also identify gaps in bioretention practice and knowledge from the surveyed DOTs, which may result in future research needs statements that identify the information required to develop DOT-appropriate specifications or evaluation and approval processes. To assess the need for collecting similar information for other stormwater control measures (SCMs), and thus informing future synthesis efforts, the study will ask respondents whether they need similar specifications and protocols for other types of SCMs, such as underground storage, dry basins, catch basin filters, catch basin separators, wet ponds, and trash-capture devices.

### **Urgency and Potential Benefits**

DOTs will be investing significantly in bioretention across the US. This study will provide information that will allow DOTs to optimize their implementation and specifications and greatly reduce duplication of effort at DOTs to develop this information.

The ultimate product of this study will be a synthesis report that provides a summary of the current DOT practices for bioretention design, construction, and maintenance that will aid DOT in development of improvement of bioretention design.

### **Implementation Considerations and Supporters**

Hydraulics, environmental, and stormwater offices within a state DOT will likely be responsible for using the research results in the development of standard specifications. State DOTs can implement the research within their own organization by developing and releasing preliminary specifications that can be used on a pilot basis to inform the development of standard specifications for that particular DOT. A workshop could be used to support implementation by DOT.

### **Recommended Research Funding and Research Period**

Research Funding: \$99,000

Research Period: Complete the research, which includes engaging in communication and a workshop: 18 months

### **Problem Statement Author(s)**

- Brian Currier, OWP at Sacramento State, (916) 278-8109, [brian.currier@owp.csus.edu](mailto:brian.currier@owp.csus.edu)

### **Others Supporting the Problem Statement**

- Statement reviewed and submitted on behalf of the TRB Committee on Hydrology, Hydraulics and Stormwater (AKD50). Contact: Scott Taylor, [STaylor@mbakerintl.com](mailto:STaylor@mbakerintl.com), (760) 603-6242
- Reviewed and ranked third by AASHTO Natural Resources Subcommittee.

## **Potential Panel Members**

- TBD

## **Person Submitting the Problem Statement**

- AASHTO Committee on Environment and Sustainability  
Tim Hill, CES Vice Chair, Ohio Department of Transportation  
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- 

## **NCHRP Review of B-17**

Reviewed By:  
Ann M. Hartell  
ahartell@nas.edu

### Comments:

A comprehensive resource on bioretention options would be a useful resource for state DOT stormwater practitioners and designers. The level of detail and range of technical and policy topics that need to be described for each bioretention strategies would require a well-designed, well-executed and significant data collection effort. An appropriate budget for the project would be \$200,000 to \$300,000.

Review Date:  
12/2/2020

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## **FHWA Evaluation of B-17**

Reviewed By: HEPE-30/Susan Jones

### Comments:

Bioretention is not a new concept; many states have performed research on evaluating the performance of bioretention best management practices in a highway environment. Due to inconsistency of soils, temperature, area limitation, consistency of bioretention BMPs. It is accurate that different state environmental agencies may have slightly different guidance on the BMPs. However, this research more aligns with a synthesis and henceforth, funding level for this initiative should be decreased.

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number:** 2022-B-18

**NCHRP Problem Statement Title:  
Improving Container Availability for U.S. Agriculture Exports**

**Problem Statement**

Intermodal freight is the common reference to cargo that is containerized and shipped in steel boxes (i.e., containers). Most intermodal import/export trade is done using 20 or 40-foot ISO containers.<sup>14</sup> Typically, shipping containers are owned and controlled by ocean container shipping lines. Because much of the import volume to the U.S. from Asia is low weight consumer goods, ISO containers usually “cube-out” before they “weigh-out” when loaded on a truck for over the road transport. To maximize the cubic capacity of over-the-road tractor semitrailers, the contents of inbound ISO containers are transloaded at or near the port to *domestic containers*. Domestic containers are typically 48 or 53-foot steel boxes that maximize the cubic capacity of over the road trucks. The emptied ISO containers are usually reloaded empty for a return trip to Asia. Historically, the trade imbalance between U.S. and Asia has also contributed to a surplus of empty containers at coastal state ports that must be repositioned back to Midwestern states as well as Asia.

In those cases where ISO containers do make it to the interior of the U.S., opportunities for intermodal transportation of agricultural products have grown. For example, containerized soybean shipments originating within 100 miles of Chicago, have grown over time primarily due to the prevalence, availability and cost of accessing empty containers destined to Asian markets. There are likely more load matching opportunities for a broader-array of agricultural products. The challenge is identifying those products, matching them with available empty containers (by type and location) and satisfying the service and cost requirements in order to create opportunities for a broader array of agricultural shippers and markets.

Inbound container movements to and across the U.S. from Asia are primarily driven by population density and economic geography, which is why so many containers end up in locations such as Chicago, IL or Memphis, TN. There are many diverse, high-value agriculture products close to these and other ports, mostly within 400-500 miles from the ports, but gaining access to containers to support agricultural exports has historically been a major challenge for shippers. What is needed is better data and research to address these challenges in order to improve value-added market opportunities for agricultural shippers.

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<sup>14</sup> ISO stands for International Standards Organization, an international body that establishes the dimensions for shipping containers used in international commerce.

## Literature Search Summary

The United States leads the world in grain production, with annual production averaging 561 million tons from 2010-2016. U.S. exports have expanded across bulk and high value product categories, with particularly strong growth among consumer-oriented product commodities. The primary source of growth in U.S. agricultural exports, are the middle-income countries like China and Mexico. These countries now account for the largest share of U.S. agricultural exports for the bulk products like wheat, soybeans, barley and rice etc. The five-year projections of grain productions and exports show a sustainable trend (Figure 2). But even this is subjected to improve as world per capita GDP is expected to grow at 1.6% in 2017, compared with 1.2% in 2016 (USDA). This increase reflects a broad-based upswing in the world economy across both developed and developing countries and further will boost the world trade volume.

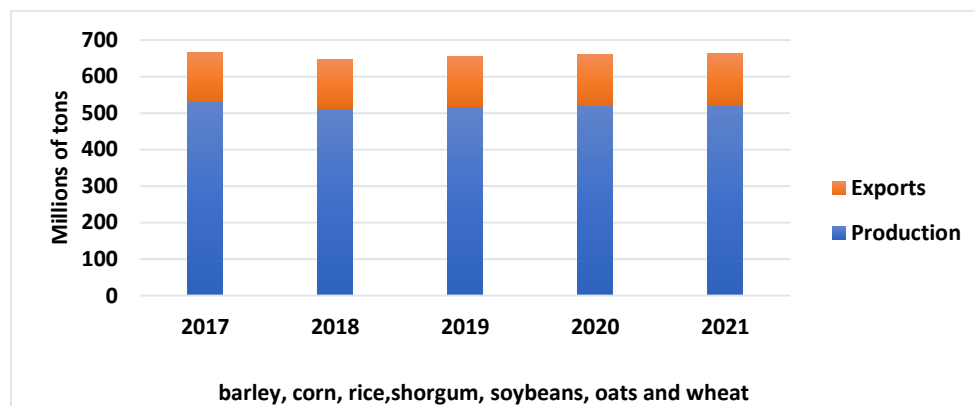
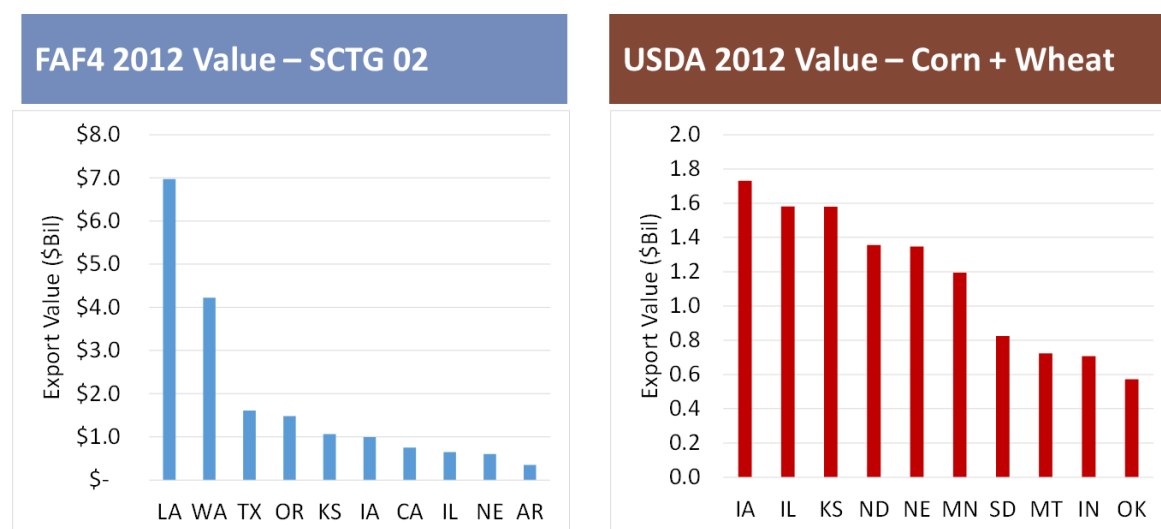


Figure 2. Total U.S. grain projections (productions and exports)  
Source: USDA

Another trend affecting global trade has been the growing demand for *identify preserved* (IP) grains. The supply chain for IP grains is designed to prevent cross-contamination or mixing with other grains and provide buyers with transparency and traceability about how the crop is handled and transported. To ensure this integrity during transport most IP grains are shipped by intermodal container. Because grains are dense, filling a domestic container will exceed over-the-road weight limits, and partially loaded containers present a load-shift and tipping problem for both road and rail transport; therefore 20-foot ISO containers are the preferred standard for grain transport.

Ports serve a vital and common function in most states, connecting regional agricultural markets, state manufacturing and economic activity to and from markets abroad. Yet while ports have common activities and functions, they are each unique in many facets, including operating characteristics, geographic scope, industrial breadth supported, commodity profile and dependence upon state/regional/local vs. international freight movements. Many of these inland and export ports are key container terminals where ocean containers are transferred between modes (truck/rail/ocean) and distributed to suppliers and customers inland or exported to markets in Asia or Europe. Another

issue which may contribute to the lack of inland facilities for grain exports concerns the quality of export data. The Freight Analysis Framework (FAF) import/export data is based on “*Shippers Export Declaration*”, or its recent replacement, the Electronic Export Information form from the US Census Bureau. These forms are filed with the U.S. Census Bureau whenever a commodity export exceeds \$2,500 in value. While this export paperwork is a reliable source for the origin of manufactured products, it is misleading for many agricultural exports and other products. The graphic that follows compares FAF corn exports by value, to data reported by the US Department of Agriculture (USDA). In 2012 (base year for FAF-4), FHWA/BTS reported Louisiana, Washington, Texas and Oregon as the top corn and soybean export states in the nation; according to the USDA, these states do not even rank in the top ten states for grain exports. A recent analysis for the Nebraska DOT, showed that the states grain exports were actually 450 percent higher than what was reported in FAF.



Intermodal means of transporting containers are primarily dependent on rail and truck involvement, and are closely tied to the grain container exports analyzed here. Drayage is the service of transferring a container between loading and shipping sites. Drayage distance is an extremely important consideration to account for, when assessing the economic viability of transport cost for containers. Cost increases with distance, and as such, rail becomes vastly more cost effective over long distances. Chicago, Illinois has transformed bulk-grain facilities into container loading ones with relative ease, for there is a large inland container pool available to pull from.

To address the transportation challenges faced by the agricultural industry especially for inland state container transportation, we must examine the function of transportation within the industry. Without effective, efficient transportation, state agriculture could not have become the backbone of our country like it is today. Investment in national transportation infrastructure makes shipping easier and faster, which saves money for the farmers, as well as widening the availability while reducing the cost to consumers.

## **Research Objective**

Agriculture shippers have increasing difficulties accessing containers for export of agriculture and other high-value commodities. The objectives of this research are:

- Identify and document the challenges of agricultural shippers gaining access to containers.
- Quantitative statewide analysis to identify optimal inland locations in proximity to the highways, railways and marine access.
- Economic evaluation for estimating the transportation infrastructure needs to build national heavy weight highway corridors to support new inland terminals and connecting them to principal transload operations.
- Analytical and economic evaluation to incorporate the business and economic realities of participating entities and to address container access and availability issues.

The output of this research will influence national and state transportation policies, decisions, and investments and further assist national, state, regional, local, and private agricultural stakeholders set priorities for future investment that will positively impact inland container transportation and enhance the economic competitiveness of U.S agricultural exports.

## **Urgency and Potential Benefits**

This research is urgent due to the global shortage of containers as a result of Covid-19 impacts. Potential benefits include:

- Improved efficiency and accessibility of agricultural industries to domestic and international markets
- Cost reductions resulting from the need to store empty containers
- Shipping cost reductions
- Improved transloading times and efficiencies

## **Implementation Considerations and Supporters**

Supported by the Transportation Research Board's Committee on Agriculture and Food Transportation (AT030).

## **Recommended Research Funding and Research Period**

- \$400,000
- 18 months.

Problem Statement Author(s)

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**Person(s) Submitting the Problem Statement**

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**NCHRP Review of B-18**

Reviewed By:

William C. Rogers

wrogers@nas.edu

Comments:

This would be a worthwhile project.

Review Date:

12/22/2020

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**FHWA Evaluation of B-18**

Reviewed By: HOFM/Chandra Bondzie

Comments:

This problem is only tangentially related to FHWA/roadway impacts. This may also be a problem statement that MARAD should also evaluate given the ports role in container availability.

Review Date: 12/18/2020

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**AASHTO Committee Evaluation for B-18**

Submitted By:

Caroline Kieltyka

AASHTO Staff

Special Committee on Freight



Priority #: 10

Comments: N/A

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American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation

FY2022 NCHRP Problem Statement

**Problem Number:** 2022-B-19

**Problem Statement Title:**

Impacts of Changing Heavy Haul Supply Chains on Rural Roads and Bridges

**Problem Statement**

From Wikipedia: *"In the United States, a farm-to-market road or ranch-to-market road is a state road or county road that connects rural or agricultural areas to market towns. These are better quality roads, usually a highway, that farmers and ranchers use to transport products to market towns or distribution centers."*

Before the designation of the national road and highway networks like the National Highway System (NHS) or National Highway Freight Network (NHFN) agricultural states, relied on horses and oxen to move their produce to market along narrow trails. In the early 1900's the invention of the automobile and development and designation of farm to market networks made the movement of produce more efficient and reliable.

*"The year 1936 brought the beginning of the first farm to market road, although the great impetus for the construction of FM roads was not to come until after World War II. The first Farm to Market Road was built between Mount Enterprise and Shiloh in Rusk County, a distance of 5.8 miles. The project began in April 1936 and was completed in January 1937 at a total cost of \$48,015.12. This FM was redesignated in the general redesignation of highways in 1939 as a segment of State Highway 315."* (Texas Department of Transportation <http://www.dot.state.tx.us/tpp/hwy/fmfacts.htm>)

During the past several decades, farming and agriculture have undergone dramatic changes in the production, marketing and transportation of raw and finished agriculture and food products. However, many of the farm to market roads and bridges, some dating back decades, have not been upgraded to current design standards or to accommodate heavy trucks. While changes in agriculture have been fairly well documented, little or no research seems to have been conducted on the evolution of farm-to-market networks or performance standards associated with farm-to-market roadways.

In addition, the Fixing America's Surface Transportation Act (FAST Act) passed by Congress specifically calls upon states to focus efforts on roadways traveled by heavy vehicles:

*In the case of roadways on which travel by heavy vehicles (including mining, agricultural, energy cargo or equipment, and timber vehicles) is projected to substantially deteriorate the condition of the roadways, a description of*

*improvements that may be required to reduce or impede the deterioration; (FAST Act Chapter 702, Section 70202).*

Guidance published in the Federal Register regarding how states should respond to this Congressional directive state (Federal Register Vol. 81, No. 199 October 14, 2016):

*c. In the case of roadways on which travel by heavy vehicles (including mining, agricultural, energy cargo or equipment, and timber vehicles) is projected to substantially deteriorate the condition of the roadways, a description of improvements that may be required to reduce or impede the deterioration;*

*d. For those facilities that are State-owned or operated, a description of the strategies the State is employing to address the freight mobility issues;*

### **Literature Search Summary**

An online search using the term “farm-to-market” resulted in several newspaper articles highlighting funding needs for farm-to-market roadway systems and historical reference to these networks in major agriculture states, but no recent research related to evaluations or performance management. In 2010, the U.S. Department of Agriculture published a significant report on rural transportation issues, as requested by Congress. Section 6206 of the Food, Conservation, and Energy Act of 2008 (PL 110-246), directed the Secretaries of Agriculture and Transportation jointly to conduct a study of rural transportation issues. *The Study of Rural Transportation Issues*, makes only one specific reference to farm-to-market networks:

*“Rural transportation serves a continuum from the countryside of isolated settlements to the urban fringe. Rural production requires **farm-to-market** or mine-to-power plant movements at one end of the continuum, and the urban fringe requires local distribution of medicines, food, and clothing similar to core urban areas. Rural transportation is becoming more complex all the time.”*  
(USDA, 2010)

### **Research Objective**

In 2018, after most states had completed their first FAST-Act compliant freight plans, the American Transportation Research Institute conducted a study to examine how well states had complied with MAP-21 and FAST-Act directives. With regard to the provision related to heavy vehicle routes, ATRI concluded: *“The vast majority of the nominated freight plans did not address the truck weight criterion in any detail.”* (ATRI 2018)

The objective then for this research is to:

1. Examine the historical context and development of farm-to-market networks in key agricultural states;
1. Document states that continue to recognize farm-to-market routes in statute or policy guidance, and determine the extent to which farm-to-market designations influence funding, design, construction and maintenance.
2. Identify best practices and develop recommendations for assessing farm-to-market networks using performance metrics and performance management.
3. Develop a template and case studies for how the recommended performance metrics can be collected and reference in future statewide freight plans.

**Urgency and Potential Benefits**

Urgency – this research would be extremely beneficial to the next generation of FAST-Act compliant statewide freight plans.

**Implementation Considerations and Supporters**

Supported by the Transportation Research Board's Committee on Agriculture and Food Transportation (AT030).

**Recommended Research Funding and Research Period**

\$250,000

18 months.

Research Problem Statement Author(s)

Mark Berndt, Quetica

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**Person(s) Submitting the Problem Statement**

Kelly Eagan

Caltrans

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**NCHRP Review of B-19**

Reviewed By:

Edward T. Harrigan

Comments:

The problem is potentially solvable through the proposed research. The objective is clear. The scope is reasonable. The research can be completed in the proposed 18 months. The proposed budget of \$250,000 is adequate. Potential references: Li, Zheng, and Magdy Mikhail. "Impacts of Energy Development on Texas Roads." 9th International Conference on Managing Pavement Assets. 2015. Iowa, D. O. T. "Alternatives for Rural Roads." Wilke, Paul W., and M. Harrell. "Assessment of impact of energy development projects on local roads." Conference of the Transportation Association, Edmonton, Alberta, Canada. 2011.

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**AASHTO Committee Evaluation for B-19**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 7

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-20**

**Problem Title**

Data Fusion Techniques for Travel Behavior Analysis

**Background**

The central role that transportation plays in the U.S. economy is reflected in this comment from the National Surface Transportation Policy and Revenue Study Commission – *"The American economy works, in large measure, because shippers, manufacturers, and service providers have a transportation system that provides many ways to access labor and move raw materials and finished products. Individuals are able to travel to workplaces, shopping, educational institutions, recreation, medical care, and other locations critical to their quality of life."*<sup>15</sup>.

The changes brought about by technology and especially the smartphone revolution (online shopping, transportation network companies, etc.) have upended the way people live, work, shop, and play and this has profound implications for transportation investment, policy, and operational decisions. One example of this change is the decrease in the proportion of licensed drivers among the 55 and under age cohorts in 2014 compared to 1983<sup>16</sup>. Collecting data on travel behavior is also becoming more challenging and is hampered by low response rates or high rates of survey attrition. Therefore, it is critical to quilt different sources of travel behavior data to provide estimates in a consistent, reliable, and sustainable manner. The recent FHWA report on data availability and gaps to understand travel behavior highlights the need for data fusion techniques to overcome these gaps<sup>17</sup>.

This research will help develop the best practices and techniques for data fusion so that agencies can access the various data sources that already have access to or can procure in a more cost-effective manner to help formulate data driven policies. This research falls within the AASHTO Committee on Data Management and Analytics purpose of helping State DOTs implement a robust data management and analytics program within their agencies especially in these times of limited resources.

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<sup>15</sup> NCHRP 20-24(84) CEO Leadership Forum: State DOT Mission Evolution

<sup>16</sup> Sivak, M. and B. Schoettle. "Recent Decreases in the Proportion of Persons with a Driver's License across All Age Groups", UMTRI-2016-4, 2016, [http://www.umich.edu/~umtriswt/PDF/UMTRI-2016-4\\_Abstract\\_English.pdf](http://www.umich.edu/~umtriswt/PDF/UMTRI-2016-4_Abstract_English.pdf)

<sup>17</sup> Tawfik, A. and I. Zohdy. "Understanding Travel Behavior: How Good are our Data Sources for Addressing Travel Behavior Information Needs?", TRB paper 17-06385, presented at the 96<sup>th</sup> Annual TRB, 2017

## Literature Search Summary

In 2009, Bonnel et al<sup>18</sup> described how data fusion and the combination of multiple data sources is helping to gather more complete datasets and help give additional utility to available data sources. Their research discusses issues rising when combining survey modes within the same survey and it presents a method to merger the data coming from different survey modes, in order to consolidate the database and defines and describes the data fusion process and discusses how it can be relevant for transportation analysis and modeling purposes. Sivakumar and Polak<sup>19</sup> tested three data pooling techniques: ad-hoc cluster sampling, Rubin's multiple imputation, and a Bayesian conditional probability model to study the impacts of household technology holdings on leisure activity participation. Kressner<sup>20</sup> developed a method that fuses consumer marketing data with anonymous, passive location data to create synthetic populations with individual-level synthetic travel diaries.

these research projects focus on either research from more than a decade ago (when smartphones were not so ubiquitous) or from overseas, or rely primarily on private sector data. There is no research that focuses on how to use existing public data sources, how to fuse it with private sector sources while being mindful of the data and privacy gaps and laws, and how to fuse them all together while being mindful of state data sharing laws and privacy agreements.

## Research Objective

The objectives of this research are the following:

- Gather the various public sector and private data sources that explain travel behavior
- Identify gaps in the dataset to explain travel behavior
- Identify and develop methods to fuse these data sources together, physically or in a combined framework, to provide a comprehensive picture of travel behavior
- Develop a guidebook for DOTs to use these data for understanding travel behavior

In order to achieve these objectives, the following tasks are envisioned as part of the research effort.

- Task 1: Literature review of existing data fusion practices
- Task 2: Gap analysis of data fusion practices and state and federal laws that hamper data fusion
- Task 3: Identify and develop methods for data fusion along with code in open source languages for replicating the methodology.

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<sup>18</sup> Bonnel, P., M. Lee-Gosselin, J. Zmud, J-L. Madre. "Survey Mode Integration and Data Fusion: Methods and Challenges", in *Transport Survey Methods: Keeping Up with a Changing World*, pp 587-611, 2009.

<sup>19</sup> Sivakumar, A., and J. Polak. "Exploration of Data-Pooling Techniques: Modeling Activity Participation and Household Technology Holdings", Paper 13-3846, Presented at the 92<sup>nd</sup> Annual Meeting of the Transportation Research Board, 2013.

<sup>20</sup> Kressner, J. "Synthetic Household Travel Data Using Consumer and Mobile Phone Data", NCHRP IDEA Project 184, 2017. <http://www.trb.org/Main/Blurbs/176216.aspx>

- Task 4: Develop guidebook for data fusion techniques in the form of Jupyter Notebooks so that analysts and data users can easily use these methods.
- Task 5: Develop training materials for DOT staff to help implement this research as part of their workflow.

### **Urgency and Potential Benefits**

Uncertainty, especially in these times of COVID-19 and its aftermath, have left DOTs foundering to understand and forecast travel behavior. Doing this research will help stretch their limited dollars and use existing data products to paint a comprehensive picture of changes in the transportation system. Not conducting such research will leave DOTs blind to changes in the way people travel and lead to misallocated resources.

The benefits accrued from this investment are for citizens who will have a better people-focused infrastructure that provides access to opportunities in a cost-efficient and equitable manner.

### **Implementation Considerations and Supporters**

This research will be within the DOT modeling and planning offices and using open source tools and well documented Jupyter notebooks that follow the principle of reproducible research will help DOT analysts implement these methods in an efficient manner.

DOTs can tailor the training materials developed as part of this research for their own internal purposes to create awareness and facilitate implementation of the research results.

### **Recommended Research Funding and Research Period**

- Funding Request: \$300,000
- Funding Period: 18 months

#### **Problem Statement Authors**

- Krishnan Viswanathan, Cambridge Systematics, Inc., 850-219-6388, kviswanathan@camsys.com
- Stacey Bricka, Macrosys, 512-921-6791, sgbricka@gmail.com

#### **Others Supporting the Problem Statement**

- AEP25 – Travel Survey Methods
- AEP30 – Traveler Behavior and Values
- Ohio DOT, Rebekah Straub Anderson, 614-551-8419, rebekah.anderson@dot.ohio.gov

#### **Potential Panel Members**

- Survey Methods, Urban Data Committees, CTPP Oversight Board

#### **Person Submitting the Problem Statement**

- Colorado DOT, Erik Sabina, 303-757-9811, erik.sabina@state.co.us



## **NCHRP Review of B-20**

Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

Comments:

This is an important topic for study given the significant changes that have occurred and are occurring in data availability, data management, and forecasting. There are many earlier and ongoing studies within NCHRP as well as other CRP programs that can have an impact on the actual work plan. Coordinating with and building on those studies is essential to avoid duplication and to achieve the highest quality possible through this research. For example, an ACRP Report 204 looked at consumer choice models in air service versus automobile access, an interesting data analysis technique that affects forecasting techniques.

Review Date:

12/14/2020

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## **FHWA Evaluation of B-20**

Reviewed By: HPTS/Jasmy Methipara; HPPI/Danny Jenkins

Comments:

The proposed action is urgently needed and frankly it is long overdue. It increases the efficiency of data utilization significantly. FHWA completed a Data Fusion project a few years ago, but it did not include an expansive effort to understand all the methods that could be used for our partners' analyses. This would provide a great toolbox for state partners and other national level estimates.

Review Date:

12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**PROBLEM NUMBER  
2022-B-21**

**PROBLEM TITLE  
“Consideration of Empty Freight Truck Mile in Transportation Plans and Analytical Processes”**

**BACKGROUND  
What is the problem, and whom does it affect?**

Empty backhaul is a significant freight industry challenge facing the nation. In the trucking industry, backhaul is the return movement of a truck from the original destination. When the truck is not hauling cargo during this movement, it is considered an empty backhaul. American Transportation Research Institute (ATRI) and National Private Truck Council (NPTC) reports 19.5% of trucking miles provide no revenue, which is a deadhead or empty miles. Private fleets, which represent half of the trucking industry, experience 28% empty miles, while for-hire or contract carriers, which represents the other half of the trucking industry, experience a significantly lower amount of empty miles. Empty truck miles contribute to an increased transportation cost, vehicle emissions, fuel waste, increased hours of service strain, and roadway congestion. According to Texas Transportation Institute (TTI) Urban Mobility Report, trucks accounted for \$20 billion (11%) of the total U.S. congestion cost in 2017. Empty trailers are a strain on the supply chain and the empty miles can incur a large cost on the industry. Empty trailers put drivers at increased risk due to unbalanced loads, driving up the cost in the supply chain. This problem affects private sector profitability, public sector infrastructure, and has a negative impact on the general public.

**How will the research solve the problem?**

Currently, the freight industry and various other entities including state and local planning organizations continue to explore opportunities to minimize losses from empty or light backhaul through early detection and smart route planning. As trade opportunities continue to increase, the challenge to create systems which reduce the number of empty trucks moving across the transportation network will become more critical. While private sector business decisions dictate the logistics of trucking operation, public sector transportation agencies at various levels of government may support policies, programs and analytical tools to improve the efficiency of goods movement and reduction in empty truck miles.

To guide these actions, a number of questions need to be answered. At a minimum, this research will explore:

1. What public and private datasets can be used to quantify empty truck mileage on the transportation system?
2. What methodology can be utilized to incorporate empty back haul into the planning and modeling processes in order to provide insights into the issue?
3. What are the different factors which lead to increase in empty back haul?
4. How can public agencies consider truck empty back haul in the transportation planning and analytical processes to better inform decision making?
5. What laws and regulations need to be enacted or modified to enable reduction in truck empty back haul?
6. How and where should public agencies (national, state, and local) prioritize resources and investments to reduce this problem?

In addition to the above key research questions, within the guidance of its NCHRP sponsors and project technical panel, this research will also consider the below listed questions:

1. In what ways can emerging technologies help in quantifying the empty truck back haul issue as well as alleviating the problem?
2. How severe is this issue across other modes and can this issue be alleviated by collaboration between different modal systems?

## **LITERATURE SEARCH SUMMARY**

The existing research has identified different data sources like Weigh-In-Motion (WIM) data, commodity flow surveys, Vehicle Inventory and Use Survey (VIUS) and other databases to quantify empty truck mileage. NCHRP studies have recommended using commodity based models to incorporate empty truck trips/miles for better forecasts. Several state freight plans have identified factors which lead to increase in empty truck trips. The factors identified are demographics of consumer demand, geography and economy of region, regulatory constraints, climate/weather resiliency, frequency of short haul movements and cargo/equipment specialization. This project is expected to build on existing work in the areas of truck empty miles research. It was found that, while the government's role in reducing truck empty miles has been studied, the available guidance is limited and there is lack of information focused on the research questions listed above. Much of the past and current research has been focused on few regional case studies and not realized on a nationwide scale. The proposed research will fill the gaps in current literature, establish a framework for enhancing planning, analysis and modeling processes, and provide actionable recommendations for the public sector to reduce empty back haul and ultimately better serve the customers.

## **RESEARCH OBJECTIVE**

The objective of this research is to develop a set of practical options for the consideration of State DOTs, Metropolitan Planning Organizations (MPOs), and other transportation agencies. This local initiative will be analyzed within the framework of a national approach on how to integrate empty freight truck mile between agency decision processes across state lines. The proposed research will include literature review of research, transportation plans, technical methods, available data, decision processes and analytical tools from representative federal agencies, state DOTs, MPOs, other transportation agencies and

private sector in the U.S. The final product will be a report detailing the findings of this research and provide actionable options for public sector transportation agencies' consideration to reduce empty miles for improving freight efficiency.

The research will be conducted through the following tasks:

1. Perform a literature review.
2. Identify subject matter experts, including motor carrier operators, shippers in the private sector, and policy makers in the public sector (e.g. Departments of Transportation, Departments of Agriculture, etc.); and conduct phone interviews, virtual panel meetings to identify planning, operational, regulatory, analytical challenges which lead to empty truck miles.
3. Frame a methodology to quantify and estimate the empty freight truck miles across the transportation network using available data sources like WIM, VIUS, commodity flow datasets and other emerging technologies.
4. Create a data gathering solution capable of providing regular updates on levels of empty backhaul.
5. Develop a Solutions Toolbox focusing on measures to facilitate reduction in truck empty back haul.
6. Partner with other state DOTs to understand whether these solutions have nationwide implications, and to further refine solutions for success across multiple industries and jurisdictions.
7. Develop a process to incorporate empty back haul into transportation planning, modeling and decision-making processes.
8. Present initial findings to broader stakeholder group(s) at appropriate venues and incorporate comments and suggestions into the project documentation.
9. Develop Interim Report and submit for panel review.
10. Document research results in final report and submit for panel review.
11. Disseminate the information to the transportation community (scholars, transportation agencies, and freight movers) in the form of a written document and other press releases.

## **URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

### **Why solving this problem is important to a majority of state DOTs.**

Truck empty back haul is a national issue facing majority of the state DOTs. Empty trailers are an increased monetary burden on the supply chain. They also contribute to other issues like safety, efficiency of the system, emissions, etc.

### **What the consequences and/or negative impacts are of not conducting this research?**

Solving the truck empty back haul issue is imperative in today's world from both public and private sector perspectives given limited infrastructure funding, truck driver shortages, and tight profit margin in the highly-competitive trucking industry. Private sector can reduce the empty trucks through optimizing supply chain logistics, but public sector initiatives are critical in setting the policy framework and improving system-wide efficiency.

**Who will experience the benefits of implementing the results of this research, and what the benefits will be.**

This research will help in developing a framework which can be implemented by state DOTs, MPOs, and other organizations in their planning process. There is a lack of standardization on how to consider empty truck mileage in planning and analytical processes. This research will assist in filling this gap in literature. The research findings will set the stage for reducing empty back haul, which will eventually benefit both public and private sectors and the general public.

**IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

**Who within a state DOT will likely be responsible for using the research results.**

Policy planners, modelers, analysts, freight planners and traffic engineers.

**How state DOTs can implement the research within their own organization and what major steps they would need to take.**

The solutions toolbox will provide recommendations and strategies as per the needs of the state DOT.

**What existing venues or processes could be used to support implementation?**

The existing statewide and metropolitan planning processes can be leveraged to support implementation. The research can be highlighted in AASHTO committee presentations and TRB committees related to trucking industry and freight planning.

**What kinds of additional products and activities (for e.g. brochures, summaries, presentations, training workshops, peer exchanges, pilot testing, and verification and validation of the research results) will help create awareness and facilitate implementation of the research results.**

1. Webinars in AASHTO committees and TRB committees
2. Training workshop on solutions toolbox
3. Stakeholder/Peer exchange meetings

**RECOMMENDED RESEARCH FUNDING AND RESEARCH PERIOD**

**Recommended Funding:**

The proposed budget for this research is \$250,000.

**Research Period:**

The research project will be conducted in 15 months.

**PROBLEM STATEMENT AUTHOR(S)**

**Rickey Fitzgerald**

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**OTHERS SUPPORTING THE PROBLEM STATEMENT**

**Birat Pandey**

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**PERSON SUBMITTING THE PROBLEM STATEMENT**

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**NCHRP Review of B-21**

Reviewed By:

William C. Rogers  
wrogers@nas.edu

Comments:

I don't see a role for government in helping the trucking industry reduce empty miles.

Review Date:

12/22/2020

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## **FHWA Evaluation of B-21**

Reviewed By: HOFM/Birat Pandey, HPPI/Steven Jessberger

Comments:

HOFM/Birat Pandey - Problem statement, work scope, approach, and deliverable are well defined. Research could provide a framework for consideration for public transportation agencies on approaches to incorporate empty truck miles in agencies' business processes. Finding from this research work could help reduce knowledge gap among public agencies practitioners.

HPPI/Steven Jessberger - This project is very practical and needed.

Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for B-21**

Submitted By:

Caroline Kieltyka

AASHTO Staff

Special Committee on Freight

Priority #: 6

Comments: N/A

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## **Submitter Response for 2022-B-21**

**From:** [email: armando.moscoso@dot.state.fl.us; rickey.fitzgerald@dot.state.fl.us]

**Comments:**

**How is this problem statement related to the strategic plan or research agenda of an AASHTO Committee(s) and/or Council(s)?**

The proposed research work directly responds to AASHTO Special Committee on Freight 2018 strategic plan's goal 2, "Improve freight transportation planning practices through the enhancement of freight data and analytical methods and the dissemination of best practices". Proposed research publication will serve as a resource for practitioner for considering empty truck miles into analytical processes, which is consistent with outlined strategy 2a (Support research to improve understanding of new freight data sources and

freight analytical tools, and to develop guidance for utilizing and integrating different freight datasets for freight planning, forecasting, modeling, and reporting).

## **POTENTIAL PANEL MEMBERS**

- Organization, contact person, phone, and email address
  - Florida DOT , Rickey Fitzgerald, [Rickey.Fitzgerald@dot.state.fl.us](mailto:Rickey.Fitzgerald@dot.state.fl.us)
  - Oregon DOT, Becky Knudson, [Rebecca.A.KNUDDSON@odot.state.or.us](mailto:Rebecca.A.KNUDDSON@odot.state.or.us)
  - Virginia DOT, Erik Johnson, [Erik.Johnson@VDOT.Virginia.gov](mailto:Erik.Johnson@VDOT.Virginia.gov)

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Review Date: 1/25/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-22**

**Problem Title**

Researching and Responding to Racial Disparities in the Construction of Expressways

**Background**

In addition to their well-documented economic benefits, construction of the Interstates uprooted an estimated one million people (Schwartz, 1976). Because planning for the Interstates and other expressways occurred at a time of significant racial change in American metropolitan areas, the Interstates became entangled in—even tools of—the racial politics of the era.

Harms varied by state and metropolitan area, and Black Americans and other marginalized communities often bore a disproportionate share. Their losses included neighborhoods central to community life and direct financial harms to individuals and their families that have compounded over time. The pain and anger in these communities is still alive today, evidenced most recently by articles that appeared in 2020 in California, New York, Michigan, Louisiana, Connecticut, and elsewhere. To concerned citizens and activists, the expressways are “monuments to racism” (Fleischer, 2020).

Negotiations among federal, state, and local officials produced the expressways. Top officials gathered in 1958 to promote cooperative approaches, agreeing that: “A community which displaces large numbers of people through activities designed for the general benefit has a responsibility to help these persons adjust satisfactorily to the new conditions. This responsibility is greatest where the potential injury is greatest—that is, among lower income and minority groups, the elderly, and others least equipped for what may be for them a major crisis” (Sagamore Report, 1958).

State DOTs have the opportunity to evaluate past actions by the standard set by their leaders in 1958. State governments have a special responsibility for leadership. It was state highway departments that used the power of eminent domain and directly displaced people from their homes, businesses, and community institutions. Today, state DOTs own the Interstates and other expressways that growing numbers—especially among the younger generations—are labelling “racist.”

This problem statement advances goals of several AASHTO committees:

- Committee on Design, “Goal 2: Develop design solutions that meet the purpose and need of the project, address its context, and protect the natural and human environment,” particularly sub-goal “2.2 Research and share techniques and

processes for involving communities and other stakeholders in the development of transportation facilities.”

- Agency Administration Management Committee, “Goal 1: Workforce Management” and Civil Rights Committee, “Goal 2: Workforce Diversity and Inclusion.” Both are part of a joint task force responsible for “identify[ing] gaps, barriers, issues and obstacles” to the future workforce.

### **Literature Search Summary**

Two types of research literature are relevant: a) contemporary and historical studies on disparate impacts and b) studies on responding to past harms to promote healing and reconciliation.

Literature on disparate impacts: Studies on the impacts of constructing expressways date to the 1960s and groundbreaking studies, such as on the Interstate highways for Boston, occurred during the 1970s. However, geographic coverage is uneven, and few studies integrate the impacts to individuals and communities. Moreover, many studies emphasize the protesters in the “freeway revolts,” instead of examining what led state decision-makers to make the choices that they did. There is a need to evaluate the existing body of research from the perspectives of state highways leaders and federal officials. In addition, more recent research comes from a range of research fields and needs to be integrated. For example, much of the recent historical scholarship is not indexed in TRID.

Literature on reconciliation processes: Leaders around the world have engaged processes that work to build trust and reconciliation in response to traumatic legacies. What is missing is guidance that applies this experience to develop best practices for state governments. State governments have lessons to teach as well. An example: Minnesota DOT’s recent program, part of its Rethinking I-94 planning process, included an apology for the harm done to the Black neighborhood of Rondo in Saint Paul. Case studies that examined environmental justice initiatives in transportation will also offer lessons learned.

### **Research Objectives**

#### Outcomes:

1. Increase knowledge among government officials and the public about disparities associated with planning and constructing expressways.
1. Equip state DOTs, MPOs, and cities with tools designed to help a community confront the truth about the disparate racial impacts of past decisions and to build accountability and trust.
2. Set an example for the transportation professional community for accountability in the treatment of groups affected by transportation investment decisions.

#### Tasks:

1. Produce a report that integrates knowledge across the decades and the disciplines and that evaluates what is known and unknown about racial disparities related to the planning and construction of expressways. The report will address a) the specific

decisions that led to dislocations, b) procedures for land acquisition; c) provisions for relocation support and the rehabilitation of remnant neighborhoods; and d) steps taken at the federal and state levels to ameliorate or prevent disparities.

1. Develop a template for a research project plan that a state, MPO, or city could use to commission and gain support for additional research to fill gaps in knowledge about racial disparities.
2. Inventory and describe past state- and locally-led public processes, events, or exhibits that responded to past harms caused by the construction of the Interstates and other expressways. The inventory would inform the handbook in Task 4.
3. Develop a handbook for use by states, metropolitan areas, or cities that outlines alternative methods and best practices for public processes of accountability, reconciliation, and repair.
4. Produce summaries of the report and handbook and other materials useful to states/MPOs/cities, to help them learn about the project's findings and to lead their own public outreach.

### **Urgency and Potential Benefits**

A process of accountability, voluntarily engaged and led by state DOTs, would go a long way to a) rebuild trust among affected populations; b) show younger generations of professionals that state DOTs take past harms, including racial disparities, seriously; c) develop replicable models for reconciliation.

### **Implementation Considerations and Supporters**

The project will produce tools designed to aid implementation, most likely as part of public engagement efforts. State DOTs could use these tools for policy development and in system planning or corridor planning processes. Numerous organizations may be interested in supporting implementation including the Association of Metropolitan Planning Organizations, National Association of City Transportation Officials, American Planning Association, Urban Land Institute, Urban League, local civic and community development organizations, and American Association for State and Local History.

### **Recommended Research Funding and Research Period**

#### **Proposed Research Budget: \$375,000:**

|                                                                                 |           |
|---------------------------------------------------------------------------------|-----------|
| Task 1: Report of research literature integration, evaluation, and gap analysis | \$100,000 |
| Task 2: Template for research project plan for a state/MPO/city                 | \$25,000  |
| Task 3: Description of past state- or locally-led projects addressing harms     | \$50,000  |
| Task 4: Handbook of alternative methods for public processes of accountability  | \$100,000 |
| Task 5: Public outreach materials on Report, Template, and Handbook             | \$25,000  |
| Task 6: Reports and panel communications                                        | \$75,000  |

#### **Recommended Research Period: Two Years**

Tasks 1 and 2 and Tasks 3 and 4 may run concurrently, if produced by separate, coordinated teams. In elapsed time, Tasks 1 and 2 are estimated to require 18 months. Tasks 3, 4, and 5 are estimated to require two years.

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

- CalSTA, Avital Barnea, Deputy Secretary for Transportation Planning, (916) 327-3370, [avital.barnea@calsta.ca.gov](mailto:avital.barnea@calsta.ca.gov)
- TRB Committee on Public Engagement & Communications (AJE40), Eileen Barron, [ebarron@utah.gov](mailto:ebarron@utah.gov)
- Greg Q. Davis, Chair, AASHTO Committee on Civil Rights, , [DavisGQ@scdot.org](mailto:DavisGQ@scdot.org), (803) 737-1717
- Earl Key, Director of the Office of Equal Opportunity, Washington Department of Transportation (360) 705-7095 , [KeyE@wsdot.wa.gov](mailto:KeyE@wsdot.wa.gov)

### **Potential Panel Members**

- **Ruben L. Anthony, Jr.**, President and CEO, Urban League of Greater Madison, (formerly Chief Operations Officer and Deputy Secretary (2003-2011), Wisconsin DOT), <https://ulgm.org/rubenanthony/>, executive assistant: [mheitzinger@ulgm.org](mailto:mheitzinger@ulgm.org)
- **Eric Avila**, Professor, History and Urban Planning, UCLA, <https://www.history.ucla.edu/faculty/eric-avila>, [EAVILA@UCLA.EDU](mailto:EAVILA@UCLA.EDU)
- **Randall K. Benjamin, II**, Director, Department of Traffic and Transportation, City of Charleston, bio: <https://nacto.org/person/keith-benjamin/>; dept. phone: 843-724-7311
- **Stephanie Gidigbi**, Director of Policy and Partnerships, NRDC, <https://www.nrdc.org/experts/stephanie-gidigbi>, [Sgidigbi@nrdc.org](mailto:Sgidigbi@nrdc.org)
- **Gloria J Jeff**, MnDOT Metro District, 651-234-7855 (office), [Gloria.jeff@state.mn.us](mailto:Gloria.jeff@state.mn.us)
- **Glenn S. Johnson**, Professor, Barbara Jordan-Mickey Leland School of Public Affairs, Texas Southern University, [glenn.johnson@tsu.edu](mailto:glenn.johnson@tsu.edu), <http://www.tsu.edu/academics/colleges-and-schools/bjml-school-public-affairs/departments/urban-planning-and-environmental-policy/faculty/dr.-glenn-johnson.html>
- **Jeffrey Lin**, Vice President and Economist, Federal Reserve Bank of Philadelphia, <https://www.philadelphiafed.org/research-and-data/economists/lin/>, [jeff.lin@phil.frb.org](mailto:jeff.lin@phil.frb.org)
- **Steve Lockwood**, Steve Lockwood, LLC, [lockwood@slockwood.com](mailto:lockwood@slockwood.com)
- **Rebecca Retzlaff**, Associate Professor, Department of Political Science, Auburn University, <https://cla.auburn.edu/polisci/directory/professorial-faculty/rebecca-retzlaff/>, [becki@auburn.edu](mailto:becki@auburn.edu)

### **Person Submitting the Problem Statement**

- Gloria J Jeff, AICP, Project Director, Rethinking I-94 Project – MnDOT Metro District, 651-234-7855 (office), Gloria.jeff@state.mn.us

### **References**

Matthew Fleischer, "Want to tear down insidious monuments to racism and segregation? Bulldoze L.A. freeways," *Los Angeles Times*, June 24, 2020.  
Sagamore Conference on Highways and Urban Development, October 1958, pp. 23-24.  
Gary T. Schwartz, "Urban Freeways and the Interstate System," reprinted in *Transportation Law Journal*, Vol. 8, 1976, p. 237.

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### **NCHRP Review of B-22**

#### Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

#### Comments:

The proposed research has a broad scope including extensive retrospective analysis that would entail greater funding. The proposed research seeks to provide state DOTs with resources to include historic/ongoing disparities and reconciliation in public involvement activities. The proposed handbook could provide a unique resource for public involvement practitioners. The project might benefit from looking to other sectors (non-transportation) or transportation examples that do not involve expressways to identify good examples. Note that a somewhat related problem statement is approved for the FY2022 TCRP program: Project H-59 Racial Equity, Black America and Public Transportation. That problem statement includes developing "policies, principles, recommendations, and guidelines for the funding of transportation projects that includes projects focused on the reversal of damage done in the last century through public funding of infrastructure projects that destroyed historically Black communities".

#### Review Date:

12/1/2020

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### **FHWA Evaluation of B-22**

#### Reviewed By: HCR-20

#### Comments:

Recommend using data and SME resources from the HCR Office of Civil Rights for current project data (the HCR Title VI toolkit has resources for conducting disparity analysis). Additionally, researchers might want to consider the historical and current gaps in equity analysis conducted on highway projects and how those gaps continue to impact neighborhoods.

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-23**

**Title:**

Planning for Innovative and Emerging Mobility Futures at Intermodal Passenger Facilities

**Background:**

In recent years, mobility hubs have become increasingly complex multimodal facilities that can include any combination of public transportation, metro rail, commuter rail, shared mobility, micromobility, active transportation, and aviation services. The introduction of innovative and emerging mobility technologies (e.g., shared automated vehicles, automated transit, and advanced air mobility) further adds to this complexity and has the potential to disrupt intermodal passenger facilities in a variety of ways (e.g., first- and last-mile connections, station/terminal access, and demand for connecting vehicular infrastructure, such as roadways and parking). While past cooperative research program (CRP) studies have conducted tactical research on specific issues, there is a lack of strategic, multimodal research focused on developing best practices and considerations to prepare intermodal passenger facilities for changes in transportation, such as automated vehicles and urban air mobility (i.e., air taxis). Preparing for these innovations requires intermodal collaboration, particularly as technologies, policies, and regulations develop simultaneously. More research is needed to support scenario planning and develop resources for state DOTs and Metropolitan Planning Organizations (MPOs) identifying considerations and potential strategies to prepare for mobility innovation. This is critical to ensure that long-range plans are sufficiently forward-looking and capital projects under development today can more readily be repurposed or adapted in the future. This research can help state DOTs maximize limited public sector resources by making these facilities “future ready” in preparation for anticipated transportation innovations. This proposed research supports the following American Association of State Highway and Transportation Officials (AASHTO) strategic plan and goals:

- AASHTO’s Council on Active Transportation goal of “*partnering and researching the appropriate inclusion of active transportation in program and project development and delivery*” and “*Monitor and share information related to new technologies that may impact active transportation.*”
- AASHTO’s Council on Aviation goal of “*strengthen the Council on Aviation’s leadership role within AASHTO and among other national organizations, institutions, and groups with complementary purposes and goals*” including collaboration with national organizations such as FAA, FHWA, NASAO, ARTBA, AGC, and other stakeholders regarding unmanned aerial systems (UAS).

- AASHTO's Committee on Design goal of *"improving the quality and cost effectiveness of projects"* and *"fostering collaboration within AASHTO and with other organizations and disciplines."*
- AASHTO's Council on Highway and Streets goal of *"fostering collaboration and encouraging multi-modal and cross-discipline efforts."*
- AASHTO's Committee on Planning goal of *"providing forward-looking ideas and thoughts that identify likely future policy issues."*
- AASHTO's Council on Public Transportation's goal of *"advancing public transportation as part of an integrated transportation system"* and AASHTO's Council on Rail Transportation's goal of *"advancing rail as part of an integrated multimodal transportation system."*
- AASHTO's Special Committee on Research and Innovation goal of *"championing deployment and innovation."*

### **Literature Search Summary**

Transportation is arguably experiencing its most transformative revolution since the introduction of the automobile. Intermodal passenger facilities have the potential to change rapidly due to shifting social and cultural trends such as the growth of micromobility and shared mobility, and technological advances such as automated vehicles, hyperloop, and advanced air mobility. Connected and automated vehicles are rapidly advancing and have the potential to change intermodal access, particularly with the advent of shared automated vehicles and automated transit. Over 40 companies worldwide are developing automated vehicle (AV) technology. According to different studies, anywhere from 2% to 95% of miles traveled on U.S. roads could be in automated vehicles by 2030. Analyses vary in the degree to which AVs are shared in the future, which impacts whether their deployment will increase or decrease VMT. Additionally, advances in urban air mobility have the potential to further disrupt passenger mobility. A number of market studies forecast the total market potential for urban aviation over the coming decade. These studies forecast an estimated market potential valued between \$2.8 to \$4 billion US in 2030. In spite of a growing body of literature documenting the potential growth and disruption of vehicle automation, urban aviation, hyperloop, and other innovative and emerging transportation technologies, to date there has been little to no research documenting practical planning considerations and emerging practices to plan for these technologies at intermodal passenger facilities. Because large capital projects are already underway that will likely be impacted by these technologies, immediate research is needed to help guide the planning and design process to ensure these projects can easily be adapted with minimal modifications, additional rights-of-way, or fiscal costs.

### **Research Objective**

The objective of this research is to identify strategies and best practices for state DOTs, MPOs, and other public agencies for planning and integrating emerging transportation modes at intermodal passenger facilities (including rail and bus transit stations, mobility hubs, water transit, and airports). A core goal of the research will be to identify best practices for short-, medium-, and long- range planning considerations. The goals of this research will be to understand:



- The role of stakeholders (public and private), partnerships, and governance structures that could support and enable planning for innovative and emerging mobility at intermodal facilities;
  - The potential impacts of innovative and emerging mobility technologies (e.g., connected and automated vehicles, hyperloop, urban air mobility) on intermodal passenger facility operation, access, and design;
  - A framework for decision-making and capital planning considerations to more intelligently plan and prepare for transportation innovations at intermodal passenger facilities, such as:
    - o Policy and design strategies for repurposing existing infrastructure; renovating and adapting facilities for changes in modal access; and replacing infrastructure to prepare for emerging transportation innovations;
    - o Cross-modal policies and strategies that can be applied to intermodal access in order to mitigate congestion, increase occupancy, shift spatial/temporal demand, more efficiently use resources, achieve infrastructure savings, and reduce greenhouse gas emissions;
    - o Practices for enhancing equity and accessibility of intermodal passenger facilities and first- and last- mile access for vulnerable populations and disadvantaged communities; and
    - o Potential long-range changes in how travelers connect to and use intermodal facilities due to potential long-term social impacts associated with concerns about public health and infectious disease.
  - Opportunities and practices for scalable intermodal connectivity in small, medium, and large communities and intermodal facilities of a variety of sizes.
- The expected final product will be a primer or guide for the public sector to integrate innovative and emerging transportation technologies at existing and planned intermodal passenger facilities. This resource will include tools and techniques that facilitate decision-making and the integration of emerging technologies by a range of stakeholders, and emerging practices for planning and implementation.

### **Urgency and Potential Benefits**

The failure to plan for changes in transportation technologies in long-range and capital planning presents notable safety, congestion, fiscal, and other risks. For example, parking facilities represent a significant source of revenue to support the development and financing of intermodal passenger facilities. As passenger facilities become increasingly multimodal and adapt to transportation innovations, such as automated vehicles and advanced aerial mobility, cross modal research is needed to identify planning considerations and best practices to minimize capital outlays required to repurpose, renovate, or redevelop intermodal passenger facilities for changes in transportation technologies. This research urgently addresses these gaps by supporting the sharing and cross-pollination of multimodal best practices for emerging transportation technologies at transit/rail stations, airports, harbors, and other intermodal passenger facilities.

### **Implementation Considerations and Supporters**

This proposed research would provide significant value for planning and modal program divisions, such as rail, mass transportation, and aeronautics, as well as project delivery sections involved in planning, rights-of-way, design, and construction. This research will provide state DOTs with a valuable blueprint and roadmap for key considerations to plan technology and modal innovations at intermodal passenger facilities. The research findings could also be supported through outreach and technology transfer activities, such as research summary sheets, presentations, workshops, and peer exchanges to enhance awareness and facilitate implementation of the research results. This research would be of interest to the following AASHTO committees and councils: 1) active transportation; 2) aviation; 3) highway and streets; 4) planning; 5) design; 6) public transportation; and 7) research and innovation.

### **Recommended Research Funding and Research Period**

Recommended for Joint Funding: \$450,000 (**\$150,000 from NCHRP, \$150,000 from TCRP, and \$150,000 from ACRP**)

Research Period: 18-24 Months

### **Problem Statement Author(s)**

- Adam Cohen, UC Berkeley, 661-912-2986, apcohen@berkeley.edu
- Karen Philbrick, San Jose State University, 408-924-7562, karen.philbrick@sjsu.edu
- Susan Herre, Susan Herre Architecture, 202-747-4087, susanherre@gmail.com
- Lisa Ballard, Washington State Department of Transportation, 206-464-1254, BallarL@wsdot.wa.gov

### **Others Supporting the Problem Statement**

- California, Michigan, Mississippi, New Mexico, and Washington Departments of Transportation
- Former Secretary of Transportation Norman Mineta
- Los Angeles Mayor Eric Garcetti
- Los Angeles Metro, Office of Extraordinary Innovation (OEI)
- Beverly Swaim-Staley, Union Station Redevelopment Corporation
- Nuria Fernandez, Santa Clara Valley Transportation Authority and American Public Transportation Association
- Randell Iwasaki, Contra Costa Transportation Authority
- Matthew Daus, International Association of Transportation Regulators

*Co-sponsored by the following standing committees of the Transportation Research Board:*

- AP045 - Standing Committee on Intermodal Passenger Facilities
- AP020 - Standing Committee on Innovative Public Transportation Services and Technologies
- AP020(3) – Subcommittee on Equity of Innovative Mobility Services and Technologies
- AR010 - Standing Committee on Passenger Rail Transportation

- AR010(1) - Subcommittee on Passenger Rail Transportation Intermodal Interface
- AV050 - Standing Committee on Airport Terminals and Ground Access

**Potential Panel Members**

- Karen Philbrick, Mineta Transportation Institute, 408-924-7562, karen.philbrick@sjsu.edu
- Amy Choi, California DOT, 916-654-5183, amy.choi@dot.ca.gov
- Jean Ruestman, Michigan DOT, ruestmanj@michigan.gov
- Sam Herr, North America Bike Share Association, sam@nabsa.net
- Adam Cohen, UC Berkeley, 661-912-2986, apcohen@berkeley.edu
- David Harris, New Mexico DOT, 505-699-4350, davidc.harris@state.nm.us
- Charles Carr, Mississippi DOT, ccarr@mdot.ms.gov

**Person Submitting the Problem Statement**

David Harris, New Mexico Department of Transportation, 505-699-4350,  
davidc.harris@state.nm.us  
AASHTO's Council on Public Transportation

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**NCHRP Review of B-23**Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

Comments:

This is a timely topic for a broad cross-section of agencies, modes, and practitioners. Securing co-sponsorship of TCRP and ACRP would help ensure a balanced study design and results.

Review Date:

12/2/2020

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**FHWA Evaluation of B-23**

Reviewed By: HPTS/Jasmy Methipara

Comments:

Beyond S, M & L communities, it is also important to identify geotypes where the various planning approaches are most applicable. This wholistic multimodal approach to planning is very necessary in our changing world.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for B-23**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 9

Comments: N/A

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### **Submitter Response for 2022-B-23**

From: [email: davidc.harris@state.nm.us]

Comments:

We would like to thank the reviewers for comments and feedback. We concur with reviewer comments and recommend, if funded, that the project also consider additional geographies and built environments, such as the those defined by the U.S. DOT in their taxonomy contained in Chapter 4 of the Mobility on Demand Operational Concept (e.g., city center, suburban, edge city, exurban, and rural).

Contact Info:

**David Harris, AICP** | Transit and Rail Division Director  
NM Department of Transportation | Transit and Rail Division  
Phone: 505.699.4350  
Email: davidc.harris@state.nm.us

Review Date:  
12/23/2020

### **FUNDING UPDATE:**

- The Airport Cooperative Research Program will contribute \$150,000 contingent NCHRP contributing least \$150,000.

- The Transit Cooperative Research Program will contribute \$100,000 with no contingencies. If other funding is not provided, TCRP will pursue the project alone with a reduced scope.
  - Total funding requested is \$450,000; a total of \$250,000 has been offered by ACRP and TCRP, leaving a balance of \$200,000 from NCHRP.
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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-24**

**Problem Title**

**Guidance to Planning Organizations on How to Update Travel Demand Models to Consider Connected and Automated Vehicles and Their Impacts**

**Background**

Within the past couple years, the author of this statement worked on two freeway widening projects. Both were widening existing four-lane freeways on the fringes of growing urban areas that could no longer handle the increasing traffic demand with any decent quality of service. One of the big questions for each project team was whether the freeway should be widened to six lanes or eight lanes. In each case, the difference in cost and impacts between six lanes and eight lanes added up to tens of millions of dollars (in a large urban project the cost difference between six and eight lanes could be hundreds of millions of dollars). The traffic forecasts in both cases showed, after appropriate traffic analysis, that in the design year of 2040 a six-lane cross-section might work adequately, but it was a close call and if the forecast was slightly too low six lanes would likely not be sufficient much of the time.

In both cases described above, the traffic forecasts providing the main quantitative input to the traffic analysts did not consider connected and automated vehicles (CAVs). Essentially, the forecasts assumed that the vehicle fleets present during model calibration in the 2010s would be the same as the vehicle fleets of 2040. However, many projections show that by 2040 CAVs will be a significant presence on US roadways, and this is likely especially true in prosperous and growing urban areas like the two project sites described above. When design years are advanced to 2045 and then 2050 it is even more likely that CAVs will be a large percentage of the vehicle fleet. In addition, we know from a library of recent research that CAVs will significantly affect both supply and demand sides of transportation, more specifically land-use, people choosing to travel who do not travel much now, empty-vehicle trips, freight movements, temporal trip patterns, mode choices, route choices, highway capacities, and in many other ways. In both cases described above the forecasts used to make important and costly decisions ignored a likely large segment of travelers that behave quite differently from those included in the model.

When asked why the forecasts in the cases described above ignored CAVs, the forecasters had a ready answer, in that their main input, the travel demand models maintained by the planning organizations (POs), did not consider CAVs. In turn, when the POs were asked why they had not updated their travel demand models to consider CAVs, they provided three reasons. First, they said that they did not have the staff or consultants available to conduct a major model update. Second, they said that they are not at all certain about how CAVs will affect travel in the target year. Some CAV-related

factors seem to push demand up, for example, while other factors seem to push demand down. Third, the POs said that they do not have guidance on how to adjust their models for CAVs. They do not have examples that they can mimic, and the available literature does not provide a recipe for making those adjustments. There is not much that research can do to overcome the first of those problems, but this research is aimed at providing guidance on how POs can overcome the second and third of those problems.

### **Literature Search Summary**

The literature on CAVs and their impacts is extensive. However, there is no document available to provide specific guidance to POs on how they should adapt their long-range models for CAVs and their impacts. A search of research underway or approved by NCHRP did not show any projects like this one.

The most important piece of literature along these lines is NCHRP Report 896 from 2018. Report 896 acknowledged the importance of CAVs to future transportation planning and provided a framework for how agencies can start to adjust. Report 896 stopped well short of providing the specific guidance being called for in this research though. Report 896 did not recommend particular variables, at particular levels, or in particular combinations. Report 896 did not provide any examples of anyone actually modifying a model and demonstrating results.

On the other hand, there is literature available describing efforts to modify travel demand models. Bardaka, et al. ("Regional Impacts of Autonomous Vehicles on Transportation Network Demand: A Case Study of the Triangle Region, NC," presented at the TRB Annual Meeting in January 2020) modified the regional travel demand model for the Raleigh area for several CAV scenarios for example. They showed that modifying a travel demand model is technically possible and does not require a large effort. However, the Bardaka, et al. team tested an arbitrary and limited set of scenarios, so their results also do not provide complete guidance to POs. This proposed research aims to combine the efforts of NCHRP Report 896 and the Bardaka, et al. team to run systematic and helpful sets of scenarios through real models.

Another aspect of the voluminous research on CAVs that warrants attention is the recent progress on the highway capacity effects of CAVs. Many efforts have been made in recent years along these lines, but the most impactful is likely the pooled fund study being led by Oregon DOT. The research team in that project is developing *Highway Capacity Manual* adjustment factors for various levels of CAV penetration and has already made several presentations to the TRB Highway Capacity and Quality of Service Committee. The highway capacity effects of CAVs are not settled science, but they seem further along than many other aspects.

### **Research Objective**

The objective of this research is to provide guidance to POs on how they should update and exercise their travel demand models to include CAVs and their effects. The guidance from this research needs to be specific such that PO staff or consultants working from this document can produce updated travel demand models and

forecasters working from those models can produce helpful project-level forecasts or ranges. The research team will produce at least two examples of successful applications in actual PO travel demand models; that is, the researchers will pick at least two working models, update them for a realistic set of CAV scenarios, run them, demonstrate the results, and discuss how well the examples went. Note that this project is scoped to look at tour-based and four-step travel demand models but not activity-based models, which currently require significant upfront costs and maintenance.

Likely research tasks should include: 1) Literature review, 2) Assemble preliminary list of CAV factors and levels to be tested, and a summary of how each of these factors likely affects the supply and/or demand sides of transportation, 3) Draft directions on how typical demand models should be updated, 4) Choose at least two test models, 5) Alter test models to be able to run CAV scenarios, 6) Run the chosen CAV scenarios through the updated models, 7) Critically examine the results from Task 6, and 8) Produce a final report/guidance document and other implementation assistance.

The final report from the research will have a narrow and technical audience. The key to research success will be that PO staff working on tour-based or four-step travel demand models can use the research report to update their models and run the best set of CAV scenarios through their model to provide forecasters and traffic engineers with the information they need to make informed project decisions. Planners and forecasters working in areas without travel demand models will also be able to use the results to help in their work. The research will also provide guidance on which projects need to make the effort to include CAVs in the forecast and which do not.

### **Urgency and Potential Benefits**

As described above, state DOTs need accurate traffic forecasts to make the best possible project decisions, and they are likely not currently getting accurate enough information without consideration of CAVs. Forecasting future traffic was difficult without CAVs (see NCHRP Report 934 for example), and CAVs have compounded the difficulties.

Nonetheless, state DOTs need to make the attempt in many cases. Even if the research eventually provides project teams with some idea of the range of future travel demand that is plausible the effort will have been worthwhile. Just one freeway widening project team that correctly chooses six lanes instead of eight lanes, and thereby saves its agency tens of millions of dollars, will repay the research costs many times over. Improved accuracy of travel demand models through the addition of CAVs also provides benefits in the variety of other uses of the models, such as long range transportation planning decisions, transportation conformity, site impact analyses, project prioritization evaluations, etc.

### **Implementation Considerations and Supporters**

The focus of implementation at the state DOT should be the “planning director” or “state planning engineer.” Those positions are typically charged with oversight and funding of the POs who maintain and exercise travel demand models. The state “planning directors” should be convinced of the need to update the travel demand models, that the models



can be updated with reasonable resources, and that using results from this research would provide an improved product to forecasters and traffic engineers. PO leadership and staff are also obvious keys in implementing the results.

Besides a pull from the planners as described above, implementation could also be hastened by a push from the consumers of forecasts, namely traffic engineers working on TIP projects. Knowing that inclusion of CAVs in forecasts was technically feasible, traffic engineers could insist that the forecasts that they receive be updated.

Several levels of webinars might be needed to implement the results. State DOT planners, traffic engineers, and project managers might be targeted with a shorter webinar emphasizing that the capability to update travel demand models and forecasts for CAVs exists. Meanwhile, a detailed webinar or series with technical step-by-step guidance and plenty of time for questions and discussion could be provided to PO staff and consultants who work on travel demand models.

### **Recommended Research Funding and Research Period**

Research Funding: The research team will need to include people with knowledge of CAVs and their impacts and people who are skilled in manipulating and using long-range planning models. These skills are not common and the people with those skills are not inexpensive. On the other hand, there is no new field data collection needed for the project, no software development, no lab work, no device fabrication, and likely minimal travel. Thus, it would seem that a mid-level budget of \$400,000 should be sufficient. Another \$50,000 for implementation activities, especially some webinars, should also work well.

Research Period: As this research will plug an existing knowledge gap, in that every day that goes by without this information puts agencies at risk of making bad decisions on projects, the research period should be as short as possible. However, it will take time for the research team to find test sites and learn the models at the test sites. Balancing these factors leads to an estimate of an 18-month research period. After publication of the main research product, some implementation work will be needed to make sure agencies across the country know of the new product and are encouraged to apply it. A six-month implementation engagement period should be adequate.

### **Problem Statement Author(s)**

Joseph E. Hummer, PhD, PE, State Traffic Management Engineer, Mobility and Safety Division, North Carolina Department of Transportation, 919-814-5040, [jehummer@ncdot.gov](mailto:jehummer@ncdot.gov).

### **Others Supporting the Problem Statement**

- North Carolina Department of Transportation, Jamal Alavi, PE, CPM, Director, Transportation Planning Division, 919-707-0901, [jalavi@ncdot.gov](mailto:jalavi@ncdot.gov).
- Charlotte Department of Transportation, Anna H. Gallup, PE, Program Manager, Metrolina Regional Model, 704-336-8034, [agallup@ci.charlotte.nc.us](mailto:agallup@ci.charlotte.nc.us).

## Potential Panel Members

The panel should include:

- At least one state DOT traffic engineer who works on TIP projects and represents the consumers of traffic forecasts,
- At least one traffic forecaster who uses travel demand models as a primary input during their work on TIP projects,
- At least a couple state DOT transportation planners who fund and oversee travel demand models, and
- At least a couple PO transportation planners who work day-to-day on travel demand models.

## Person Submitting the Problem Statement

Joseph E. Hummer, PhD, PE, State Traffic Management Engineer, Mobility and Safety Division, North Carolina Department of Transportation, 919-814-5040, [jehummer@ncdot.gov](mailto:jehummer@ncdot.gov).

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## NCHRP Review of B-24

### Reviewed By:

B. Ray Derr  
[rderr@nas.edu](mailto:rderr@nas.edu)

### Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. As noted, NCHRP Report 896 explored the topic but did not present specific recommendations. The Pooled Fund Study led by the Oregon DOT is helping with HCM parameters which will be helpful to this effort. The dilemma faced by planners is described well in the problem statement in that they need to account for these technologies but lack the data and methodologies to do so. Better information should result in better capital program planning. AMPO's *National Framework for Regional Vehicle Connectivity and Automation Planning* will be another useful resource. NCHRP Project 20-102(29), Incorporating New Mobility Options into Transportation Demand Modeling, is getting underway but the funding is limited and will not allow the model testing described in the problem statement.

### Review Date:

12/18/2020

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## FHWA Evaluation of B-24

Reviewed By: HEP/Jeremy Raw, HRDO/Rachel James

Comments:

(1) This proposal identifies an important issue: how can planning agencies make responsible, informed, confident decisions about expensive highway projects that may be affected by possible fleet penetration of connected and automated vehicles (CAV). The proposal correctly observes that accurate regional travel demand models are not available to provide predictive forecasts for these purposes. (2) However, the proposed response to that issue (developing guidance about how to incorporate CAV into regional demand models, and specifically for trip- and tour-based models) fails to correctly diagnose the reasons that these models are unavailable, nor does it address the state of practice in planning for possible CAV impacts. As a result, this effort seems to miss the mark in addressing the stated need. (3) Emerging practices at State Transportation Agencies and MPOs suggest the key need is not to make models more “accurate”, but rather to establish better planning processes to support effective decision-making under uncertainty. The technical challenge may best be addressed with rapid-response tools that can explore the value of projects using scenario planning, strategic modeling, formal risk assessment, and critical path analysis so as not to make high-stakes decisions that are deeply dependent on arbitrary and unverifiable assumptions. (4) The proposal is not up to date on recent research on how to address CAV in the planning process. Following up on NCHRP Report 896, cited in the proposal, FHWA held a peer exchange on AV modeling in 2019 that squarely addresses the concerns raised in this proposal (report is here:

[https://www.fhwa.dot.gov/planning/tmip/publications/other\\_reports/automated\\_vehicle\\_modeling/](https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/automated_vehicle_modeling/)). Per that peer exchange, we do not recommend that agencies attempt to make predictive “forecasts” of AV outcomes at the level of regional demand – there are far too many unknowns with far too many unknowable interactions. (5) While it is feasible to code most CAV alternatives into regional models, the central challenge is not the technical issue of “how to do it” that the proposal seeks to address (and which, despite the proposal’s dismissive language, were quite comprehensively identified in NCHRP Report 896). The real issue is what to model and why. Alternative strategies that show promise are being explored, including formal decision-making under uncertainty (report here:

[https://www.fhwa.dot.gov/planning/tmip/resources/peer\\_review\\_program/sacog/report\\_2/](https://www.fhwa.dot.gov/planning/tmip/resources/peer_review_program/sacog/report_2/)). (6) Research is underway with a high priority at FHWA and elsewhere to develop conceptual and microsimulation approaches to CAV. Such modeling is focused on identifying what can be known today about CAV, especially physical and operational constraints. Such detailed modeling efforts dovetail with work also underway at FHWA on system dynamics and scenario analysis to ensure that all available information about the new technologies can be considered during project planning, without over-committing to inevitably arbitrary assumptions about fleet penetration, operation in mixed traffic, travel market changes, behavioral shifts, additional system-level effects such as restructuring the delivery of transit services, etc. etc. Additional information on these efforts is available here (<https://highways.dot.gov/automation>) and here

(<https://highways.dot.gov/research/operations/analysis-modeling-simulation/ams-projects>).

Review Date:  
12/18/2020

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## **Submitter Response for 2022-B-24**

**From:** [email: jehummer@ncdot.gov]

### **Comments:**

The authors appreciate the review by Mr. Ray Derr of NCHRP. His support for the problem statement is welcome and the references he provided to ongoing research and research about to begin are welcome.

The authors have addressed the comments by Mr. Jeremy Raw and Dr. Rachel James of FHWA in detail below.

Raw and James: (1) This proposal identifies an important issue: how can planning agencies make responsible, informed, confident decisions about expensive highway projects that may be affected by possible fleet penetration of connected and automated vehicles (CAV). The proposal correctly observes that accurate regional travel demand models are not available to provide predictive forecasts for these purposes.

Statement authors: Thank you.

Raw and James: (2) However, the proposed response to that issue (developing guidance about how to incorporate CAV into regional demand models, and specifically for trip- and tour-based models) fails to correctly diagnose the reasons that these models are unavailable...

Statement authors: The authors agree that current demand model structures are fine for this problem, but it is in the application of those models where the problem lies. The project panel can provide clarity on this in writing the RFP if they wish.

Raw and James: ... nor does it address the state of practice in planning for possible CAV impacts. As a result, this effort seems to miss the mark in addressing the stated need.

Statement authors: The authors disagree that the "state of the practice" has moved beyond traditional planning practices at this point. Certainly, there are a few POs across the US conducting tests in this regard. However, the vast majority of planning organizations (POs) have not begun to plan for possible CAV impacts.

Raw and James: (3) Emerging practices at State Transportation Agencies and MPOs suggest the key need is not to make models more "accurate",

Statement authors: The authors of the statement only used the word "accurate" or "accuracy" three times in the statement--model accuracy is not the focus of the problem statement.

Raw and James: ...but rather to establish better planning processes to support effective decision-making under uncertainty.

Statement authors: The authors of the statement fully embrace this phrase and that is entirely what we intended with our statement.

Raw and James: The technical challenge may best be addressed with rapid-response tools that can explore the value of projects using scenario planning, strategic modeling, formal risk assessment, and critical path analysis...

Statement authors: We hope that Mr. Raw and Dr. James join the project panel to ensure that the researchers take a look at the techniques that they suggest may end up helping. We see this research as the opportunity to develop a framework within regional models that allows agencies to address the uncertainties around CAV rollout, impacts to land use, and impacts to the transportation system through scenario planning. Systems modeling informs project planning from the identification of a need in the CTP through project level forecasting needed for environmental documents and design. Understanding the range of potential impacts of CAVs through macro systems modeling early in the long-range planning process positions local DOTs, MPOs, RPOs, and state DOTs to make informed decisions at the systems level as well as the project level.

Raw and James: ...so as not to make high-stakes decisions that are deeply dependent on arbitrary and unverifiable assumptions.

Statement authors: The statement authors thought they were clear that the need for the research was to avoid making high-stakes decisions that are deeply dependent on arbitrary and unverifiable assumptions. This is the case now as POs are generally assuming zero CAVs.

Raw and James: (4) The proposal is not up to date on recent research on how to address CAV in the planning process. Following up on NCHRP Report 896, cited in the proposal, FHWA held a peer exchange on AV modeling in 2019 that squarely addresses the concerns raised in this proposal (report is here: [https://www.fhwa.dot.gov/planning/tmip/publications/other\\_reports/automated\\_vehicle\\_modeling/](https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/automated_vehicle_modeling/)).

Statement authors: The peer exchange report cited by Mr. Raw and Dr. James, while informative, involved five agencies from four states. The peer exchange report stops

short of solving the problem or providing the needed guidance described in this statement. The peer exchange report provides interesting data and the panel and the proposers should be aware of it, but there is a long way to go in this area.

Raw and James: Per that peer exchange, we do not recommend that agencies attempt to make predictive "forecasts" of AV outcomes at the level of regional demand - there are far too many unknowns with far too many unknowable interactions.

Statement authors: The statement authors are under no illusions that a single forecast will provide adequate information to project teams making the kinds of difficult decisions that the statement describes. Of course, with many unknowns some sort of scenario generation and analysis will come into play. The objective of the research is intended to provide guidance on how to establish and run that scenario framework and use the results, not to provide a determinate answer.

Raw and James: (5) While it is feasible to code most CAV alternatives into regional models, the central challenge is not the technical issue of "how to do it" that the proposal seeks to address (and which, despite the proposal's dismissive language, were quite comprehensively identified in NCHRP Report 896). The real issue is what to model and why.

Statement authors: The statement authors are not focused on the technical issue of "how to do the modeling". The statement already included a reference to recent research that demonstrated "how to do the modeling." We completely agree that the real issue is what to model and why, and we need this research to help answer that question. NCHRP 896 does not provide sufficient guidance.

Raw and James: Alternative strategies that show promise are being explored, including formal decision-making under uncertainty (report here: [https://www.fhwa.dot.gov/planning/tmip/resources/peer\\_review\\_program/sacog/report\\_2/](https://www.fhwa.dot.gov/planning/tmip/resources/peer_review_program/sacog/report_2/)).

Statement authors: The referenced report is a peer review involving a handful of POs in only four states. The "robust decision making" framework described in the peer review report is interesting but the chasm between the real state of the practice in project planning as experienced by the statement authors (and we suspect by the vast majority of agencies across the US) and the "robust decision making" framework discussed in the report is vast. If "robust decision making" is to be the way forward for project planning, the proposed research is desperately needed.

Raw and James: (6) Research is underway with a high priority at FHWA and elsewhere to develop conceptual and microsimulation approaches to CAV. Such modeling is focused on identifying what can be known today about CAV, especially physical and operational constraints. Such detailed modeling efforts dovetail with work also underway at FHWA on system dynamics and scenario analysis to ensure that all available information about the new technologies can be considered during project planning,

without over-committing to inevitably arbitrary assumptions about fleet penetration, operation in mixed traffic, travel market changes, behavioral shifts, additional system-level effects such as restructuring the delivery of transit services, etc. etc. Additional information on these efforts is available here (<https://highways.dot.gov/automation>) and here (<https://highways.dot.gov/research/operations/analysis-modeling-simulation/ams-projects>).

Statement authors: The statement authors thank Mr. Raw and Dr. James for the link. However, the listed projects are mostly in the operational realm and most appear to be trying to advance quite detailed vehicle hardware and software solutions. The statement authors maintain that the operational side of CAV is, at this point, the most well known and well-researched. However, in making decisions about projects for the years 2040 or beyond, we cannot rely on just the relatively well-understood operational side of the equation. To ignore the difficult issues of fleet penetration, travel market changes, behavioral shifts, etc., as we are doing now in project planning, is to guarantee sub-optimal decisions.

In summary, the review offered by Mr. Raw and Dr. James does not negate the need for the proposed research. The problem statement was mischaracterized several times. Their proposed solutions are at very early stages, or, in the case of the operational projects, out of scope. The central fact remains that planning organizations need the information that this research would provide and that there is no past or ongoing effort that provides that information.

**Contact Info:** Joseph Hummer, NCDOT, [jehummer@ncdot.gov](mailto:jehummer@ncdot.gov), 919-814-5040

Review Date: 2/8/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-25**

**Problem title:**

**Best Practices for Data Fusion of Probe and Point Detector Data**

**Background**

This research is needed to define the types and characteristics of data for entry into a data fusion engine. It will delineate the challenges, issues, and best practices for performing data fusion by agencies to estimate or predict travel time, speed, and reliability on road networks. Road traffic datasets of interest include traditional inductive loop detectors (ILDs); Bluetooth; GPS devices embedded in smartphones, personal navigation devices, taxis, fleets, and other sources; third party travel time data (such as INRIX, Google, HERE, and WAZE); and emerging connected vehicle data sets. This problem statement is responsive to Goals 4 and 5 of the Strategic Plan of the AASHTO Data Management and Analytics Committee. In summary, these goals aim to facilitate the development and advancement of tools and dissemination of research to support decision making related to data and analytics needs; advance best practices in the management, use, and standards relating to data and analytics; collaborate with other committees and federal partners to develop federal policy, programs, and regulations related to data use, management, and analytics; and assist member agencies with the adoption/implementation of completed research.

**Literature Search Summary**

Although the sensor and data fusion models were originally developed for the military, non-military uses now abound in fields such as robotics, medical diagnosis, environmental monitoring, sensor networks, video and image processing, and traffic management.

Dissimilar sensors produce heterogeneous datasets of varying parameter types, aggregation times, frequencies, biases, and noise. Hence, several data fusion techniques are required for the various applications and data. El Faouzi, et al. [1] demonstrated the application of Dempster-Shafer theory for fusing data gathered from ILD pairs and electronic toll collection (ETC) stations to estimate travel time. Westerman, et al. [2] developed a model to estimate link mean speed from probe vehicle data and loop detectors. Lim and Lee [3] investigated the time lag in travel time prediction using an interval detection method with data from a dedicated short-range communication detector.

Li [4] investigated the relationship between traffic flow and travel time by combining data from loop detectors that measure traffic flow and cameras that record vehicle travel time. Heilmann, et al. [5] studied heavy goods vehicle (HGV) speed prediction on a



motorway by integrating data from loops and ETC of HGVs on freeways with closely spaced loops. Travel time estimation using loop volume and occupancy data alone and in combination with GPS data was proposed by Dailey [6] and Choi and Chung [7], respectively. Other studies have revealed the benefits of using multiple sources of data for travel time estimation and developed a variety of data fusion approaches [8, 9].

In last decade, projects such as mobile millennium [10] explored data fusion of probe and fixed sensor data. Other researchers have integrated loops and probes to estimate travel time on motorways [11], signalized arterials [12–15], and for vehicle trajectory estimation [16]. Zhang, et al. [17] found that the combination of loops and probe vehicles offers a better estimation of vehicle speed than using either of them alone. Klein has recently described the many applications of sensor and data fusion to Intelligent Transportation Systems and traffic management in his summary of data fusion models and algorithms [18].

### **Research Objective**

The objective of this NCHRP proposal is to identify the data and data fusion algorithms that will enable road operators to better understand the traffic state on their network for both operations and planning applications. This will be achieved by fusing data from multiple traffic data sources that have differing spatial and temporal characteristics.

The project will develop a clear pathway from data selection to fusion model selection that is implementable in the field by agency staff or their contractor. The research will promote the adoption of data fusion technology for improving the safety and efficiency of traffic management by:

1. Developing a data characterization catalog that assesses the suitability of sensor data as an input into a data fusion process. This characterization will include properties such as coverage, quality, granularity, time lag, usability, accessibility, and geospatial referencing.
2. Developing a decision process that enables the choice of data fusion model and provides guidance on the expected information gain.
3. Developing methods to estimate the traffic state and the reliability of the estimate considering various traffic flow and data availability scenarios.

Major tasks to be performed to successfully conduct the research are the following:

*Task 1. Literature review:* The review will focus on the state of practice of data fusion for travel speed and related applications. Surveys of stakeholders will be conducted to identify issues and challenges.

*Task 2. Select use cases, data fusion methods, and testing methodology:* First, a set of potential data fusion use cases will be defined. Based on the identified use cases and the results of the literature review and survey, a set of candidate data fusion methods for testing will be identified. Data fusion methods will be selected by identifying techniques that can be reasonably integrated into transportation agency operations. An objective is to define methods that are not computationally intense, in order to encourage agencies to adopt them. A series of data sets will be compiled to assess the accuracy of the various methods and identify the advantages and limitations of the techniques across a range of facility types and traffic conditions.

*Task 3. Testing using simulated and real data:* Two-phase testing of the methodology will be implemented. In Phase 1, the data fusion methods will be tested in a controlled environment using simulated data. In Phase 2, the methods will be tested using real-time data from a real network. Testing results will be presented clearly with all necessary data and assumptions so that the research is reproducible. The primary point detectors will be ILDs, side-fired presence-detecting radar, and video, although other technologies (e.g., magnetic, LIDAR, acoustic, passive infrared, and ultrasonic) will be acceptable if they are available.

*Task 4. Develop implementation guidelines:* A major outcome of this research will be implementation guidelines that support practitioners in their implementation of the methodology to real-world applications. The guidelines will strive to be data source independent and will consider minimum agency expertise in data fusion algorithms and modeling.

### **Urgency and Potential Benefits**

INRIX estimated traffic congestion economic costs of \$124 billion in 2013, with growth to \$186 billion by 2030 assuming nothing is done<sup>21</sup>. By enabling better knowledge of the network state, the outcomes of the proposed research will enable improved traffic management and planning decisions. Even a 5% reduction in congestion will produce large economic savings. The economic cost of traffic crashes was estimated at \$871 billion in 2013. Improved network state estimates will enable enhanced safety outcomes by identifying locations with high crash rates and anomalous traffic flow conditions.

### **Implementation Considerations and Supporters**

The research results will be used by the following:

- Government: state and local transportation agencies including their traffic engineering, operations, and ITS divisions.
- Industry: Third party data providers, modelers
- Academia

Task 4 of the project will address how state DOTs can implement the research within their own organization and what major steps they would need to take.

What existing venues or processes could be used to support implementation. Can we identify test sites or specific states that would support this research?

As funding opportunities present themselves, this research is well-suited to be publicized through brochures, summaries, presentations, training workshops, peer exchanges, pilot testing, and demonstration projects.

### **Estimated Funding**

\$200,000

### **Research Period**

Approximately 18 months

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<sup>21</sup> <https://www.forbes.com/sites/federicoguerrini/2014/10/14/traffic-congestion-costs-americans-124-billion-a-year-report-says/#4bc8e0d4c107>

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### **Others Supporting the Problem Statement:**

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### **Potential Panel Members**

A large pool of individuals can serve on a panel for this study, including the volunteer members of the TRB Subcommittee on Travel Time, Speed, and Reliability (AED20(3)). The most likely members include those who authored the original problem statement, and the authors of some of the cited reference papers.

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  - [17] N. Zhang, J. Xu, P. Lin, and M. Zhang, "An approach for real-time urban traffic state estimation by fusing multi-source traffic data," in *10th World Congress on Intelligent Control and Automation (WCICA)*, 4077–4081 (2012).
  - [18] L. A. Klein, *Sensor and Data Fusion for Intelligent Transportation Systems*, PM305, SPIE Press, Bellingham, WA (2019).
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## NCHRP Review of B-25

### Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

### Comments:

This is a highly technical study that might be coordinated with B-20, as data sources, collection, and management are critical to the fusion process. The amount of money proposed for this study is not sufficient to accomplish the proposed objective. Bringing together B-20 and B-25 with a sufficient amount of funding should provide a better option than pursuing each of these two studies separately.

Review Date:

12/14/2020

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## **FHWA Evaluation of B-25**

Reviewed By: HRDO/Jon Obenberger, HOP/John Harding

Comments:

1) As each agency will have different practices and terminology, we recommend removal of terms that are not needed (e.g., engine, fusion, data fusion model) from the problem statement. 2) Recommend the problem statement address the following items: formats of different types of data, issues to consider with developing and using application program interfaces (APIs), the message handling and other capabilities required for different APIs used to support translating data between different formats with different manufacturer's equipment to a data subsystem, and considerations when selecting and using interfaces to allow access to use or manage data that may be located in different locations (e.g., servers, cloud). 3) Recommend the problem statement address the collection and use of data will require translations and use of APIs to enable data to be combined and used with different applications (e.g., TMS, ITS devices or other systems). With this concept, we would encourage a simplification of what is proposed for Tasks 2 and 3 to focus on the requirements to develop, test, and validate an API, where the functionality may vary based on the data collected, issues unique to each manufacturer's products, and the requirements of the data base where the data will be stored and made available for future use.

Review Date:

12/18/2020

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## **Submitter Response for 2022-B-25**

**From:** [email: sam.granato@dot.ohio.gov]

**Comments:**

**Specific replies to FHWA comments:**

1) As each agency will have different practices and terminology, we recommend removal of terms that are not needed (e.g., engine, fusion, data fusion model) from the problem statement.

*We can do this.*

2) Recommend the problem statement address the following items: formats of different types of data, issues to consider with developing and using application program interfaces (APIs), the message handling and other capabilities required for different APIs used to support translating data between different formats with different manufacturer's equipment to a data subsystem, and considerations when selecting and using interfaces to allow access to use or manage data that may be located in different locations (e.g., servers, cloud).

*Considering APIs appears to be a new objective for our project. Our committee would have to consider if we want to get into this? In the past, some vendors have considered APIs as proprietary and have resisted standardization of their serial data transfer protocols. Formats for different types of data are dependent also on the specific data fusion algorithm used. For example, a Bayesian data fusion algorithm requires information different from that needed in a Dempster-Shafer data fusion algorithm. Adding the API task would probably absorb all of the available funding and not leave any (or much) to accomplish what we originally intended.*

3) Recommend the problem statement address the collection and use of data will require translations and use of APIs to enable data to be combined and used with different applications (e.g., TMS, ITS devices or other systems). With this concept, we would encourage a simplification of what is proposed for Tasks 2 and 3 to focus on the requirements to develop, test, and validate an API, where the functionality may vary based on the data collected, issues unique to each manufacturers products, and the requirements of the data base where the data will be stored and made available for future use.

*My comments pertaining to this recommendation are similar to that in #2 above concerning APIs. Also getting information from each manufacturers products is a daunting task and may be unachievable due to proprietary issues.*

### **Specific replies to NCHRP comments:**

In the background portion of the 2022-B-20 proposal, the authors state "This research will help develop the best practices and techniques for data fusion so that agencies can access the various data sources that already have access to or can procure in a more cost-effective manner to help formulate data driven policies."

The 2022-B-20 project's focus is travel behavior. The title of the 2022-B-20 proposal is "Data Fusion Techniques for Travel Behavior Analysis." The research objectives include statements such as "Gather the various public sector and private data sources that explain travel behavior" and "Develop a guidebook for DOTs to use these data for understanding travel behavior."

*Our data fusion proposal is focused on "Developing methods to estimate the traffic state (this comment added by me: i.e., congestion) and the reliability of the estimate considering various traffic flow and data availability scenarios." It appears that the two data fusion proposals have different objectives (different end uses for the data fusion results) and should be two different projects. True, they can be combined, but to meet*

*our committee's needs, there would have to be two separate sets of objectives. This may complicate completion of a combined project as funds would probably not be sufficient to cover both objectives. Each committee's needs appear to be different and the management of a combined project by one of the interested committees may jeopardize the objectives of the other committee.*

*That said, our committee's interest in traffic state or congestion does tie in with travel time as travel time is a function of the congestion level encountered on the journey. So perhaps the proposals can be combined from that point of view. We would have to determine what specific travel time data and fusion algorithm the other committee requires and how that meshes with our committee's needs.*

**Contact Info:** same as above

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-26**

**Problem Title**

High-Impact/Low-Incidence Travel and Its Effects

**Background**

Travel behavior data are traditionally collected in Household Travel Surveys (HTS), which are now augmented by aggregated Location Based Services (LBS) datasets. Many high-impact trips, including those using a Transportation Network Company (TNC) or long-distance travel, are rarely captured in these datasets. However, these trips greatly impact the reliability of the transportation system and have large effects on the need for capacity projects either in high-density neighborhoods (e.g. CBDs and entertainment districts) or rural freeways (i.e. long-distance trips which are typically infrequent but in total account for a large share of VMT).

Behaviors or travel choices that do not occur frequently fall into different categories:

- Travel that most people undertake but not frequently enough to be captured in a standard behavior survey, including long-distance travel, trip replacement behavior such as home delivery of goods and services, or travel by TNC.
- Behaviors that a small number of people participate in or consider in their travel choice set, new or emerging travel modes, including bicycling, carshare and connected/autonomous vehicles.
- Travel behavior in the context of complex analytical structures, including travel with many stop locations.

This project aims to determine what low incidence travel most impacts the transportation system, how the associated travel behavior can be understood and analyzed, under what circumstances low incidence travel data can be pooled, and its overall financial impact on the transportation system.

This proposal is of potential interest to the AASHTO Standing Committee on Planning (SCOP) and deals with items 1.7 “Provide Greater Institutional Support for Planning Resources within AASHTO” and 4.1 “Identify Successful Efforts at Communicating the Value of Transportation” of the strategic plan. The project potentially relates for all four of its Task Forces.

**Literature Search Summary**

This proposal was developed from a Research Needs Statement from the Travel Survey Methods Committee (AEP25). Various research projects have concluded that this topic needs further research and has thus led to this submission. A number of relevant studies were omitted due to space limitations.

- Schiffer, R. *National Cooperative Highway Research Program Report 735: Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models*. Transportation Research Board. 2012. – **This report notes**



that “trips of more than 100 miles account for less than 1 percent of all vehicle trips but 15.5 percent of all household-based vehicle miles.” It also notes that most surveys are not adequately capturing this travel and only the national survey, two statewide long-distance surveys and 2 other statewide surveys were able to be used for that project.

- Donnelly, R. and R. Moeckel. *National Cooperative Highway Research Program Synthesis 514: Statewide and Megaregional Travel Forecasting Models: Freight and Passenger*. Transportation Research Board. 2017. – **Notes that 65% of states have an active statewide model, showing the need for long-distance data collection.**
- Berliner, R., Aultman-Hall, Lisa, and Circella, Giovanni. *Exploring the self-reported long-distance travel frequency of millennials and generation X in California*. Transportation Research Board. 2018. **The report notes that “The patterns of infrequent long-distance trips are poorly understood especially compared to the better studied (and understood) local daily travel patterns and calls out limitations of MPO surveys and the NHTS.”**

### Research Objective

Identify and analyze methods for sampling people or households and incidences of rare or emerging travel behaviors, including how to incorporate new methods into HTS data collection. This may involve looking at non-traditional sampling methods or survey designs and overcoming the practical and logistical barriers to finding and collecting samples of rare behaviors. Research objectives should also consider how the data can be weighted and analyzed on its own and within the context of a traditional “representative” HTS dataset.

Potential research tasks may include:

- Identification of the types of behaviors that cannot be easily captured in a traditional travel survey
- Determine which behaviors have sufficient impacts on the transportation system or on transportation model systems as to warrant changes in survey methods
- Synthesis of non-traditional or non-representative sampling methods to capture low-incidence travel behaviors and/or supplemental or special generator survey methods
- Analysis of non-traditional sampling methods (data quality, cost-effectiveness, integration of data with traditional household travel survey data)
- Comparison of traditional survey methods with the resulting data fused with LBS datasets
- Analysis or recommendations for how sampling methods, data and results can be applied across different modes or different regions

Produce a report with recommended data sources, data collection methods and instruments, data fusion techniques, transferable parameters and procedures (update of NCHRP 716 and 735) and recommended practices, and training slides and guides.

Update the *tfresource* and Travel Survey Manual.

A variety of datasets are available for this analysis including the current NHTS and the Ohio 1-year long-distance dataset, 7-day smartphone HTS and StreetLight data, and the Minneapolis/St. Paul MN regional HTS datasets.

### **Urgency and Potential Benefits**

Thirty-three states have statewide models that need accurate long-distance travel data. Emerging, low-incidence travel modes (e.g. CAVs and TNCs) are becoming critical policy issues in regional and statewide long-range plans that need quality data to analyze and forecast. This project will help with targeting the low-incidence travel needed to make both the statewide and regional travel models accurate in predicting those trips and to determine in what cases collected data can be pooled or transferred to other regions, thus reducing the overall cost to each state. Given that the National Household Travel Survey is currently underway, this work can be conducted in cooperation with that data collection effort in order to save project costs and to undertake a more robust analysis.

### **Implementation Considerations and Supporters**

Forty state DOTs have statewide models either in use or under development (NCHRP Synthesis 514). This project benefits those statewide model as well as the regional MPO travel models. The results of this project have the potential to feed into BUILD and INFRA project Benefit-Cost Analysis and priorities.

Specifically, it is anticipated that long-distance results can be implemented in the 33 states with long-distance models, and that the 40 statewide and many regional MPO models can implement other low-incidence travel parameters (e.g. TNC trips). Results will be presented at the TRB Transportation Planning Applications Conference, the TRB Innovations in Travel Modeling Conference, on a TRB or TMIP webinar and at TRB, particularly at the AEP25 Travel Survey Methods Committee, the Long-Distance Subcommittee and the Statewide Modeling Subcommittee meetings. Additionally, a Statewide Modeling peer exchange was being planned prior to the COVID-19 pandemic. This peer exchange is still anticipated and may be able to participate depending on schedule.

The AASHTO Standing Committee on Planning (SCOP) and the Travel Model Improvement Program (TMIP) are expected to be interested in the research results and could help support implementation.

- AASHTO – SCOP – Matthew Hardy
- AASHTO – Penelope Weinberger

### **Recommended Research Funding and Research Period**

Recommended Funding: \$375,000

It is estimated that this project could take a senior and a junior staff member one full year. This assumes that the NHTS project is underway and the University of Maryland is available to run necessary data tabulations.

Research Period: 24 months, including reviews

**Problem Statement Author(s)**

- Rebekah Straub Anderson, Ohio Department of Transportation, 614-551-8419, rebekah.anderson@dot.ohio.gov
- Jonathan Ehrlich, Metropolitan Council, 651-602-1408, jonathan.ehrlich@metc.state.mn.us

**Others Supporting the Problem Statement**

- AEP25 – Travel Survey Methods
- AEP30 – Traveler Behavior and Values
- AEP50 – Travel Demand Modeling
- North Carolina DOT, Tae-Gyu Kim, 919-707-5735, tae-gyukim@ncdot.gov
- Colorado DOT, Erik Sabina, 303-757-9811, erik.sabina@state.co.us

**Potential Panel Members**

- FHWA Liaison – Daniel Jenkins, FHWA Office of Highway Policy Information, 202-366-1067, daniel.jenkins@dot.gov

**Person Submitting the Problem Statement**

- Ohio DOT, Rebekah Straub Anderson, 614-551-8419, rebekah.anderson@dot.ohio.gov
- 

**NCHRP Review of B-26**Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

Comments:

This research issue is important and needs to be addressed. Coordination with others, including the University of Maryland, is critical to carrying out the objective, especially with respect to the relatively low level of estimated funds necessary.

Review Date:

12/14/2020

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**FHWA Evaluation of B-26**

Reviewed By: HPTS/Jasmy Methipara; HPPI/Danny Jenkins

Comments:

The project's objective is concrete. The proposed work is needed. Determining methods to capture these trips is very much long overdue and needed.

Review Date:

12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-27**

**Problem Title**

Evaluating and Integrating Emerging Data Sources to Support Health-Promoting Transportation Planning and Operations

**Background**

Acquiring, evaluating, and integrating transportation and health data are obstacles to understanding and incorporating health into the transportation decision-making process at the state and metropolitan levels. This can lead to transportation funding decisions, infrastructure design, and policies that exacerbate existing health disparities. New technologies to collect crowd-sourced data (e.g., personal health and activity tracking apps) and advanced methods to analyze data (e.g. machine learning methods) can facilitate collection, analysis, and in some cases integration of large data sets in various fields, including transportation. However, data on active modes of transportation (i.e., bicycling, walking) and micromobility options (e.g. e-scooters) are lacking in most regions in the United States. Even when available, crowd-sourced datasets can suffer from biases that need to be addressed to ensure equitable outcomes. Other challenges include data accuracy, that could vary based on traffic conditions, weather, or areas being monitored, and data resolution mismatch between transportation and health data sources (e.g., county-level health data vs more disaggregate transportation data).

There is a need to evaluate the various emerging, big data sources to identify areas of bias and error—particularly in relation to vulnerable road users, pedestrians and bicyclists, and historically underserved populations. Research also needs to address challenges with health and transportation data integration, which can facilitate development of transportation planning and policy recommendations, e.g., adjustment of project scoring methodologies. This research will ultimately lead to the development of systematic data collection standards and approaches for managing, analyzing, and integrating transportation and health data to ensure consistent and efficient health assessment of transportation across states and metropolitan planning areas. This problem statement supports many of the goals listed in the AASHTO’s Council on Active Transportation Strategic Plan, such as Goal 3, which is related to creating voluntary data collection and analysis systems that can facilitate reaching other stated goals, e.g., assessing safety for non-motorized users (Goal 1), and evaluating the impact of new technologies on active transportation (Goal 6).

**Literature Search Summary**

NCHRP 20-112 [1] emphasized the need to advance knowledge on emerging data sources such as smartphones) and their integration with traditional ones to advance health in transportation. Limitations associated with transportation and health data such as their accuracy and resolution mismatch as well as limited data for certain modes of

transportation (e.g. e-scooters) have been reported as barriers in data integration efforts [1, 2]. NCHRP Project 20-112 also noted the need to institutionalize data collection, management, and integration of key transportation and health data sources to ensure unbiased and reliable data that can be used for transportation planning, management, and policy. A preliminary literature review has identified recent research summarizing types of emerging data sources, sampling biases and privacy issues, as well as current applications of such data for non-motorized travel [3, 4]. However, there is a lack of understanding on best practices for acquiring (e.g. technology types), managing (e.g. formatting, storing, sharing), processing (e.g. cleaning, filtering), and integrating (data fusion of transportation and health data) for use in state and metropolitan-level transportation planning and policy decisions.

### **Research Objective**

The objective of this research is to understand and improve the use of emerging transportation and health data, including data acquisition, accuracy, representation, and integration. The final product will be a guidebook targeted at agencies of various sizes and resource levels. The guidebook will summarize recommendations for ensuring systematic and consistent data collection, analysis and management approaches across states as well as bias correction and integration methods of health and transportation data. Anticipated tasks to address these objectives include:

- Conducting a literature review to identify limitations (e.g. biases) in transportation and health data, such as GPS accuracy and coverage, to inform a discussion on implications of such limitations, and ways to address them.
- Conducting interviews with appropriate parties (e.g. state DOTs, MPOs, and state health departments) to summarize: 1) existing transportation and health data sources, 2) passive data collection techniques for transportation and health data, and 3) management approaches of big datasets (e.g., tools, platforms, updated frequency, personnel background), data usage agreements, 4) level of integration of transportation and health data, and 6) applications of such data to advance health in transportation, and 7) challenges associated with integrating transportation and health data.
- Developing a guidebook that will include a tiered set of recommendations for agencies of different sizes summarizing recommendations for performing: 1) data collection (e.g., surveillance technologies, locations, time frame of data collection) with an emphasis on capturing accurate active transportation use, 2) data cleaning and fusion methods, 3) data management (e.g., data formatting, storing, data sharing and data governance models), and 4) integration of emerging transportation and health data with traditional data sources to support cost-effective and sustainable acquisition, storage, and usage of data towards promoting health in transportation.
- Developing and delivering training material summarizing these recommendations and showcasing a few case studies to facilitate adoption and implementation of the final product.

Ultimately, this research will advance the state of practice in improving and applying big data sources to support active travel, equity considerations, and transportation decision-making at the state and metropolitan planning levels.

## **Urgency and Potential Benefits**

The Federal Highway Administration has stressed the need for performance-based long-range transportation plans that utilize performance measures related to operations, safety, and air quality. A number of states and metropolitan planning organizations (MPOs) have already started incorporating health performance measures in their decision making. This research will benefit the majority of state DOTs and MPOs, by providing guidelines on how to collect data with a focus on vulnerable users that are often harder to obtain or are not representative. This will include guidelines on types of technologies that can be used for data collection as well as appropriate methods for storing, analyzing, and managing these data. Most importantly, the final product will offer guidance on the integration of transportation and health data. To ensure that all state DOTs and MPOs can utilize this research, guidelines will be tailored to various levels of agency sizes and resources. Implementation of the research results will lead to a better understanding of the connection between transportation infrastructure, policy, and planning with health outcomes and can lead to decision making that advances healthy communities. Maintaining the status-quo on data acquisition, processing and storing methods creates inefficiencies and potential inequities that could be resolved if DOTs and MPOs adopted consistent, systematic methods that will be the outcome of this research. This research will ultimately benefit both state DOTs and MPOs and their constituents through more efficient planning and operations and improved health for their communities.

## **Implementation Considerations and Supporters**

The research results can be used by state DOT transportation planning offices as well as MPOs to monitor transportation and health outcomes and performance-based health assessment of transportation projects to guide funding decisions that promote health. The guidebook will inform the data acquisition process as well as outline management and analysis processes to ensure accurate, reliable, and representative data. For example, it can guide DOTs and MPOs on the types of monitoring programs and surveillance technologies in which they should invest to obtain data on active transportation.

A major step could be involvement of public health experts to facilitate interpretation and integration of health data. This could be achieved via collaboration with state and local health departments. Training workshops on best practices for data collection, analysis and bias removal, and management could be useful for state DOTs and MPOs. This will inform them on actions that need to be taken and caution them on data aspects that need to be considered to achieve reliable data. Some states have already made efforts to incorporate health impacts in their transportation decision making (e.g., MassDOT, VDOT, Tennessee DOT). A few pilot tests in selected states that can be used as case studies to showcase the benefits of a systematic and consistent data inventory could facilitate implementation by other states.

Councils and Committees with an interest in this research:

- AASHTO's: Council on Active Transportation, and its multimodal task force Toks Omishakin, 916-654-5267, [william.segraves@dot.ca.gov](mailto:william.segraves@dot.ca.gov) (assistant); and

Committees on: Safety, Mike Tooley, 406-444-6201; Performance-based Management, Alma Mujkanovic, 404-631-1446; Planning, Kristina L. Swallow, 775-888-7440; Research and Innovation, Melinda McGrath, 601-359-7002

- TRB's AME70 Transportation and Public Health committee, Ed Christopher, Transportation Planning Consultant, 708-269-5237, edc@berwyned.com and Leslie Meehan, Tennessee Department of Health, 615-770-0304, leslie.meehan@tn.gov [Committee Co-chairs]

### **Recommended Research Funding and Research Period**

The funds necessary to achieve the research objectives are estimated at \$400,000 with an additional \$50,000 allocated to training and other technology transfer activities to facilitate implementation of the project findings. Research objectives should be accomplished within 24 months with an additional 6 months for assisting (i.e., training) with initial steps state DOTs and MPOs might take to implement the research.

### **Problem Statement Author(s)**

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- Ipek N. Sener, PhD, Texas A&M Transportation Institute, 512-407-1119, i-sener@tti.tamu.edu
- Laura Sandt, PhD, UNC Highway Safety Research Center, 919-962-2358, sandt@hsrcc.unc.edu

### **Others Supporting the Problem Statement**

TRB's AME70 Transportation and Public Health [see end of 6 for contact information]

### **Potential Panel Members**

- Andy Dannenberg, adannenberg2@gmail.com
- Active Transportation Division, Washington State DOT, Barb Chamberlain, Seattle office: 206-716-1130, Cell/text: 509-869-2949, ChambBa@wsdot.wa.gov
- Massachusetts DOT, Jackie DeWolfe, 857-368-8897, jacqueline.dewolfe@state.ma.us

### **Person Submitting the Problem Statement**

- Melanie Murphy
- 615.252.2158 (office), 615.440.6137 (Cell)
- Melanie.Murphy@tn.gov
- Planning Supervisor, Tennessee Department of Transportation

### **References**

- [1] National Academies of Sciences, Engineering, and Medicine (NASEM). (2019). *A Research Roadmap for Transportation and Public Health*. NCHRP Research Report No. 932. Washington, DC
- [2] Christofa, E., Pollitt, K., Goins, K.V., Lemon, S., Frisard, C., Deliali, A., Esenther, D. & Page, M. (2020). *Public Health Assessment for Transportation Projects*, Massachusetts Department of Transportation Report No. 19-011.
- [3] Lee, K., & Sener, I. N. (2020). Emerging data for pedestrian and bicycle monitoring: sources and applications. *Transportation research Interdisciplinary Perspectives*, 100095.



[4] Lee, K., & Sener, I. N. (2020). Strava Metro data for bicycle monitoring: a literature review. *Transport Reviews*, 1-21.

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## **NCHRP Review of B-27**

Reviewed By: Camille Crichton-Sumners [ccrichton-sumners@nas.edu](mailto:ccrichton-sumners@nas.edu)

### Comments:

Already studied extensively in the health and medicine field, this scope must include privacy, and data collection and storage considerations. If included, along with convening workshops with a varied group of stakeholders, this would increase the budget to 500K and 36 months timeframe.

### Review Date:

12/21/2020

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## **FHWA Evaluation of B-27**

Reviewed By: HEP/Fleming El-Amin

### Comments:

This research problem statement aims to increase understanding of data needs and implementation strategies to support health in transportation planning and operations. The research has potential to add value to FHWA research, however there are a few areas that the authors may wish to consider. Regarding transportation planning and policy, more focus could be given to documenting the process of integrating emerging data sources in the planning process to support health in transportation outcomes. Specifically, highlighting the impact of adjusting active transportation project scoring methodologies (based on the data) in the STIP, TIP, or other planning documents to influence project prioritization. Additionally, more focus could be given to demonstrate how integrating the emerging data sources can inform performance-based planning for health in transportation. Identifying, obtaining and utilizing the data available to make better decisions is the foundation of being good stewards of public investments (through good planning and programming and project delivery). The ability to gather new data and the new data available to make these investment decision is changing and transportation decision making/makers is being asked to change with it. This proposal is an important step in this process of moving to a data and performance based transportation system that is more equitable and resilient. The research problem should include some tasks to highlight how new data sources are informing investment decisions, such as where are people walking or biking to and from, ride hailing pickup/drop-off locations, and multimodal parking areas.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-B-27**

**From:** [email: Melanie.Murphy@tn.gov]

### **Comments:**

#### **FHWA Evaluation of B-27**

Reviewed By: HEP/Fleming El-Amin

#### Comments [FHWA]:

*This research problem statement aims to increase understanding of data needs and implementation strategies to support health in transportation planning and operations. The research has potential to add value to FHWA research, however there are a few areas that the authors may wish to consider. Regarding transportation planning and policy, more focus could be given to documenting the process of integrating emerging data sources in the planning process to support health in transportation outcomes. Specifically, highlighting the impact of adjusting active transportation project scoring methodologies (based on the data) in the STIP, TIP, or other planning documents to influence project prioritization. Additionally, more focus could be given to demonstrate how integrating the emerging data sources can inform performance-based planning for health in transportation. Identifying, obtaining and utilizing the data available to make better decisions is the foundation of being good stewards of public investments (through good planning and programming and project delivery). The ability to gather new data and the new data available to make these investment decisions is changing and transportation decision making/makers is being asked to change with it. This proposal is an important step in this process of moving to a data and performance based transportation system that is more equitable and resilient. The research problem should include some tasks to highlight how new data sources are informing investment decisions, such as where are people walking or biking to and from, ride hailing pickup/drop-off locations, and multimodal parking areas.*

Review Date:  
12/18/2020

#### Response:

We agree that it is important to investigate how these emerging data sources can be integrated and affect transportation planning processes and project scoring methodologies as well as inform investment decisions as mentioned in the 2<sup>nd</sup>

paragraph of the “Background” section. In response to the comment, we propose revising the third sentence of the first paragraph of the “Research Objective” section as follows (changes are shown as underlined text):

- “The guidebook will summarize recommendations for ensuring systematic and consistent data collection, analysis and management approaches across states, bias correction and integration methods of health and transportation data, as well as examples on how such data can be used to inform investment decisions, update project scoring frameworks, and further advance performance-based planning for health in transportation.”

In addition, we propose including an additional item in the described contents of the guidebook (research objective 3) as follows (changes are shown as underlined text):

- Conducting interviews with appropriate parties (e.g. state DOTs, MPOs, and state health departments) to summarize: 1) existing transportation and health data sources, 2) passive data collection techniques for transportation and health data, and 3) management approaches of big datasets (e.g., tools, platforms, updated frequency, personnel background), 4) data usage agreements, 5) level of integration of transportation and health data, and 6) applications of such data to achieve health-promoting performance-based transportation planning and operations including: a) using such data to inform investment decisions based on demand patterns, and b) proposing project scoring criteria and overall changes to decision-making processes, which would not be possible to assess without these emerging data sources, and 7) challenges associated with integrating transportation and health data.

and incorporating such examples of updated project scoring processes and their impact on transportation project health outcomes as part of the 4<sup>th</sup> research objective as follows (changes are shown as underlined text):

- Developing and delivering training material summarizing these recommendations and showcasing a few case studies (including discussion of changes in project prioritization and health outcomes that could occur when new project scoring criteria focusing on improving health are introduced) to facilitate adoption and implementation of the final product.

Finally, similar additions can be made as part of the “Urgency and Potential Benefits” section:

- Implementation of the research results will lead to a better understanding of the connection between transportation infrastructure, policy, and planning with health outcomes and can lead to revised decision making processes that achieve healthy communities.

## **NCHRP Review of B-27**

Reviewed By: Camille Crichton-Summers ccrichon-summers@nas.edu

*Comments: Already studied extensively in the health and medicine field, this scope must include privacy, and data collection and storage considerations. If included, along with convening workshops with a varied group of stakeholders, this would increase the budget to 500K and 36 months timeframe.*

Review Date: 12/21/2020

Response:

We absolutely agree that data collection and storage considerations and privacy are crucial aspects of incorporating these emerging data sources in transportation planning and operations and we had included data storage and privacy previously within the more general term of data management. We understand that these might not have been communicated explicitly throughout the problem statement and propose problem statement revisions as follows (changes are shown as underlined text):

- The last sentence in the first paragraph of the “Background” section could also be revised to include privacy issues: “Other challenges include data accuracy, that could vary based on traffic conditions, weather, or areas being monitored, privacy issues that could arise from passive and crowdsourced data, and data resolution mismatch between transportation and health data sources (e.g., county-level health data vs more disaggregate transportation data).”
- Privacy is mentioned as an issue that has been noted by existing literature (“Literature Search Summary” section): “A preliminary literature review has identified recent research summarizing types of emerging data sources, sampling biases and privacy issues, as well as current applications of such data for non-motorized travel [3, 4].” Data collection (e.g., technology types to obtain such data) and data storage issues (e.g., formatting, storing, and sharing) are identified as areas lacking best practice guidelines and would be the focus on this proposed research; yet the last sentence in the “Literature Search Summary” section could be revised to explicitly include “privacy” as follows: “However, there is a lack of understanding on best practices for acquiring (e.g. technology types), managing (e.g. formatting, storing, sharing, privacy protection), processing (e.g. cleaning, filtering), and integrating (data fusion of transportation and health data) for use in state-level transportation planning and policy decisions.”
- The second research objective could be revised to explicitly mention data storage and privacy as part of bullet 3: “management approaches of big datasets (e.g., tools, storage platforms and formatting, privacy protection, updated frequency, personnel background).”
- In the “Urgency and Potential Benefits” section, the fourth sentence could be changed to include privacy issues: “This will include guidelines on types of technologies that can be used for data collection as well as appropriate methods for storing, analyzing, managing, and maintaining privacy of such data.”

- In the “Implementation Considerations and Supporters” section the second sentence could be revised as follows: The guidebook will inform the data acquisition process as well as outline management and analysis processes to ensure accurate, reliable, and representative data and protect privacy.

Given the additional recommendations that pertain to integration of emerging data sources with project prioritization frameworks as suggested by the other reviewer as well as the additional emphasis on outlining privacy issues and solution for such data, we agree that the budget could be increased to \$500,000 and the duration to 36 months.

**Contact Info:** Melanie.Murphy@tn.gov  
(o): 615-253-2158  
(c): 615-440-6137

**Review Date:** 1/26/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-B-28**

**Problem Title:** A Best Practices Handbook for Overcoming Just-In-Time Delivery Challenges

**Background**

Every day, and increasing throughout the years, almost 60 million tons of freight, worth \$40 billion, moves through the transportation system in the United States. This underscores how having effective and efficient goods movement is essential to our economy and society. The market for goods movement is changing and the importance of the integration of freight needs with other partners in the evolving, complex communities is changing the ways freight needs to be planned within livable communities. The current surge in on-demand delivery, under pressure from e-commerce, is increasingly impacting the shipping industry, leading to technological, organizational, and behavioral transformations. The shipping industry is adjusting to changes in consumer demand by adopting the “just-in-time” (JIT) delivery model, a concept originated by Toyota Motor Company in Japan.

The traditional model where items are created to meet demand rather than producing it in surplus, or in advance of need, is no longer feasible. Consumers, like businesses and customers, have grown to expect items delivered immediately upon demand. The rise in JIT delivery favors trucks due to their flexibility using roadways, in comparison to rail and water, to reach business and customer doorsteps. Adopting the JIT delivery model allows short-production runs, reduces warehouse costs, improves order accuracy, and frees up cash flow. It also unlocks new opportunities in technological innovation, including tracking technology and increased use of connected mobile technology by customers. These innovations have fostered the creation of new enterprises and business models in the logistics sector. At the same time, the rise in JIT delivery creates a range of challenges to the shipping industry because of smaller and more frequent shipments. First, the reliance of JIT delivery on trucks is reflected in the mode’s exponential market growth and contributes to roadway congestion. Second, the short delivery windows of JIT delivery results in a greater number of trucks hauling smaller commodities and operating underutilized, which tends to increase total fuel consumption.

In contrast, however, many communities that have experienced the JIT delivery model are not aware of the unique needs and challenges. This lack of knowledge may impact multiple direct and indirect stakeholders who have diverse needs, perceptions, objectives, constraints, and experiences relating to JIT delivery. Stakeholders include: (1) elected officials and local governments, (2) transport agencies (e.g. FHWA, state DOTs, and MPOs), (3) private-sector freight (e.g. beneficial cargo owners, logisticians, motor carriers, industrial real estate developers, and chambers of commerce), (4) economic development agencies that assist governments in sustaining and increasing economic

activity and work closely with freight companies that are expanding, launching, or relocating, (5) environmental, air quality, or community groups who wish to be engaged in planning, programming, and environmental review and the permitting process, and (6) general public. An effective and efficient JIT delivery is a challenge that cannot be tackled by stakeholders in isolation; rather, the needs and challenges of the JIT delivery must be viewed as an integrated system. Identification of JIT delivery enables decision makers to have an in-depth grasp of the issues and provide effective and efficient freight transport considering the limitations. As many uncertain events happen in the real world, JIT delivery planning goals may not be met as expected, including the strain the US economy is experiencing with the COVID-19 2020 pandemic.

There is a need for a “Best Practices Handbook” to help stakeholders understand and effectively integrate JIT freight delivery trends, dynamics, and forecasts into decision-making on topics that directly affect communities’ economic vitality, sustainability, and quality of life. This handbook would do more than simply explain how JIT delivery works. Rather, it would provide examples of effective approaches for planning and design to ensure meaningful socio-economic benefits across America.

### **Literature Search Summary**

In recent years, the shipping industry is increasingly under pressure from the expanding volume of online purchases and growing customer expectations for the delivery performance. In this highly competitive setting, the ubiquity of communication technologies, accessibility of information, flexibility of resources in time and space, and the open source revolution have facilitated the evolution of JIT delivery. The burgeoning JIT delivery market has fueled the interest of researchers to examine the distinctive dimensions of the system. Studies have tackled the JIT delivery model from the three pillars of supply, demand, and operations and management and has explored three research domains. The first domain introduces the business model analysis and evaluates the potential growth of this business in the freight market. The second domain describes the benefits and weaknesses of JIT delivery model. The third domain looks at JIT delivery as an opportunity to respond to the evolving e-commerce marketplace, and formulates and solves logistic optimization problems.

Studies have shown that the JIT delivery model has the potential to supply different client categories such as consumer-to-consumer (C2C), business-to-consumer (B2C), business-to-business (B2B), and consumer-to-business (C2B) for reverse logistics. The companies, however, have shown a growing interest in the B2C and B2B markets. As JIT business models increasingly penetrate the market, there is an urgent need to investigate their needs and challenges and to develop effective strategies to boost their delivery performance and counteract negative consequences. In contrast, the knowledge of the fundamental functioning and levers for improvement at the system level is still rudimentary and little is known about the unique needs and challenges of JIT delivery and how stakeholders should handle this evolving model. Importantly, stakeholders face unique challenges when experiencing the JIT delivery model. As interaction between stakeholders is increasing, their cooperation and collaboration needs to be assessed by the system coordinators. This assessment translates into knowledge creation as it assists calibrating logistical capabilities and implementing evidence-based initiatives.

### Technical Reports and Books

- US Department of Transportation, National Freight Strategic Plan 2020.
- National Academies of Sciences, Engineering, and Medicine 2019. Impacts of Policy-Induced Freight Modal Shifts. Washington, DC: The National Academies Press.
- National Academies of Sciences, Engineering, and Medicine 2015. Improving Freight System Performance in Metropolitan Areas: A Planning Guide. Washington, DC: The National Academies Press.
- National Academies of Sciences, Engineering, and Medicine 2013. Integrating Freight Considerations into the Highway Capacity Planning Process: Practitioner's Guide. Washington, DC: The National Academies Press.
- National Academies of Sciences, Engineering, and Medicine 2012. Guidebook for Understanding Urban Goods Movement. Washington, DC: The National Academies Press.

### **Research Objectives**

The objective of this research is to develop the best practices handbook to identify, explore, and address challenges with JIT deliveries. This includes categorizing stakeholders and the impacts of JIT delivery on them followed by a catalog of practical solutions. When surveying or reviewing to capture information, a distinction must be made for four types of businesses: (1) businesses that must make off-peak deliveries, (2) businesses that deliberately make off-peak deliveries, (3) businesses that could make off-peak deliveries given the right incentives, and (4) businesses where off-peak deliveries are not a feasible option for them. The research tasks should consist of, but not be limited to, the following.

- **Define JIT Delivery and Identify Impacted Stakeholders:** Explain JIT delivery, types of JIT delivery (Business-to-Business [B2B], Business-to-Consumer [B2C], etc.), and the importance of JIT delivery by each sector (health, food, e-commerce, etc.). Identify the stakeholders (public sector, private industry, communities) and the impacts of JIT delivery on these stakeholders.
- **Investigate Challenges from the Stakeholder's Perspective:** Study the challenges of JIT delivery from the stakeholder's perspective (diverse interviews), examine the barriers for JIT delivery, perform an in-depth analysis of impacts, broadly categorize the challenges (communication, parking, security, NIMBY, etc.) and identify the possible solutions (engineering, policy, outreach, technical, planning). Explore the variations in JIT delivery and issues by sector or industry.
- **Explore Best Practices:** Perform a review of best practices to solve the issues arising from JIT delivery, categorize best practices based on their implementability and effectiveness. The best practices should cover examples from various sectors (health/medical, food/perishables, mail/e-commerce parcels, etc.). Present up to two case studies where the JIT delivery challenge was addressed effectively for various stakeholders.



- **Recommended Solutions:** List all the challenges and possible solutions. Prioritize the solutions based on their scale, cost, effectiveness, and overall impact with clear identification of Most Viable Product (MVP) for each challenge. Also, acknowledge the short-term and long-term limitations of the solutions.

### **Urgency and Potential Benefits**

With the development and increase in e-commerce, consumer demands mixed with increased efficiency in the modern freight distribution and logistics industries has created a patchwork of JIT strategies. Industry and the public sector do not have a unified front for addressing consumer demands and yet rely on each other for information and infrastructure to distribute necessary commodities.

E-commerce and the need for JIT delivery has risen during the COVID-19 2020 pandemic shutdowns; meanwhile the nation has witnessed how inability to deliver goods has taken months to return to normalcy. Evidence showed how a lack of collaboration between the public sector and industry with those who can support just-in-time delivery impacts businesses and consumers.

Without understanding JIT delivery challenges, communities, along with federal, state, and local Departments of Transportation (DOTs) will continue to face burdens and societal conflicts. The critical function of State DOTs is the safe and efficient movement of goods and people - this is essential for communities. By ensuring that they and industry can proactively deliver infrastructure and technology solutions that address existing barriers, the DOTs can remove one level of strain on communities. The benefits of this work will be most directly be felt by state DOTs, the general public, and the freight industry. Benefits of using the proposed handbook will specifically be:

- Identification of successful practices that work to remove barriers and enhance JIT delivery to result in greater reliability, safety, and security to support economic growth.
- Identification and prioritization of “low-hanging fruit” to provide a list of actions that can be implemented that industry, in collaboration with the public sector, deem important to address quickly.
- Businesses will benefit by increasing reliability to their consumers.
- Consumers and the general public will benefit from increased access to goods for all communities as well as a documented understanding of JIT operations.

### **Implementation Considerations and Supporters**

This research will develop a handbook to identify, explore, and address challenges with JIT deliveries. This handbook will allow state DOTs, and their partnering agencies at the local and state level work with communities to better understand and mitigate JIT delivery challenges, and their impact on community infrastructure.

### **Recommended Research Funding and Research Period**

- Recommending \$350,000 for 18-month period.

### **Problem Statement Authors**

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- Heather Monteiro, Owner and Director of Research and Data Science, Hickory Ridge Group LLC. Email: heather@hickoryridgegroup.org; Phone: (702) 530-7719.
- Sushant Sharma, Associate Research Scientist, Texas A&M Transportation Institute. Email: s-sharma@tti.tamu.edu; Phone: (817) 462-0508.

### **Others Supporting the Problem Statement**

- Sponsoring Committee: AT025 - Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
- AASHTO, Special Committee on Freight, Caroline Kieltyka, 202-624-8489, ckieltyka@aashto.org

### **Potential Panel Members**

- Casey Wells, Texas DOT, Casey.Wells@txdot.gov
- John Tompkins, Minnesota DOT, john.tompkins@state.mn.us

### **Person Submitting the Problem Statement**

- Casey Wells, Texas DOT, Casey.Wells@txdot.gov
- John Tompkins, Minnesota DOT, john.tompkins@state.mn.us

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### **NCHRP Review of B-28**

#### Reviewed By:

William C. Rogers  
wrogers@nas.edu

#### Comments:

This would be a useful project just by looking at the impact of the pandemic on JIT through a series of case studies.

#### Review Date:

12/22/2020

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## **FHWA Evaluation of B-28**

Reviewed By: HOFM/Chip Millard

Comments:

The Freight Office supports this proposed research initiative; it would provide a comprehensive view of Just-In-Time delivery challenges and requirements from all of the key stakeholders' points of view and identify ways stakeholders could better coordinate with one another on these requirements. The Freight Office recommends the "private sector freight" stakeholder group identified in the background section be broken down into multiple, distinct groups, specifically 1) beneficial cargo owners (buyers of the goods), 2) cargo shippers (producers or sellers of the goods), 3) freight carriers, and 4) other private sector stakeholders.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for B-28**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 8

Comments: N/A

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number:** 2022-B-29

**Problem Title:** Communicating the Value, Interactions, and Impacts of Freight to Stakeholders

**Background**

Freight is a critical component of the national and international transportation system, though its importance is not always recognized. Over 51 million tons of goods valued at nearly \$52 billion are moved every day through U.S. highways, railways, waterways, airports, and pipelines,<sup>22</sup> and freight shipments are projected to increase by 22 percent over the next 20 years.<sup>23</sup> The relevance of the freight transportation system is further accentuated by increasing e-commerce: deliveries to households in an average month doubled between 2009 and 2017.<sup>24</sup> Despite the importance of freight to local communities and the economy, many planning, transportation, and government professionals and the general public do not understand its value, its connection to land use and other transportation uses, or how best to address impacts of the freight system.

Many local and regional planning and transportation initiatives focus primarily on the movement of people, without adequate consideration of the movement of goods. With increasing urbanization and changing technologies driving both growing freight volumes and disruption of the transportation system, it is imperative for freight officials to effectively communicate the importance of freight to stakeholders and the general public. While there are some resources and toolkits available to support freight professionals with implementing specific freight strategies, resources are needed to improve public dialogue about the importance, impacts, and interconnectedness of freight with our day-to-day lives to make visible, and understandable, a part of our transport system that sometimes goes unnoticed.

The proposed project would provide DOTs, MPOs, and local agencies with visually-engaging and research-based resources, such as factsheets and presentations that identify why freight is important and provide examples of how jurisdictions have effectively communicated the role of freight in their communities. By considering the impacts of freight as part of the transportation system, planners, engineers, elected officials, and other stakeholders will all be able to maximize the efficiency of the transportation system and minimize the negative impacts of freight on their community.

**Literature Search Summary**

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<sup>22</sup> Bureau of Transportation Statistics, “Freight Facts and Figures,” <https://www.bts.gov/product/freight-facts-and-figures>.

<sup>23</sup> National Freight Strategic Plan, 2020, <https://www.transportation.gov/freight/NFSP/fullreport>

<sup>24</sup> U.S. Department of Transportation: Transportation Statistics Annual Report 2018, <https://rosap.ntl.bts.gov/view/dot/37861>

While there is a well-developed body of research on freight, most research in recent years has focused on implementation strategies and analysis tools, rather than more fundamentally focusing on why these solutions matter and “telling the freight story.” Previous research projects have made substantial inroads in developing tools and technical resources to deepen the knowledge base of freight transportation professionals. This research has not, however, provided freight professionals and general planning professionals with resources on why they should invest in developing this technical expertise or why they should incorporate freight into their planning and construction projects. This work would build upon, and add context for, the importance of these prior efforts (including, but not limited to):

- NCHRP 08-106, which provides tools to facilitate urban freight management strategies.
- NCHRP 08-111, which provides guidance for improving system performance and land use.
- NCHRP 08-134 (on-going), which will provide a toolkit to integrate freight improvements.

To develop precedents for best practices in freight communication, the following state and regional plans also provide context for location-specific solutions:

- Florida Freight and Mobility Trade Plan  
<https://www.fdot.gov/rail/plandev/freight-mobility-and-trade-plan>
- Montana Freight Plan <https://mdt.mt.gov/freightplan/>
- Delaware Valley Regional Planning Commission’s Freight Planning Program  
<https://dvrpc.org/webmaps/phillyfreightfinder/freight-center-story.html#>
- New Jersey Transportation Planning Authority  
<http://www.njtpa.org/Planning/Regional-Programs/Freight.aspx>
- Trucking Association of New York: The Voice of Trucking  
<https://www.nytrucks.org/>
- Minnesota Manufacturer’s Perspectives <http://www.dot.state.mn.us/mps/>

This research will create tools that communicates the value, interactions, and impacts of freight in one suite of visually engaging, accessible, and informative products.

## **Research Objective**

The objective of this research is to present resources and best practices for public-sector practitioners, including:

- Conducting a comprehensive literature review to document the economic, equity/environmental justice, and infrastructure impacts of freight, including but not limited to:
  - Freight impacts on non-motorized traffic in major urban areas, and conflict between user groups on streets and at the curb.
  - Land use decisions and policies on freight pickup and delivery needs, including, but not limited to, alley network development and preservation; off-street or actively managed curbside loading and unloading zones for postal, freight, ride-sharing, and waste collection; and connections to intermodal facilities, like ports, airports, and rail facilities.

- Methods of integrating freight with passenger modes including transit, transit hubs, ride-share services, bike and scooter sharing, and freight-multimodal centers.
- Developing a briefing book and corresponding factsheets for the public, elected officials, and public-sector practitioners, ranging from staff level to director level, on the impacts of freight, the interaction of freight and the community, and the need to consider freight in community development and policy decisions.
- Documenting case studies that tell the stories of specific regions with differing geographies (e.g. urban, suburban, rural) and industries that enable other agencies to apply lessons learned.
- Creating a series of short (two-minute maximum) videos or animation/motion graphics to explain the role of freight for presentation and online use.

### **Urgency and Potential Benefits**

With few exceptions, freight-accommodating infrastructure design and community land use decisions have traditionally been addressed exclusive of each other, despite their relationship and collective economic impact. This divide often creates challenges for freight professionals and other transportation officials to effectively communicate about why freight matters and how freight vehicles, non-freight vehicles, and non-motorized traffic can coexist in major areas.

This project is expected to provide the following benefits:

- Foster the application of effective and innovative strategies from this and other research by public practitioners to “think bigger” about the impacts on freight on transportation and land use.
- Enable elected and appointed officials to make sound planning and capital investment decisions for the mutual benefit of freight and communities.
- Provide resources to fill the decision-making gaps between freight impacts, infrastructure design, and land use decisions.
- Improve the safety of freight vehicles, non-freight vehicles, and non-motorized traffic by encouraging the inclusion of freight where appropriate.
- Strengthen the capacity of state DOT staff involved in freight planning and decision making.
- Strengthen the effectiveness and role of freight advisory committees in DOT decision-making.

### **Implementation Considerations and Supporters**

This research will help freight professionals at DOTs, MPOs, and local governments communicate the value and impacts of freight in conversations with planners and transportation officials who do not specialize in freight, with elected officials, and with the general public. It will also serve as a resource for public sector professionals who do not specialize in freight but may need to consider freight on a particular project.

### **Recommended Research Funding and Research Period**

\$350,000 and 24 months

**Problem Statement Author(s)**

| <b>Name</b>    | <b>affiliation</b>                             | <b>phone</b>          | <b>email address</b>         |
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**Others Supporting the Problem Statement**

- Sponsoring Committee: AT025 - Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
- Co-sponsoring TRB committee: AT015 – Standing Committee on Freight Transportation Planning and Logistics, Sushant Sharma (Chair), s-sharma@tti.tamu.edu
- AASHTO Special Committee on Freight, Caroline Kieltyka, AASHTO Program Manager for Freight, ckieltyka@aaashto.org

**Potential Panel Members**

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- John Tompkins, Minnesota DOT, john.tompkins@state.mn.us
- Alisha Pena, Port of Tacoma
- José Holguin-Veras, Rensselaer Polytechnic Institute, holguj2@rpi.edu
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- Mike Browne, University of Gothenburg, michael.browne@gu.se

**Persons Submitting the Problem Statement**

Casey Wells, Texas DOT, Casey.Wells@txdot.gov

John Tompkins, Minnesota DOT, john.tompkins@state.mn.us

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**NCHRP Review of B-29**

Reviewed By:  
William C. Rogers  
wrogers@nas.edu

Comments:

The National Cooperative Freight Research Program (NCFRP) published numerous reports on this subject, but they were completed at least 10 years ago, and before ecommerce and massive home deliveries were even contemplated. It would be good to update the importance of freight in a new handbook.

Review Date:  
12/22/2020

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**FHWA Evaluation of B-29**

Reviewed By: HOFM/Tiffany Julien

Comments:

The freight office strongly supports this research and the value in communicating the interactions and impacts of freight to stakeholders. This work will further support the encouragement of State Freight Advisory Committees development and engagement, and their efforts to articulate freight transportation needs and projects to DOTs, MPOs, and local governments.

Review Date:  
12/18/2020

**AASHTO Committee Evaluation for B-29**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 1

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-30**

**Problem Title**

COVID-19's Influence in Shaping E-commerce and Its Last-mile Impact

**Background**

Growth in online shopping over the last decade has drastically changed household shopping behavior. It is not only altering household consumption patterns but is also influencing the entire supply chain in terms of how freight moves from producers to consumers. Pre-COVID, online shopping predominantly involved occasional discretionary purchases such as electronics, books, furnishings etc. With the onset of COVID-19 (see Figure 1), households are increasingly using online platforms not only for their discretionary purchases but also for household maintenance. This shopping behavior exhibited by households could be short term or could substitute, or complement, in-store shopping over the long run<sup>25</sup>. This could have a significant impact on the urban road network due to the characteristics of the last-mile deliveries in terms of vehicle types, their trip frequencies and timing of such deliveries.

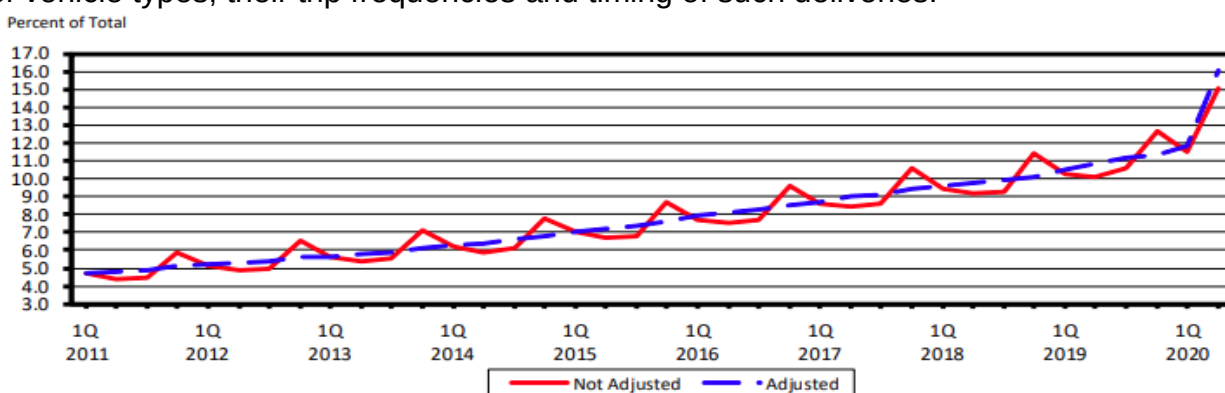


**Figure 1 : Estimated Quarterly U.S. Retail E-commerce Sales as a Percent of Total Quarterly Retail Sales  
(Source : US Census)**

This potentially-significant impact on the roadway network results because in-store maintenance shopping tends to be far more frequent than an occasional discretionary purchase, and often is fulfilled by households making trips to neighborhood stores. Further, the convenience of shopping online leads households to make more frequent and smaller shipments<sup>26</sup> resulting in additional last-mile trips compared to in-store maintenance shopping that are often pre-planned. In addition to the trips for deliveries across the two purchase modes, the rate of returns and replacement for online

<sup>25</sup>[FMI and Nielsen: 70% of consumers will be grocery shopping online by 2024.](#)

<sup>26</sup>[How increasing e-commerce is changing LTL freight](#)

shopping tends to range anywhere between 13-30%, compared to in-store shopping being around 8%. This has led to an increase in a phenomenon referred to as “reverse logistics,” which adds additional miles on urban road networks for product returns. In general, last-mile trips resulting from online shopping could be either made by the household or businesses based on households’ delivery choices: *pick from store or lockers, a delivery service or a third-party shopper/service*. These trips could be made using a range of vehicle modes including bikes, passenger cars or single-unit delivery trucks.

The above discussed how changes in household consumption patterns are altering existing supply chains. As per American Transportation Research Institute (ATRI)<sup>27</sup>, there has been a significant drop in average length of long-haul truck trips with a simultaneous increase in the number of intra-urban truck trips, along with increase in registrations for single-unit trucks. There have also been noticeable shifts on the land use side as well, with historically-retail locations being transformed into industrial sites to be used as fulfillment centers by retailers<sup>28</sup>. It is being pursued with the intent for major online retailers to use these centers to enhance their supply chain to improve delivery times. The adverse impact on urban transportation networks resulting from the above discussed changes is likely to continue and potentially accelerate post COVID-19<sup>29</sup>. It might not be evident during this pandemic, but could deteriorate even further with resumption of pre-COVID activities (e.g., resumption of work and school activities). It is difficult to evaluate the impact from these change in household consumption patterns unless it is well understood and quantified. Thus, this research proposes to develop a scenario-planning tool to estimate the extent of personal and commercial travel resulting from household e-commerce activities through synthesis of multiple data sources ranging from surveys to emerging big data sources.

### **Literature Search Summary**

E-commerce has significantly transformed business to business (B2B) and business to consumer (B2C) services over the past decade. Literature has extensively examined their notable impacts across social, economic, technological and environmental sectors<sup>30</sup>. In the B2C realm, studies have predominately focused on the potential substitution of personal travel with commercial travel to fulfill B2C activities during the last mile. In general, these studies suggest that the substitution between personal and commercial travel results in lower last-mile trips, with the latter likely to be optimized by the shipper based on their delivery schedule. This might not always be the case, as a growing number of independent logistic players entering into the market providing last-mile logistics operate with poor vehicle utilization rate, as was observed in the UK<sup>31</sup>. This is likely occurring in the US as well, as is apparent from the increase in the number of intra-urban truck registration discussed in the previous section. In addition to the above, within an urban context, the above changes in last-mile services are also likely

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<sup>27</sup> E-Commerce impacts on the trucking industry, ATRI (2019)

<sup>28</sup> [U.S. Market Flash: Retail-to-Industrial Property Conversions Accelerate, CBRE \(2020\)](#)

<sup>29</sup> [The future of last mile ecosystem, World Economic Forum \(2020\)](#)

<sup>30</sup> The Impact of E-Commerce-Related Last-Mile Logistics on Cities: A Systematic Literature Review (2020)

<sup>31</sup> Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: the case of London (2020)

resulting in additional trips being made between distribution and fulfillment centers being placed in the proximity of the urban areas.

Further, on the demand side, household shopping decisions tend to be more nuanced than their broad treatment of being online vs. in-store. This has become more relevant and evident with the onset of COVID-19. Specifically, households during the initial years of E-commerce primarily used the online platform to make discretionary purchases. As identified in literature, these purchases potentially compete with in-store shopping at a regional mall. In this context, household's decision could be influenced by not only their motivation to pursue shopping but also to participate in entertainment activities (dining, movie etc.). In contrast, maintenance shopping tends to be more frequent, and is motivated by the need for essential goods, which often is pursued as an intermediate stop during a commute. The literature identified about a third of commuters make such a stop on their daily commute across a couple of US metro areas. The substitution of these trips likely could have a significant impact based on how these trips are being replaced and its magnitude. Further, these trips are likely to be made during the weekday compared to those made predominately during weekend for discretionary purchases. In terms of the delivery mode, the potential substitution could either involve curbside pickup or home delivery, which could further alter the existing urban travel patterns. Thus, a household's decision to shop online across the above-mentioned motivations might be distinct not only in terms of how the good is accessed during the last mile, but also in terms of what they shop for, and how it is fulfilled by businesses. Thus, it is essential to segment out these household shopping choices prior to understanding the influence of e-commerce on them, and their resultant impact on urban transportation network. Specifically, to what extent are these choices influencing the trips to be made by household and commercial vehicles. Importantly, the above-discussed factors could have distinct spatial and temporal impacts on an urban transportation network. This calls for further assessment through understanding how household shopping choices and associated travel has evolved prior to their quantification.

### **Research Objective**

From the above perspective, the objective of this research is to develop a quick response scenario-planning tool. This tool would provide practitioners (State Department of Transportation and partnering agencies) with the ability to analyze potential shifts in vehicle-miles traveled (VMT) resulting from changes in household shopping patterns in a given region. Specifically, it would provide metrics on the vehicle-miles traveled in a given region segmented by those made by commercial and personal vehicles to fulfill household shopping needs. It could be used to analyze scenarios such as the extent to which the personal VMT could be replaced by commercial VMT across an urban network in scenarios such as the COVID-19 pandemic.

This objective would be pursued over two phases. The first phase of this research focuses on undertaking a meta-analysis of existing literature to assess the evolution of household shopping behavior and its influence on urban freight movement. The intent of this phase is to draw insights from existing literature to develop a methodological

framework to quantify vehicular impacts from changing household consumption patterns on a given region's roadway network. In the second phase, the insights drawn from the literature and exploratory analysis would be used to develop a data structure and scenario analysis tool. This tool would be developed from the perspective of household consumption patterns and their life-cycle stage. For example, millennials may use the online option far more frequently compared to baby boomers. Further, their rate of adoption of a new medium (channel) could be distinctly different as well. Alternatively, a household with a single parent being more time constrained might choose to shop online rather than shop in-store. This tool can be used for analyzing varied policy scenarios (from changing household composition/socio-demographics as introduced above to relocation of business/services in the area) to inform infrastructure investment decision-making.

Importantly, the tool could be used to quantify the changes in trip distribution patterns, and associated VMT to fulfill the shopping needs of the population of any given region. This would be developed by using multiple data sources ranging from surveys to emerging passive data sources. In addition, this tool would be accompanied by a reference handbook that would provide details on procedures to undertake an analysis. Specifically, it would discuss the data needs, input parameters and caveats that need to be considered to understand the analysis outcomes. This research intends to develop this tool to scale, such that it could be used for any each region with input datasets that are accessible and available over time.

### **Urgency and Potential Benefits**

E-commerce has been drastically changing our daily lives, mostly enhancing our quality of life. More-so, in the current pandemic, it has been very useful in terms of being able to deliver essential goods to households. However, along with it also comes numerous adverse effects, one of them being the additional commercial VMT on urban road networks and associated negative externalities on society and the environment. Therefore, one might want to quantify this impact to inform policy-making decisions. To this effect, this tool can assist practitioners to analyze potential impacts under different scenarios, such as the extent of commercial and personal miles traveled for shopping during this pandemic.

This tool is not limited to just the above specific use cases. With travel for shopping being a derived demand, resulting from a household's desire for consumption. An understanding of the distinct shopping behavior across different population groups could help practitioners evaluate how it could shape their regions' personal and commercial travel over time. This tool, and its outputs, could be used for a variety of "what-if" analyses, and to evaluate its influence on a given region's network travel times, pavement condition and overall environment. These insights would be valuable for policy makers and analysts to plan for future infrastructure investment needs given the changing consumer behavior.

### **Implementation Considerations and Supporters**

This research proposes to develop a scenario-planning tool to estimate the extent of personal and commercial travel resulting from household e-commerce activities through synthesis of multiple data sources ranging from surveys to emerging big data sources. These insights will be valuable for policy makers and analysts to plan for future infrastructure investment needs given changing consumer behavior. The tool will also allow state DOTs and their partnering agencies a way to evaluate “what-if” scenarios to assess the travel impact on the urban infrastructure.

### **Recommended Research Funding and Research Period**

Research Funding: \$500,000

Research Period: 24 months

### **Problem Statement Author**

Vijayaraghavan (Vijay) Sivaraman

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### **Others Supporting the Problem Statement**

- Sponsoring Committee: AT025 – Standing Committee on Urban Freight Transportation, Bill Eisele (Chair), b-eisele@tti.tamu.edu
- AASHTO, Special Committee on Freight, Caroline Kieltyka, 202-624-8489, ckieltyka@aashto.org

### **Potential Panel Members**

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- John Tompkins, Minnesota DOT, john.tompkins@state.mn.us

### **Persons Submitting the Problem Statement**

- Casey Wells, Texas DOT, Casey.Wells@txdot.gov
- John Tompkins, Minnesota DOT, john.tompkins@state.mn.us

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## **NCHRP Review of B-30**

### Reviewed By:

Lawrence D. Goldstein

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### Comments:

The changes incurred in response to the pandemic and its effect on online shopping behavior and delivery is significant; however, the timeline for this study would result in output in a, hopefully, different environment. What is really necessary is to look at current effects and examine how these might evolve into long-term changes, and how alternate scenarios might have an impact on logistics. How to incorporate these potential changes into long-term transportation planning is also the subject of several

studies currently underway. Coordinating a work plan for this study with the research subjects of other studies is critical to the success of this proposed study.

Review Date:  
12/14/2020

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### **FHWA Evaluation of B-30**

Reviewed By: HPTS/Heather Rose; HPPI/Patrick Zhang

Comments:

Project is significant as Covid may have escalated ecommerce and at home delivery emerging trends. As more businesses allow teleworking and more people prefer online shopping, personal vehicle VMT includes driving to work, and shopping will be reduced permanently after the pandemic. Consequently, the share of VMT for commercial vehicles will increase. It is necessary to quantify the changes in trip distributions. A tool as proposed using multiple data sources to project those changes by region helps state and local transportation agencies.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for B-30**

Submitted By:  
Caroline Kieltyka  
AASHTO Staff  
Special Committee on Freight

Priority #: 5

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-B-31**

**Title:** United States Army Corp of Engineers Section 404 Permit Decision Matrix

**Background** – Any work that requires discharge of dredged or fill material into Waters of the United States requires a Section 404 of the Clean Water Act permit from the United States Army Corps of Engineers (USACE). The USACE has 45 District offices that are defined geographically by watershed boundaries. On the other hand, transportation projects are administered geographically by the respective state border by a state's Department of Transportation.

There are three types of 404 permits under Section 404 of the Clean Water Act (33 U.S.C. 1344): Nationwide, Regional, and Individual. Individual permits are required for potentially significant impacts to the environment. Regional and Nationwide Permits have minimal impacts to the environment. As of 2017, there are 54 Nationwide Permits to be used by all 45 USACE Districts. Each Nationwide Permit is for a different type of activity, has a maximum amount of impact that is allowed, general conditions, regional conditions, state specific Water Quality Certification General Conditions, if issued. Furthermore, certain Nationwide Permits require a Pre-Construction Notification if the impact meets a certain threshold. A Pre-Construction Notification requires the permittee to coordinate with the USACE. If a project meets a Nationwide Permit applicability, and does not require a Pre-Construction Notification, then the applicant must document the type of permit in the project folder and no coordination with USACE is required. If a state did not certify that the discharge will comply with the water quality standards of the state for a Nationwide Permit then the permittee must receive an individual Water Quality Certification from the state in order to use that Nationwide Permit.

It is a challenge for staff from the state DOTs, local government entities (counties, villages, cities, towns), and consultants to understand the permitting process and all of the general, regional, and state specific Water Quality Certification conditions, when a Pre-Construction Notification is required or not, or when an individual Water Quality Certification is required, etc.

The software program will allow the 404 permittee to determine which, or if, the project qualifies to be processed under a Nationwide Permit, which Nationwide Permit applies to the work, the general conditions that must be met, the regional conditions that must be met, if a Pre-Construction Notification is required. The software program will also determine if the state has issued, or not issued, a Water Quality Certification for the Nationwide Permit the project qualifies for. If the Water Quality Certification was issued the software program will indicate the appropriate state specific Water Quality Certification General Conditions. The software program would make all of the USACE

Districts more consistent and it will standardize the Nationwide Permit process for all State personnel, local public government agency personnel, and consultants working for State DOTs using a web-based, interactive online tool/program. This will benefit the development and permitting process for Highway, Transit, Rail, Airports, and Freight transportation projects.

Due to the variations between states in how the 404 and Water Quality Certification is set up it was determined that the database should be developed for one or two states. Once all issues are resolved then the database could be expanded to include additional states.

This study supports AASHTO Committee on Environment and Sustainability 2018 strategic plan by collaborating with internal and external stakeholders to seek a solution to an existing problem faced by members and by providing technical support to members in order to increase the members capacity to efficiently and reliably deliver environmentally sound transportation programs and services.

**Literature Search Summary** - The TRID and RIP databases were searched and only one current project was found that is similar. The project is titled, 'Improving SCDOT Project Delivery Through Identifying Potentially Suitable Locations for Mitigation and Standardizing 401/404 Permit Application Process' (2018-09-01). This project only benefits SCDOT and this project would not standardize the Nationwide 404 Permit application process for all states.

**Research Objective** - The Objective is to develop a software program for one or two states that will clearly guide the permittee to make appropriate determinations based on the USACE conditions. Once the database has been set up and is functioning properly then it would be extended to other states. This application would result in more efficient and standardized processing of transportation improvement projects.

**Major Tasks:**

Develop a software program that would

1. determine which USACE district the project would occur in.
1. determine if the project would fit within any of the 54 Nationwide Permits.
  - If yes, the program would determine if a Pre-Construction Notification is required or not and tell the permittee the General and Regional Conditions.
  - If no, then the program would indicate the permittee needs to contact the USACE.
2. Based on the program's determination of the appropriate Nationwide Permit, the program would determine if the project has an applicable Water Quality Certification
  - If yes, the program will indicate the applicable Water Quality Certification General Conditions.
  - If no, the program will indicate to contact the applicable state agency to apply for an individual Water Quality Certification.
3. The database would produce a .pdf stating the
  - type of permit the project fits within,
  - the USACE 404 general and regional conditions,



- if Water Quality Certification has been issued and the applicable general conditions of the Water Quality Certification, and
- if the USACE requires a Pre-Construction Notification.

**Urgency and Potential Benefits** – The research objectives will allow adherence to the Clean Water Act while saving time and confusion for State DOT personnel, local public agencies, and their consultants. It will also save time for USACE personnel. This research will remove the confusion, and learning curve, that exists around the different 404 permits, general and regional conditions, and the Water Quality Certification General Conditions; thus, making the many USACE districts more uniform in permitting, as well as saving time and money for all State DOTs and local public agencies. If the project was not funded then personnel will be left with the current confusion, lack of understanding, and ensuing delays that currently exists.

**Implementation Considerations and Supporters** - Anyone applying for a USACE 404 permit would use the research results. The only step a state DOT would need to take to use the research results is the website of the program/database. The program would be user friendly and walk the user through the 404 permitting process. If USACE approves, the database could be posted onto USACE's website for users to gain access. A mass email could go out to all state DOTs regarding the database and where the database is located. One issue is who will maintain the database once it is created and who will fund the maintenance of the database. The entity that maintains this database would need to update the database every time the nationwide permits are renewed. Historically, this occurred every five years. The Environmental Process Subcommittee is interested in the research results.

### **Recommended Research Funding and Research Period**

Recommended Funding: The study is expected to involve the equivalent of two professional staff for 18 months each at a rate of \$200 thousand per year and software cost, for a total of or \$650 thousand overall.

Research Period: Two years total.

### **Problem Statement Author(s)**

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- Daniel Burgin, Oregon DOT, Daniel.G.BURGIN@odot.state.or.us, 503-509-7415
- Carissa Watanabe, Utah DOT, cwatanabe@utah.gov, 503-939-3798

### **Others Supporting the Problem Statement**

- AASHTO COES – Subcommittee on Environmental Process, Carissa Watanabe, Utah DOT, cwatanabe@utah.gov; 509-939-3798

### **Potential Panel Members**

- Organization, contact person, phone, and email address
- Illinois DOT, Felecia Hurley, Felecia.hurley@illinois.gov, (217) 785-2130

- Iowa DOT, Mark Solberg, Marc.solber@iowadot.us, (515) 233-7712
- USACE, Jackie Groves, Jackie.m.groves@usace.army.mil
- USACE, Albert Frohlich, Albert.J.Frohlich@usace.army.mil

#### **Person Submitting the Problem Statement**

- Tim Hill, AASHTO Committee on Environment and Sustainability Vice Chair
  - Ohio Department of Transportation
  - 614-644-0377
  - Tim.hill@dot.ohio.gov
  - Affiliation: Ohio DOT
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#### **NCHRP Review of B-31**

##### Reviewed By:

Ann M. Hartell  
ahartell@nas.edu

##### Comments:

The problem statement authors acknowledge several challenges to successfully completing the proposed project. These challenges include (1) the variation in how states pursue permits and Water Quality Certification that make it difficult to create nationally appropriate software and (2) uncertainty over hosting and maintenance responsibilities and costs. These issues, as well as the critical work to develop detailed software requirements, must be resolved before pursuing software development. If state DOTs find merit in the concept proposed, the appropriate first step is a scoping study to develop detailed requirements, secure agreement on hosting and maintaining the software, and establish acceptance of by relevant partners (e.g., USACE).

##### Review Date:

12/4/2020

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#### **FHWA Evaluation of B-31**

Reviewed By: HEP/Damaris Santiago

##### Comments:

USACE put out notices for NWP changes recently that include the exemption for federal aid projects/permittees and NEPA assignment states, from having to submit Pre-Construction Notification forms to the Corps. Without this consideration, HEP does not

see this research as being something very useful or transferrable. Additionally, it must be noted the New England District has rescinded the NWP program and uses a programmatic approach, which this problem statement did not recognize, at least in the write up. With the changes brought about by the NWPR, the pending release of NWPs, and the numerous transportation programmatic out there, HEP does not recommend supporting this effort.

Review Date:  
12/18/2020

### **AASHTO Committee Evaluation for B-31**

Submitted By:  
Jenn Billo  
AASHTO Staff  
Committee on Environment and Sustainability

Priority #: 6

Comments: Response to FHWA: I acknowledge that USACE put out a notice for changes to the 404 program. The notice states "Consistent with the recommendation included in the Legislative Outline, the Corps is considering whether it can use its existing authority to create specific procedures or conditions by which Federal agencies that currently require an NWP would not need to submit a PCN, consistent with applicable law." Thus, it is unknown whether Pre-Construction Notifications will be required or not required for federal aid projects. If this change does go through then this project would need to be amended as such. The issue as to which USACE permit is required would still need to be answered and this project could still answer that question. There are a number of areas throughout the Country that do not use the NWP program. Due to differences in the 404 program the USACE suggested this project start with one or two states. Once the issues are worked out then it could be duplicated in other applicable areas of the Country. Response to NCHRP: The challenges Ms. Hartell points out are valid. The variation between states is an issue. It is why the USACE suggested the project begin with only one or two states. Then the project could be expanded. The uncertainty over hosting and maintenance responsibilities and cost is an issue that would need to be worked out with the USACE for the project to be successful.

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# **Research Field C**

DESIGN

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-01**

**Problem Title:** “Determination of Maximum Safe Gap in Permanent Concrete Barrier”

**Background**

Agencies encounter situations where there are longitudinal gaps located within permanent concrete barrier. For example, small gaps ranging from one to four inches may occur when accommodating an expansion/contraction joint between permanent concrete barrier and concrete bridge rail. Larger gaps of up to 4 feet may occur due to accommodation of drainage features, such as an existing storm sewer catch basin or a manhole access point. Relocating these types of features is typically discouraged as the process would add significant costs and delays to the project. However, gaps in permanent concrete barrier can create a potential safety hazard for errant vehicles due to potential vehicle snag on the downstream end of the gap and corresponding risks for rapid vehicle deceleration, increased occupant risk, and vehicle instability. Gaps in these barriers may also pose a structural issue due to the discontinuity in the barrier section. Currently there is limited guidance on the maximum, unshielded gap that meets current MASH safety performance criteria, which limits agencies ability to effectively address this issue.

Based on these concerns, a need exists to determine the maximum allowable unshielded gap in a permanent concrete barrier system under MASH TL-4 safety performance criteria. This issue directly addresses goals of the AASHTO Strategic Highway Safety Plan and the FHWA Roadway Departure Strategic Plan, including the importance of reducing the incidence and severity of roadside crashes. The AASHTO Technical Committee on Roadside Safety (TCRS) has also prioritized the combined use of in-service performance evaluations (ISPEs), computer simulation, and full-scale crash testing in its strategic plan.

**Literature Search Summary**

Limited research has been conducted regarding gaps and shielding of gaps in permanent concrete barrier. Most of the existing research has dealt with evaluation of expansion gaps in concrete bridge rails. The Midwest Roadside Safety Facility (MwRSF) tested a Nebraska open concrete bridge rail with a 4.5-in expansion gap under the AASHTO PL-2 criteria. The barrier was evaluated at the gap location with a 5,399 lb pickup truck at 61 mph and 20 degrees and a 18,000 lb SUT at 51.9 mph and 16.8 degrees. Both of these tests were successful, but snag was evident in both tests. Additionally, the pickup truck test was conducted at a lower angle than prescribed NCHRP Report 350 or MASH TL-3 and TL-4, and no small car testing was conducted. More recently, TTI tested the Texas T224 bridge rail to MASH TL-4. As part of that

evaluation, they successfully tested the 10000S vehicle across a 2" wide expansion gap. The passenger vehicle tests were not conducted across the expansion gap.

Similarly, temporary barrier designs in free-standing and anchored configurations have had gaps as large as 4-in. that have been successfully traversed by vehicle in MASH TL-3 crash tests. For example, the Midwest States F-shape PCB was tested to MASH TL-3 when anchored to a bridge deck with a 4-in. barrier gap. This test did exhibit some snag across the PCB joint, but the vehicle was safely redirected. The snag may have even been exaggerated in this type of system as compared to a permanent concrete barrier as the upstream barrier translate laterally to some degree prior the vehicle traversing the gap, thus increasing the exposure of the barrier face at the downstream end of the gap.

Additional research has been conducted for shielding of larger barrier gaps. MwRSF developed a steel cover plate for spanning a large expansion joint in a TL-5 bridge rail developed for Manitoba Infrastructure and Transportation. In this effort, a steel cover plate was incorporated to span a 6 5/8-in. gap in a 49 1/4-in. tall, narrow single-slope concrete bridge rail, and it was crash tested according to MASH test designation 5-12. It may be possible to develop a similar reinforced steel cover plates for bridging other type of barrier gaps. The bridge rail in this research was also designed with increased barrier reinforcement adjacent to the gap to compensate for the lack of continuity in the barrier section.

While this research provides some insight into the issue of gaps in permanent concrete barrier, it does not provide guidance on the maximum allowable unshielded gap for commonly used permanent concrete barrier profiles in accordance with AASHTO MASH TL-4.

### **Research Objective**

The objective of this research is to determine the maximum allowable unshielded gap for permanent concrete barriers under MASH TL-4 impact conditions. The research should provide guidance for the maximum allowable gap for a range of permanent concrete barrier geometries.

- a. The desired outcome of this research will be guidance for incorporation in the AASHTO Roadside Design Guide. The final product will include guidance to agencies to avoid placing permanent concrete barriers with gaps exceeding the maximum allowable limit.
- b. The research contractor will require the following major tasks:
  - Literature review of previous research related to barrier gaps and gap spanning systems
  - Surveying state DOTs for permanent concrete barrier geometries and permanent concrete barrier gap configurations and scenarios, including expansion joints, drainage structures, etc.
  - Analyze existing barrier geometries to determine a potential maximum unshielded gap length for permanent concrete barriers and determine

a critical gap length and barrier geometry for evaluation through full-scale crash testing

- Evaluate the critical gap configuration through full-scale crash testing to MASH TL-4
- Provide generalized guidance for allowable gaps lengths for permanent concrete barrier
- Provide a summary report to document all design, analysis, testing, conclusions, and recommendations

### **Urgency and Potential Benefits**

Roadside safety hardware is critical for reducing severe crashes on the nation's highways. There is an urgent need to develop guidance for the agencies. Knowing the maximum allowable unshielded gap and development of crashworthy barrier hardware would provide agencies with increased safety through protection of vehicle snag posed by the interruption of the permanent concrete barrier system. This research will provide a measure of assurance in the placement of permanent concrete barrier and a higher level of safety for the traveling public.

State Transportation Agencies continue to strive to reduce the frequency and severity of run off the road crashes while balancing community and environmental needs, accommodation of utilities, and effects use of limited transportation budgets. Construction costs and delays can be reduced by not having to relocate drainage and utility structures located within alignment of the new concrete barrier system. State Transportation Agencies may utilize the results of this research for policy development for the placement of permanent concrete barrier. It is anticipated that the results of this research will be incorporated into the AASHTO Roadside Design Guide.

In the absence of this research, needless severe injury and fatal crashes will likely continue to occur due to the hazard posed by excessive gaps within permeant concrete barriers. Continuing without such guidance will result in the inconsistent and potentially unsafe practices by user agencies.

This research is ranked as the #3 priority by the AASHTO Technical Committee on Roadside Safety and #4 by the Committee on Design.

### **Implementation Considerations and Supporters**

The results of this research will assist state and local standards engineers to update the standard drawings and design manuals to provide guidance on the installation of permanent concrete barrier. With proper review, the AASHTO TCRS could assist implementation through adopting the research results into the future update of AASHTO Roadside Design Guide and *MASH*. Implementation could also be supported through a discussion of the findings at a TRB AKD20 meeting and the conduct of the TRB webinar.

### **Recommended Research Funding and Research Period**

Research Funding: \$600,000

Research Period: 36 months

**Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

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**Potential Panel Members**

Hung Tang, New Jersey Department of Transportation, AASHTO Technical Committee on Roadside Safety (TCRS), (609) 963-1839, hung.tang@dot.nj.gov

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**NCHRP Review of C-01**

Reviewed By:

David M. Jared  
djared@nas.edu

Comments:

Consistent with the AASHTO-TCRS and -COD prioritizations, I agree that this is worthwhile, moderate-priority research. Although details on potential rather than actual effects of the barrier gaps on crashes were provided, this problem statement proactively anticipates these effects and requests investigation thereof. I agree with the FHWA comment that consideration of only MASH TL-4 impact conditions, and not also TL-3, should be explained (TL-4 considered inclusive of TL-3 in this context?). Depending on the level of crash testing expected, the project budget may not be sufficient, so further explanation of the budget would be helpful.

Review Date:

1/5/2021

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**FHWA Evaluation of C-01**



Reviewed By: HRDS/Eduardo Arispe

Comments:

While this isn't a big problem, it would be useful to know how to handle openings between barriers. The problem statement is for TL4 but why not include TL3 in this study?

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for C-01**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Design

Priority #: 4

Comments: N/A

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### **Submitter Response for 2022-C-01**

**From:** [email: erik.emerson@dot.wi.gov]

**Comments:**

MASH TL-4 was selected for the problem statement because many of the median barriers and bridge rails that may have these gaps would be TL-4 rather than TL-3. When one considers TL-4, you must design for the 10000S (Single-Unit Truck) vehicle in addition to the 1100C and 2270P vehicles. Thus, if you meet TL-4, it would meet TL-3 by default. We believed that consideration of MASH test nos. 4-10, 4-11, and 4-12 would need to be part of the effort. The 4-12 test would evaluate structural concerns adjacent to a large gap as well as a snag. The passenger vehicle tests would largely look at occupant risk concerns for deceleration and instability induced by a snag on the joint. While we don't know exactly what path the proposing researchers would take, we would agree that crash testing a maximum gap with all three TL-4 tests could push the budget past \$600K. Research groups proposing the effort will likely be faced with overhead rates over 50%. Thus, the actual money for the project is closer to \$400K or less.

We do believe this is a significant concern as it was rated as one of the highest priority research projects by the AASHTO Subcommittee, TCRS (Technical Committee for Roadside Safety).

**Contact Info:**

Erik Emerson

Vice-Chair TCRS

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608-266-2842

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-02**

**Problem Title:** “Development of a Crashworthy Tangent End Treatment for Low Speed Curbed Roadways”

**Background**

Roadside barriers installed in low speed urban environments often have limited space available to include adequate Length of Need or apply currently available crashworthy end treatments. With the increasing interest in multimodal transportation, the demand for appropriate barrier solutions to address roadside safety issues in low speed urban and suburban conditions has increased. These environments often have closely spaced intersections/driveways, improvements intended to encourage bicycle and pedestrian travel, physical limitations to the available lateral offset, and commonly involve curbed roadway sections. Because of the physical space limitations, barriers are frequently installed without a crashworthy end treatment (e.g., sloped end treatments on concrete barrier), or employ systems that have not been evaluated for use in combination with curbs (e.g., crash cushions), and/or involve compromises with respect to length of need (i.e., use of gating hardware). Because barriers in these locations are normally installed in combination with curbing, terminals commonly cannot be flared to avoid conflicts with adjacent pedestrian or bicycle accommodations.

As a result of these constraints, it's anticipated that a viable end treatment for barriers in these environments needs to minimize:

- Length – allow for installations along roadways with longitudinal constraints (i.e. discontinuities for intersections, driveways, predestination crossings, etc.),
- Width – have a narrow cross-section to reduce impacts on infrastructure and adjacent pedestrian pathways.
- Height – reduce impacts on sight distance and allows for use with low profile barriers, guardrail, and typical concrete barriers/bridge traffic railings shapes.

Minimizing the above elements will also allow for retrofitting existing barriers with a crashworthy end treatment.

The results of this research will provide roadside safety design practitioners and roadway owner agencies a low speed tangent crashworthy end treatment (i.e., MASH TL-2) that minimizes the length, width, and height required to safely terminate rigid and semi-rigid barrier systems installed in combination with curb.

The AASHTO Strategic Highway Safety Plan and the FHWA Roadway Departure Strategic Plan both highlight the importance of reducing the incidence and severity of roadside crashes. The AASHTO Technical Committee on Roadside Safety has also prioritized the combined use of ISPEs, computer simulation, and full-scale crash testing in its strategic plan.

### **Literature Search Summary**

While there is a significant amount of existing literature that will help guide the decision-making process and concept development (e.g., effects of curb on vehicle trajectory, crash testing simulations of roadside hardware, evaluations of transitions, etc.) there is no known existing research that specifically addresses the development of a crashworthy tangent end treatment for low speed curbed roadways.

### **Research Objective**

The objective of the research is to develop a MASH TL-2 Tangent End Treatment that minimizes the required length, width, and height of the system, and can be used in common conditions found in urban areas, specifically in combination with 6" vertical curb (minimum height), and that can be transitioned into either; TL-2 low profile, TL-3 F-shape concrete, and semi-rigid w-beam barrier systems. The final product will be non-proprietary system drawings and specifications that will allow for component manufacturing and installation.

The research contractor will likely have to perform these major tasks:

- Comprehensive Literature review to determine critical design elements, evaluate potential components, and establish baseline for system design concepts
- Determine appropriate curb heights (Minimum 6" Vertical)
- Develop Design Concepts
- Present Concepts to Panel
- Perform Component/Material Testing
- Perform Computer Device Simulations of Selected Concepts
- Present Simulations to Panel
- Proof of Concept Crash Testing
- Validation of Computer Simulations
- Full Scale Crash Testing to MASH TL-2 Terminal/Crash Cushion testing matrix
- Development of design drawings and construction specifications needed for the manufacturing and installation of the system
- Develop design drawings of concepts for commonly needed transitions
- Submit drawings for inclusion in the Task Force 13 Hardware Guide
- Presentation of final design to AASHTO TCRS and TRB Roadside Design (AKD20) Committee.

Note that an important element of this research will be review of related current and expired patents to ensure a non-proprietary system can be developed.

## **Urgency and Potential Benefits**

Much emphasis has been made recently by AASHTO, FHWA, and state DOT's themselves in promoting the importance of multimodal solutions to address congestion, environmental, and livability concerns. These solutions often involve development of accommodations and improvements that change the roadside environment, involve the need to provide barriers to mitigate issues associated with a more livable street environments (e.g., trees, poles, landscaping, etc.). Low profile barriers designed to address risks at lower speed conditions (TL-2) are often preferred, because they are more consistent with public expectations associated with these context sensitive designs. While MASH compliant versions of these low profile barriers are in the process of development, there remains the need for crashworthy terminals for these barriers that are also designed to be consistent with the urban landscape.

In the absence of progress on context appropriate, low speed, low profile barrier terminals, application of these barriers as a part of an overall multimodal solution will be limited. However, with the introduction of a flexible, low speed tangent terminal, highway and urban designers will have confidence to provide the trees, poles, and other features associated with these urban, multimodal improvements, confident that they can employ both barriers and terminals that address both these popular livability design objectives and roadside safety concerns. Without this research, it is expected that livability designs will still be developed but will include potentially hazardous features without being appropriately shielded by barrier and crashworthy end treatments.

This research is ranked #4 in priority by the AASHTO Technical Committee on Roadside Safety and #1 by the Committee on Design.

## **Implementation Considerations and Supporters**

The results of this research will be used by state standards engineers to update the standard drawings, construction specifications, and design manuals to provide a MASH TL-2 crashworthy tangent end treatment for low speed curbed roadways. The Task Force 13 Hardware Guide could assist implementation through inclusion of design details and component standardization. Implementation would also be supported with presentations to AASHTO and TRB membership.

## **Recommended Research Funding and Research Period**

### Research Funding:

\$750,000

### Research Period:

36 months

## **Problem Statement Author(s)**

- Derwood Sheppard, P.E., M.Eng., Florida Department of Transportation, (850)414-4334, Derwood.sheppard.@dot.state.fl.us
- John Donahue, P.E., Washington Department of Transportation, (360) 705-7952, donahjo@wsdot.wa.gov

**Others Supporting the Problem Statement**

- AASHTO Technical Committee on Roadside Safety (TCRS), Derwood Sheppard, P.E., M.Eng., Florida Department of Transportation, (850) 414-4334, Derwood.sheppard.@dot.state.fl.us
- AASHTO Technical Committee on Roadside Safety (TCRS), John Donahue, P.E., Washington Department of Transportation, (360) 705-7952, donahjo@wsdot.wa.gov
- FHWA, Greg Schertz, FLH Safety Discipline Champion, (720) 963-3764, Greg.Schertz@dot.gov

**Potential Panel Members**

- Derwood Sheppard, P.E., M.Eng., Florida Department of Transportation, (850)414-4334, Derwood.sheppard.@dot.state.fl.us
- John Donahue, P.E., Washington Department of Transportation, (360) 705-7952, donahjo@wsdot.wa.gov
- Greg Schertz, FLH Safety Discipline Champion, (720) 963-3764, Greg.Schertz@dot.gov

**Person Submitting the Problem Statement**

November 2, 2020

Erik Emerson, P.E.  
Vice Chair, AASHTO Technical Committee on Roadside Safety  
Wisconsin Department of Transportation  
4822 Madison Yards Way  
Madison, WI 53705  
Tel: (608) 266-2842  
Email: Erik.Emerson@wi.gov

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**NCHRP Review of C-02****Reviewed By:**

David M. Jared  
djared@nas.edu

**Comments:**

This research could fill a gap in roadside safety hardware design and facilitate retrofits/improvements to existing barriers. Depending on the level of crash testing expected, the project budget may not be sufficient, so further explanation of the budget would be helpful.

Review Date:  
1/5/2021

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## **FHWA Evaluation of C-02**

Reviewed By: HRDS/Eduardo Arispe

Comments:

There is a Federal Lands project to develop a TL2 terminal, but it does not include the effect of curbs. Therefore a non-proprietary terminal for use in urban areas is needed. The costs stated in the project do seem low and should be higher.

Review Date: 12/18/2020

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## **AASHTO Committee Evaluation for C-02**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Design

Priority #: 1

Comments: N/A

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## **Submitter Response for 2022-C-02**

**From:** [email: erik.emerson@dot.wi.gov]

**Comments:**

It is difficult to estimate the cost of crash testing because tests can fail. If the project runs short of funds and is showing a benefit additional funds or another phase of research could be implement.

**Contact Info:**

Erik Emerson  
TCRS Vice-Chair  
Erik.emerson@dot.wi.gov  
608-266-2842

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-03**

**Problem Title:** Development of Guidance for Enhanced Delineation of Barriers and other Roadside Safety Hardware, Slopes, and Hazards

**Background**

Roadside safety hardware is crash tested to assess the crashworthiness of the device. The current crash test criteria are contained in the AASHTO Manual for Assessing Safety Hardware (MASH) and all transportation agencies are in the process of implementing MASH hardware on their highway systems. However, like all hardware assessment, MASH testing is conducted within the sterile, idealized environment of a laboratory test deck, and does not encompass human factors regarding perceived danger and consequent driver behavior to specific delineation practices of safety barriers or other roadside hazards.

Transportation agencies have encountered situations where enhanced continuous delineation of the face of existing roadside barriers seem to be playing a significant role in the reduction of crashes and injury severity. Examples of such situations could be related to the reduction of motorcycle impacts at strategic locations where a metal rub-rail was added to the guardrail system and painted yellow. Similar crash reductions were noticed when the yellow colored DR-46 motorcycle attenuator rub-rail was added to existing guardrail systems.

This research will develop guidance for enhanced delineation of roadside barriers and other hazards such as steep slopes in order to provide increased visibility and improved safety performance. Such guidance will also address delineation applications for reducing vehicle interaction with pedestrians and bikes on multi-modal roadways.

The guidance developed through this research directly correlates with TCRS's Strategic Plan and the number one goal in the TCRS mission statement which is, "develop, implement, and maintain guidance which will reduce fatal and incapacitating-injury roadway departure crashes."

**Literature Search Summary**

At the recent AKD20 Roadside Safety Conference, Utah DOT noted that their installations of a yellow powder coated metal motorcycle rub-rail under a standard w-beam guardrail on two state maintained routes resulted in a significant reduction in motorcycle crashes and injuries. California Department of Transportation (CalTrans) installed the yellow colored DR-46 Motorcycle Attenuator rub-rail in a curve on one of their state primary routes experiencing a high number of motorcycle crashes and in the after evaluation



period, the number of motorcycle crashes in the subject curve reduced to zero. CalTrans and UDOT Engineers theorize that the yellow color may have played a significant role in the reduction of motorcycle crashes. Similarly, North Carolina DOT's experience with the yellow DR-46 installed on NCDOT highways shows promise in reducing motorcycle crashes, although it is early in the evaluation phase of the project. While all these examples are specific to motorcycle crashes, improved/enhanced delineation may have the potential to reduce crashes with other vehicle types as well.

Although transportation agencies often encounter situations where enhanced delineation of existing safety barriers and steep slopes could likely contribute in the reduction of vehicle crashes and severe injuries, there is no specific documentation of proper practices and their effectiveness in mitigating these problems. Neither are guidelines available on how transportation agencies should address these situations. Irrespective of this perceived lack of resources, a literature search should be conducted to identify to the extent possible, best practices in the field and any published studies that might provide insight into the effectiveness of delineation practices. There were a small number of studies conducted in the late 1980's examining delineation practices specific to crash cushions (see below) that may provide a starting point but other studies may exist.

- Lerner ND, Turner BK. Laboratory Evaluation of Crash Cushion Delineation. Transportation Research Record 1093: 1986.
- Creasey FT, Dudek CL, Huchingson RD. Evaluation of the Effectiveness of Crash Cushion Delineation. Transportation Research Record 1111: 1987
- Torbic, D.J. et al. Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. Volume 7: A Guide for Reducing Collisions on Horizontal Curves. NCHRP Report 500, Transportation Research Board, Washington DC, 2004.
- <http://international.fhwa.dot.gov/scan/12028/12028.pdf>

## **Research Objective**

The objective of this research is to:

1. Identify best practices of enhanced delineation of roadside barriers and steep slopes, as currently adopted by transportation agencies.
2. Identify the effectiveness of such delineating practices, as reported by existing transportation agencies data/ studies.
3. Develop guidance that agencies can apply to delineate roadside hardware systems, slopes, and multi-modal facilities adjacent to roadways.
4. Propose any needed updates of appropriate sections of the AASHTO Roadside Design Guide (RDG) and the Manual on Uniform Traffic Control Devices Recommended (MUTCD), and the AASHTO MASH standards.

## **Urgency and Potential Benefits**

Based on before and after crash studies conducted by multiple states, there appears to be a strong correlation between enhanced longitudinal delineation measures and crash and injury reductions. Thus, there is an urgent need to explore this topic further with the goal of developing new delineation guidelines and procedures that would assist

transportation agencies in the application and implementation of delineation strategies for roadside barriers, steep slopes, multimodal facilities, etc. Potential benefits include improving the safety of roadways through effective delineation practices as well as decreasing the potential for tort liability for transportation agencies. Another potential benefit of this guidance would be increased exposure of effective delineation methods available to agencies. As delineation methods tend to be lower cost strategies, these solutions are likely to be more readily and widely implemented by transportation agencies resulting in a potentially far-reaching effect on reducing crashes and injuries.

This research is the #2 priority (of 5) for the AASHTO Technical Committee on Roadside Safety and #2 by the Committee on Design.

### **Implementation Considerations and Supporters**

The result of this research project will provide guidance to assist state and local transportation agencies in determining enhanced practice solutions for delineating roadside safety barriers and steep slopes. Such guidance will also support effective delineation practices to limit the interaction between vehicles and vulnerable users for multimodal pedestrian /bicycles facilities. The guidance could be further implemented through an update of appropriate sections of the AASHTO RDG, MUTCD and MASH.

Results of this research and the resulting guidance will be disseminated to state DOT design engineers, state and local traffic safety engineers, engineering consultants, and practitioners through presentations and webinars at appropriate industry and professional meetings including TRB Roadside Safety Design Committee, AASHTO TCRS, and Committee on Bridges and Structures Technical Committee T-7 “Guardrails and Bridge Rails.”

List the AASHTO Committee(s) and/or Council(s) – and any other organization – that might be interested in the research results and could help support implementation.  
AASHTO, Technical Committee on Roadside Safety: D. D. “Bucky” Galloway, TCRS  
AASHTO, Committee on Bridges and Structures Technical Committee T-7, Alex Bardow, TCRS  
AASHTO, Committee on Traffic Engineering  
AASHTO, Committee on Safety

### **Recommended Research Funding and Research Period**

Research Funding:

\$450,000

Research Period:

30 months

### **Problem Statement Author(s)**

Chiara Silvestri Dobrovolny, Ph.D. Texas A & M Transportation Institute, (979) 317-2687, c-silvestri@tti.tamu.edu

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doug.gabauer@bucknell.edu

Richard Butler, Brifen, USA, Inc., (904) 707-2728, richard@brifenusa.com

D. D. "Bucky" Galloway, P.E., NCDOT, (828) 650-2700, ddgalloway@ncdot.gov

**Others Supporting the Problem Statement**

AASHTO Technical Committee on Roadside Safety (TCRS)  
TRB Committee on Roadside Safety Design

**Potential Panel Members**

D. D. "Bucky" Galloway, P.E., NCDOT, (828) 650-2700, ddgalloway@ncdot.gov  
Shawn Debenham, UDOT, (801) 971-9575, sdebenham@utah.gov

**Person Submitting the Problem Statement**

Erik Emerson, P.E.  
Vice Chair, AASHTO Technical Committee on Roadside Safety  
Wisconsin Department of Transportation  
Tel: (608) 266-2842  
Email: Erik.Emerson@wi.gov

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**NCHRP Review of C-03**

Reviewed By:

David M. Jared  
djared@nas.edu

Comments:

I agree that this research is timely and needed, since related work has been done here and there over time, but not a concentrated, comprehensive study on the national level. The Georgia DOT conducted a "Comprehensive Evaluation of Guardrail Delineator Systems" on the state level in 2004 (Amedkudzi, Polls, Zureick). The scope of that study, however, was limited to cost (acquisition, installation), durability, and conspicuity considerations. It did not address crash/injury reductions, which I understand to be the context of "best practices" and "effectiveness" in this problem statement's Objectives #1-#2.

Review Date:

1/5/2021

## **FHWA Evaluation of C-03**

Reviewed By: HRDS/Eduardo Arispe

Comments:

This problem statement is a priority. The scope does seem limited and would benefit from a broader scope to include evaluation of delineating fixed objects like trees, utility poles and culvert head walls. Since this project might include an ISPE effort, the 30-month period seems appropriate. Depending on what is included, the fund cost might be low.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-C-03**

**From:** [email: erik.emerson@dot.wi.gov]

**Comments:**

Trees and utility poles are object that could benefit from delineation. However, there is some concern that the focus of the research would become too diluted to provide guidance on delineating barriers, steep slopes and drainage features. Research will need to provide recommendations on how to do this and on effectiveness. This may require statistically analysis of experimental sites. It can take some time to develop method to delineate, find test sites, and data collection.

**Contact Info:**

Erik Emerson  
TCRS Vice-Chair  
Erik.emerson@dot.wi.gov  
608-266-2842

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-04**

**Problem Title**

MASH Hardware Evaluation with New Proposed Test Vehicles

**Background**

The Manual for Assessing Safety Hardware (MASH) requires full-scale crash testing of roadside features using worst practical impact conditions, which are supposed to be representative of the composition of vehicles involved in run-off-road crashes and roadside departure speeds and angles. Previous NCHRP projects have driven changes in standard test conditions and test vehicles. For NCHRP Report No. 230, multiple vehicle classes were added for consideration including box trucks, semi tractor-trailers, and buses. Test vehicle classes were reduced to six standardized test levels during NCHRP Report No. 350, corresponding to TL-1 through TL-6 categories, and recommended three standard passenger vehicle classes: a 1,543-lb (700-kg) minicompact car, a 1,808-lb (820-kg) subcompact car, and a 4,409-lb (2,000-kg),  $\frac{3}{4}$ -ton pickup truck. In the middle-2000s, MASH was introduced which updated the criteria for selecting passenger car and pickup truck standards to 2,425 lb (1,100 kg) and 5,004 lb (2,270 kg), respectively. In addition, a mid-size test vehicle was introduced, corresponding to a mid-size passenger car, weighing approximately 3,306 lb (1,500 kg). After exploratory crash-testing programs for each of these changes in test vehicle selection criteria, a narrow number of selected makes and models were informally adopted as the “preferred” test vehicle types, which offered economical and reproducible outcomes.

Recent research in publication under NCHRP Project 20-07 Task 372, *Evaluation of MASH Test Vehicles*, indicated a significant decline in new passenger car sales and a rise in new light truck sales since approximately 2014, driven primarily by “compact” or “crossover” utility vehicle (CUV) sales. In 2017, CUVs were the highest-selling vehicle class, and more new CUVs were sold than all passenger car classes combined. As a result, updates for the selection criteria used when selecting standardized passenger car and light truck test vehicles were recommended, and it was also recommended that an exploratory full-scale testing program be conducted to evaluate roadside hardware using the CUV class of test vehicle.

A pilot testing program evaluating existing, MASH-approved hardware using the new proposed vehicles, with emphasis on the CUV vehicle class, is needed to ensure that testing criteria remains representative of the “practical worst-case” impact conditions. Differences in the performance of these systems with the new, proposed vehicles compared to existing tests with MASH vehicles should be documented. This exploratory testing program may also better-define which vehicles are best-suited for acceptance as

standardized test vehicles for future MASH testing based on availability of options, cost, and model continuity. Moreover, this exploratory testing program may identify critical behaviors from one or more of the candidate mid-size vehicle classes. If these critical behaviors represent a consistent, demanding condition for common roadside hardware, future MASH testing requirements may be adjusted to accommodate these new conditions. Lastly, the selection of preferred MASH test vehicle candidate vehicles will inform the generation of new finite element analysis (FEA) models of vehicles which will be utilized in computer simulations of roadside hardware and vehicle applications in the future.

### **Literature Search Summary**

Several pilot testing programs have been conducted to support major revisions to full-scale crash test criteria, and usually accompanied major criteria revisions. NCHRP Project 22-07, *Update of "Recommended Procedures for Safety Performance Evaluation of Highway Appurtenances"*, was conducted to revise the full-scale crash testing procedures, performance evaluation criteria, and full-scale crash test vehicle selection from previously-accepted NCHRP Report No. 230 guidelines and to synthesize with AASHTO's *Guide Specifications for Bridge Railings*. The resulting document, NCHRP Report No. 350, unified the parameters for evaluating roadside safety hardware using standardized vehicle types and classes, unified evaluation criteria, and standardize test conditions. Subsequently, TTI conducted some testing of the standard G4(1S) configuration of W-beam guardrail using four passenger vehicles, a Chevrolet Lumina, Ford Taurus, Plymouth Neon, and Dodge Caravan, to assist with computer simulation modeling efforts. Although this program was not intended to evaluate the performance of barrier systems with non-standard test vehicles, significant instability was observed with the Dodge Caravan and the Chevrolet Lumina impact caused W-beam rail rupture at a splice, which was believed to be related to a stiff point on the vehicle and localized rail pocketing.

In the early 2000s, the Texas Transportation Institute was the recipient of NCHRP Project No. 22-14(a), to reassess the criteria and test conditions described in NCHRP Report No. 350 and to recommend updates, if any, to improve the validity of those conditions. Subsequently, the Midwest Roadside Safety Facility was the recipient of a pilot testing program under NCHRP Project No. 22-14(b) which consisted of full-scale crash testing various barrier systems using the proposed MASH vehicles and impact conditions. Systems included a New Jersey permanent concrete barrier, portable concrete barriers, G4(1S) and MGS guardrail systems, and an approach guardrail transition. Test vehicles included the new 1100C small car, two options for 2270P pickup trucks (1/2-ton quad cab Chevrolet Silverado 4x4 and 1/2-ton quad cab Dodge Ram 1500 RWD), and the heavier 22,000-lb (10,000-kg) single-unit truck. Results were used to identify the Dodge Ram as the preferred pickup truck test vehicle and to provide initial evaluation and acceptance of some common hardware which had been approved under NCHRP Report No. 350 impact conditions.

### **Research Objective**

The objective of this research effort would be to conduct a series of full-scale crash tests of MASH-approved non-proprietary roadside safety hardware using test vehicles consistent with recommendations provided in NCHRP Project No. 20-07 Task 372, *Evaluation of MASH Test Vehicles*.

- a. The outcome of this research effort will be guidance for selecting preferred standardized vehicles for the light truck, small car, and mid-size vehicle classes for recommendations to updating AASHTO's MASH evaluation criteria, and to select the preferred characteristics (weight, size, c.g. height, etc) of the preferred mid-size test vehicle.
- b. The researcher or contractor would be expected to complete these major tasks:
  - Install roadside safety system identified for testing.
  - Perform full-scale crash tests of prioritized hardware previously evaluated using MASH evaluation criteria and impact conditions using the new proposed vehicles described in NCHRP Project 20-07 Task 372.
  - Compare results of the full-scale crash testing using the new proposed vehicles with correlated MASH full-scale crash testing results.
  - Identify preferred vehicles and recommend the configurations, trim levels, or sizes are needed for developing new vehicle models using finite element analysis (FEA) methods. Note that the development of those FEA vehicle models are not within the scope of this project.
- c. Results of the full-scale crash testing and comparisons with existing MASH testing shall be showcased at annual meetings of the Transportation Research Board AKD20 sessions and other update venues. Examples of showcase venues include the International Roadside Safety Conference, meetings with AASHTO Task Force 13 and Technical Committee on Roadside Safety, and annual meetings of the two largest roadside safety pooled fund organizations aligned with the Texas A&M Transportation Institute and the Midwest Roadside Safety Facility.
- d. This research will provide recommendations for updating MASH guidelines for conducting full-scale crash testing, preliminary evaluations of hardware based on the recommended update to MASH, and preferred vehicles which can be developed into finite element analysis models for future simulation-based research.

### **Urgency and Potential Benefits**

NCHRP Project 20-07 Task 372 indicated that MASH standard vehicle selection may no longer be representative of the contemporary vehicle fleet. New vehicles tend to be larger, heavier, and taller than during the initial adoption of MASH. It is critical to ensure that roadside hardware performance during impacts does not deteriorate, causing containment failures, contributing to rollovers, or breaking apart under design impact conditions. This research effort will provide the first indications of the likelihood that existing, successfully-tested hardware will continue to be perform acceptably with the updated test vehicles. In addition, the research team or contractors will identify

recommended vehicles to be developed into FEA models in future NCHRP studies which will eventually augment evaluation of hardware using the updated vehicles.

This research is ranked by the AASHTO Technical Committee on Roadside Safety as its top priority, and #5 by the AASHTO Committee on Design.

### **Implementation Considerations and Supporters**

Research results produced during this study will serve to provide the first indication of the performance of successfully-tested MASH devices during impacts with newer, heavier test vehicles as well as a critical evaluation of the performance of devices with the growing class of CUV vehicles. Results will be documented in technical reports, journal papers, presentations to national committees and research groups involved in roadside safety (examples: AASHTO TCRS and Task Force 13, TRB's AKD20 annual winter meeting in Washington, D.C. and during the summer meeting, presentation to TTI and MwRSF pooled fund groups) and full-scale crash test videos and post-test documentation will be published and freely available for review.

The contracting agency will also recommend specific vehicles to be modeled with FEA. These vehicle models will greatly improve the evaluation of roadside hardware using numerical simulation to aid the design and retrofit (if needed) for systems tested under MASH and NCHRP Report No. 350 to be compliant with the update to MASH and new test vehicles. The new vehicle recommendations should be consistent with full-scale crash tested vehicles used during this project to improve the validation of the final vehicle models in future studies.

List the AASHTO Committee(s) and/or Council(s) – and any other organization – that might be interested in the research results and could help support implementation.

AASHTO, Technical Committee on Roadside Safety

AASHTO, Committee on Bridges and Structures Technical Committee T-7

AASHTO, Committee on Traffic Engineering

AASHTO, Committee on Safety

### **Recommended Research Funding and Research Period**

Research Funding: \$1,000,000

Research Period: 36 months

### **Problem Statement Author(s)**

Cody Stolle, Midwest Roadside Safety Facility at the University of Nebraska-Lincoln: 402-472-4233, cstolle2@unl.edu

Filiberto Sotelo, Illinois Department of Transportation, 217-524-0946, Filiberto.Sotelo@illinois.gov

Chiara Dobrovolny, Texas A&M Transportation Institute, 979-317-2687, c-silvestri@tti.tamu.edu

### **Others Supporting the Problem Statement**



## TRB Committee on Roadside Safety Design

### **Potential Panel Members**

Filiberto Sotelo, Illinois Department of Transportation, 217-524-0946,  
Filiberto.Sotelo@illinois.gov

### **Person Submitting the Problem Statement**

Erik Emerson  
Wisconsin DOT  
TCRS Acting Chair  
(608) 266-2842  
Erik.Emerson@wi.gov

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### **NCHRP Review of C-04**

Reviewed By:  
David M. Jared  
djared@nas.edu

#### Comments:

High priority safety research that builds on the findings of NCHRP 20-07(372) and gives due consideration to fleet changes nationwide. I believe that the higher budget is owing to extensive crash testing within the project scope.

Review Date:  
1/5/2021

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### **FHWA Evaluation of C-04**

Reviewed By: HRDS/Eduardo Arispe

#### Comments:

This problem statement is a priority. The current test vehicles used in MASH are based on data that is nearly 20 years old. The 20-7 (372) project identified potential updated vehicles, but it will be critical to understand whether these vehicles meet the "practical worst case" before they are adopted. Also very important in determining which vehicles FHWA should use to create the new FE vehicle models used for developing roadside hardware.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for C-04**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Design

Priority #: 5

Comments: N/A

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## **Submitter Response for 2022-C-04**

**From:** [email: erik.emerson@dot.wi.gov]

### **Comments:**

Budgets for crash testing devices are difficult especially when looking at updating the crash test vehicle. The purpose would be to focus on common generic hardware and test as many devices as possible. If project runs out of funds another research project could be proposed.

### **Contact Info:**

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Erik.emerson@dot.wi.gov  
608-266-2842

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-05**

**Problem Title**

Methods to Relate and Predict In-Service Performance of Pavements from Accelerated Pavement Testing

**Background**

The use of accelerated pavement testing (APT) for determining pavement response and performance has increased over the years primarily because of the ability to provide an expedited means of evaluating potential materials, designs, and construction methods. However, because of the short duration and controlled conditions of these accelerated tests, APT studies may not necessarily reflect all factors that potentially contribute to long-term performance such as climatic conditions and changes in material properties over time. Some APT facilities have developed methods that attempt to simulate long-term effects of environment and aging of materials while recognizing the difficulty to accurately and consistently represent the conditions found in-situ. In addition, magnitude, duration, and configuration of the loads applied in APT studies often differ from those imposed by traffic on in-service pavements. Methodologies that relate data obtained from APT studies to in-service performance are not readily available. These methods should consider common APT goals which often include evaluations limited to surface layers, quantifying improvement in performance of new and emerging materials compared to traditional treatments, limiting distress development, and other focused objectives. Thus, there is a need for research to provide methodologies for relating APT results that are acquired under specific environmental and loading conditions to expected long term pavement performance under in-service traffic and environmental conditions.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards, Goal 2 – Develop and Maintain Pavement Design Guides and Goal 3 – Develop and Champion Research for COMP.

**Literature Search Summary**

NCHRP 10-66 was initiated in 2004 but was not pursued. The panel at that time recognized that satisfying the project objective depended on finding sufficiently compatible pairs of APT and in-service test sections. Because of concerns about data availability, practicality of the proposed research approach, and the likelihood of implementable results, the panel suggested that a similar effort be considered when relevant data became available. It is expected that APT data and compatible in-service pavements are more abundant now and that changes in the proposed scope will result in successful research findings.

**Research Objective**

The objective of this research is to identify and develop methodologies in an AASHTO recommended practice that relate APT findings to long-term in-service pavement performance under diverse climatic conditions, axle loads, and design vehicle speeds.

**Research Tasks:**

1. Conduct a literature review to establish current methodologies that relate APT and in-service pavement performance. The literature review will also focus on determining common objectives of APT studies (e.g., evaluation of improved material or construction technique, design method calibration, etc.) as well as documenting relevant APT loading, environmental simulation, and pavement response measurement capabilities
2. Identify or develop methodologies for relating APT and in-service performance.
3. Provide guidance in the form of a recommended practice on data analysis and interpretation of methodologies that relate to pavement performance.
4. Apply methodologies and guidance developed through this research to a minimum of three real-world case studies.
5. Verify or adjust guidance provided in Item #3 based upon the case studies in Item #4.
6. Develop an implementation plan for stakeholders.

**Urgency and Potential Benefits**

As transportation infrastructure ages, highway agencies face a growing challenge to provide practical and cost-effective pavement evaluation and rehabilitation approaches. To meet these challenges, many agencies have relied on APT to quickly evaluate and implement promising technologies that have the potential to improve pavement performance and increase pavement life. This research will make APT studies more widely applicable to state agencies through better defined relationships with in-service performance.

**Implementation Considerations and Supporters**

Due to the economic benefits of APT, a growing number of agencies and organization have either implemented APT programs or rely on APT findings to evaluate new pavement materials, pavement designs, and construction methods. The success of this research will speed the use of new pavement materials, improved pavement designs, and more effective construction methods. Pavement design and management programs will benefit greatly from the outcome of the research. More appropriate APT testing conditions and more accurate performance data will improve pavement designs (structure and materials) and management (life cycle cost analysis, treatment selection and timing).

Organizations and contacts interested in the research results that could help support implementation are:

Florida Department of Transportation  
Contact: Bouzid Choubane  
Phone: 352-955-6302  
Email: bouzid.choubane@dot.state.fl.us

Minnesota Department of Transportation  
Contact: Ben Worel  
Phone: 651-366-5522  
Email: Ben.Worel@state.mn.us

Virginia Transportation Research Council  
Contact: Brian Diefenderfer  
Phone 434-293-1944  
Email: brian.diefenderfer@dot.virginia.gov

Federal Aviation  
Authority Contact:  
Navneet Garg  
Phone: 609-485-  
4483  
Email: naveet.garg@faa.gov

National Center for Asphalt Technology  
Contact: Raymond Powell  
Phone: 334-844-6857  
Email: buzz@auburn.edu

### **Recommended Research Funding and Research Period**

It is anticipated that the research will require \$350,000 and 30 months to complete.

### **Problem Statement Author(s)**

James Greene  
Florida Department of Transportation  
Phone: 352-955-6329  
Email: james.greene@dot.state.fl.us

### **Others Supporting the Problem Statement**

TRB Committee AKP40, Pavement Structural Testing and Evaluation  
Contact: Regis Carvalho  
Phone: 240-331-0103  
Email: rcarvalho@oakenconsult.com

AASHTO COMP

### **Potential Panel Members**

Florida Department of Transportation, Bouzid Choubane, (352) 955-6302,  
bouzid.choubane@dot.state.fl.us

Minnesota Department of Transportation, Ben Worel, (651) 366-5522,  
Ben.Worel@state.mn.us

**Person Submitting the Problem Statement**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, [mfelag@hotmail.com](mailto:mfelag@hotmail.com)

Note: This was ranked #1 for COMP Pavement related RPS.

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**NCHRP Review of C-05**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

Comments:

A. The problem is not solvable through the proposed research. Accelerated pavement testing (APT) is generally performed with repeated loads of specific magnitudes and configurations at a specific rate and under a specific conditions of temperature and moisture that do not account for the variations in traffic (axle load spectra, traffic speed), climatic conditions (temperature and moisture) that occur in service. Also, because of the short duration and selected exposure and test conditions, these tests do not account for aging effects. These limitations make it extremely unlikely that APT findings would provide reliable relationship to in-service pavement performance. However, accelerated pavement tests would provide an indication of the relative behavior of different layers and materials under the specific test conditions. B. The topic of research should be of interest to the majority, if not all, state DOTs but accomplishing the expected objective is unlikely. C. The objective, as stated in the problem statement, provides a clear intent of the research. However, because APT test conditions do not resemble those encountered in in-service pavements, reliable relationships between APT findings and in-service performance cannot developed. D. The stated scope appears to be specific but it will not result in a reliable product or implementable findings because of the lack of relevant data. E. Regarding project duration, many years are required to implement an APT program that adequately simulates in-service conditions and produces performance data comparable to those of in-service pavements. F. Regarding the budget, several millions of dollars are required to implement an APT program that adequately simulates in-service conditions and produces performance data comparable to those of in-service pavements. G. Only NCHRP Project 10-66 has been cited. This project was discontinued because of lack of relevant data; this concern remains unchanged. Note: This problem statement is one of 6 problem statements submitted by the AASHTO Committee on Materials and Pavements (3 related to Materials and 3 related to Pavements); it was ranked the highest priority among the 3 pavement-related problem statements.

Review Date: 12/14/2020

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## **AASHTO Committee Evaluation for C-05**

### Submitted By:

Casey Soneira

AASHTO Staff

Committee on Materials and Pavements

### Priority #: 4

Comments: This would help establish the relationship between APT results and field performance. A better understanding of this relationship will help greatly in our knowledge of pavement design. This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards, Goal 2 – Develop and Maintain Pavement Design Guides and Goal 3 – Develop and Champion Research for COMP. #1 for Pavements within COMP, #4 overall

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## **Submitter Response for 2022-C-05**

**From:** [email: mfelag@hotmail.com] Mark Felag (AASHTO COMP Secretary) from Author's Response James Greene

Author's Comment: No comments were received by FHWA. Our response to the NCHRP comments is below:

NCHRP Comment A: The problem is not solvable through the proposed research. Accelerated pavement testing (APT) is generally performed with repeated loads of specific magnitudes and configurations at a specific rate and under a specific conditions of temperature and moisture that do not account for the variations in traffic (axle load spectra, traffic speed), climatic conditions (temperature and moisture) that occur in service. Also, because of the short duration and selected exposure and test conditions, these tests do not account for aging effects. These limitations make it extremely unlikely that APT findings would provide reliable relationship to in-service pavement performance. However, accelerated pavement tests would provide an indication of the relative behavior of different layers and materials under the specific test conditions.

Author's Comment to A: The primary objective of this research is to develop relationships between APT results and field results. The challenges noted in the comments are also described in the problem statement outline and forms the basis of the research. It should be noted that current pavement design approaches and performance models mostly rely on transfer functions developed primarily from laboratory tests and conditions that are much more different than conditions found in APT experiments.

NCHRP Comment B: The topic of research should be of interest to the majority, if not all, state DOTs but accomplishing the expected objective is unlikely.

Author's Comment to B: See the above response.

NCHRP Comment C: The objective, as stated in the problem statement, provides a clear intent of the research. However, because APT test conditions do not resemble those encountered in in-service pavements, reliable relationships between APT findings and in-service performance cannot be developed.

Author's Comment to C: The relationships and procedures developed within this research will also consider specific APT goals which often include comparisons of new treatments with existing ones and limiting/minimizing distress development among other focused objectives. Relationships may be in the form of expected performance improvement or the probability of no observed distresses over a given time period.

NCHRP Comment D: The stated scope appears to be specific but it will not result in a reliable product or implementable findings because of the lack of relevant data.

Author's Comment to D: There are at least 14 active APT programs in the United States and many more abroad. It is expected that data relevant to this research will be available from these programs.

NCHRP Comment to E: Regarding project duration, many years are required to implement an APT program that adequately simulates in-service conditions and produces performance data comparable to those of in-service pavements.

Author's Comment to E: See the response above. In addition, many APT programs have been in existence for decades. Materials and construction methods evaluated within these programs have now been in service for many years with available performance data.

NCHRP Comment to F: Regarding the budget, several millions of dollars are required to implement an APT program that adequately simulates in-service conditions and produces performance data comparable to those of in-service pavements.

Author's Comment to F: It is expected that this research will be based on data already available. New APT tests nor the implementation of a new APT program will not be needed.

NCHRP Comment to G: Only NCHRP Project 10-66 has been cited. This project was discontinued because of lack of relevant data; this concern remains unchanged.

Author's Comment to G: With the growing role of APT programs over the last few decades, it is expected that APT data and compatible in-service pavements are more abundant, and data is readily available. Changes in the proposed scope will also lead to successful research findings related to specific APT goals and objectives. In addition, work on this topic has been performed in the past with reasonable but limited success. Researchers at the National Center for Asphalt Technology (NCAT) authored a paper that documented a methodology relating rutting performance at the NCAT test track with rutting performance of a linear type APT device at the Florida Department of Transportation. While this research was not published and does not directly relate APT tests to actual field performance, it did establish a methodology that considers different loading and material aging scenarios and could be expanded upon. This research is



available as part of the 87<sup>th</sup> Annual Meeting of the Transportation Research Board Compendium Papers, Paper #08-2596 (2008).

Author's Comment: This problem statement is one of 6 problem statements submitted by the AASHTO Committee on Materials and Pavements (3 related to Materials and 3 related to Pavements); it was ranked the highest priority among the 3 pavement-related problem statements.

Contact Info:  
Mark Felag  
mfelag@hotmail.com  
401-245-1327 cell

Review Date: December 14<sup>th</sup> from Author, January 17, 2021 from Mark

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022–C-06**

**Problem Title**

Impact of Flooding and Inundation on the Performance of Pavements

**Background**

The performance of pavements after inundation by flooding will gain greater significance in the foreseeable future. For many years, transportation agencies have dealt with the aftermath of flooding from major storm events, but the threat of sea level rise from global climate change now looms more ominously. During the 20th century, the sea level rose 15-20 centimeters (roughly 1.5 to 2.0 mm/year), with the rate accelerating towards the end of the century.

Climatological projections predict an even faster sea level rise in the 21st century. For example, the Southeast Florida Regional Climate Change Compact is estimating the SE Florida region will experience an increase between 9 and 24 inches in the next 50 years. To help mitigate some of the impacts, the region has already implemented \$400 million worth of mitigation/adaption projects of to construct 2 pump stations to in part to keep the roads from flooding.

FHWA Technical Brief on Climate Change and Pavement Sustainability (FHWA-HIF-15-015) provides an introduction on how pavements may be fortified against climate change impacts due to extreme conditions, such as longer heat waves and severe flooding, and explains how these changes will accelerate the deterioration of highway pavements. However, it recognizes that the state of the practice is largely limited to general observations and is lacking with regards to specific adaptation strategies.

This proposed research will answer the following questions:

1. What is the impact of flooding on the short- and long-term performance of pavements?
2. What is the sensitivity of individual pavement design features to mitigate or reduce the negative effects of flooding on performance?
3. What asset management strategies can be used for pavements exposed to prolonged flood events?

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

**Literature Search Summary**

Existing research documentation related to this topic discuss primarily real-time assessments of flooded pavements for purposes opening back to traffic, and reducing water intrusion through pavement design, materials selection and construction methods. No comprehensive performance evaluation of inundated pavements of all types, accompanied by full scale testing, has occurred.

## **Research Objective**

The objective of this research is to determine the impact that submergence and inundation related to flooding and sea-level rise have on the long-term performance of a pavement system and provide guidance on improving pavement resiliency. It is anticipated the work will be structured as shown in the following phases and tasks:

### **Phase 1**

Task 1. Conduct a literature review of the performance of pavements with respect to inundation and submergence. Summarize the information collected noting pertinent results as appropriate. Identify any gaps in the information. Document the results in a technical memorandum.

Task 2. Develop a detailed research plan to address the knowledge gaps identified in Task 1. It is anticipated this plan would include building laboratory and full-scale, asphalt and concrete pavement test sections that can be inundated so that the differences in the short term responses (e.g. stress, strain and deflection, etc.) and accelerated load testing performances (faulting, cracking, deflection, material properties etc.) between flooded and non-flooded test sections could be evaluated. Another portion of the research could entail doing pavement testing on pavements inundated by flooding from actual events from storms in order to compare the field results with the laboratory and full-scale test results.

Task 3. Prepare an interim report that documents the research performed in Phase I. Include an updated work plan for Phase 2.

### **Phase 2**

Task 4. Execute the work plan approved in Task 3. Based on the results of this work, recommend a methodology for quantifying the impacts of flooding on pavements. Identify pavement properties that may influence performance and identify test methods and protocols (e.g., FWD, GPR or other tests/instrumentation) that can be used to evaluate and/or quantify the near-term load capacity and the long-term pavement damage / performance reduction caused by inundation.

Task 5. Document results and propose guidelines, standard practices, training sessions and other activities that can be given to practicing engineers for limiting flood damage to new and existing concrete pavements.

Task 6. Perform technology transfer / training concerning the project findings, guidelines and tools in a one-day pilot workshop to FHWA and DOT participants. Revise project training materials and deliverables, as necessary, based on comments received following this workshop.

Task 7. Submit final versions of all project training materials and deliverables, along with a final report that documents the entire research effort.

### **Urgency and Potential Benefits**

Weather and flooding events already negatively influence pavement systems. Many States; including Louisiana, Florida, North Carolina, Colorado, Vermont, Tennessee, Iowa, Texas, Missouri and Nebraska; have experienced severe precipitation events and flooding during the past several years. Fortification of pavement systems is critically needed in areas of potential flooding.

### **Implementation Considerations and Supporters**

The results of this work will be disseminated to transportation departments through training, such as webinars, and will be adopted by them through guidelines for modifications of pavement design methods, construction specifications, material specifications, etc.

### **Recommended Research Funding and Research Period**

#### **Recommended Funding:**

Estimated cost of research and development is \$650,000.

#### **Research Period:**

24 months.

### **Problem Statement Author(s)**

James W. Mack, CEMEX, jamesw.mack@cemex.com

### **Others Supporting the Problem Statement**

#### **TRB committees and Chairs**

TRB Committee AKP20 – Concrete Pavement Design and Rehabilitation,  
Georgene Geary, 770-337-5817, ggeary@ggfga.com

TRB Committee AKP30 – Asphalt Pavement Design and Rehabilitation, Dave  
Timm, 334-844-6282, timmdav@auburn.edu

TRB Committee AKC50 – Concrete Pavement Construction and Rehabilitation,  
Sabrina Garber, 512-451-6233 Ext 242, sgarber@thetranstecgroup.com

TRB Committee AKC60 – Asphalt Pavement Construction and Rehabilitation,  
Adam Hand, 775-784-1439, adamhand@unr.edu

AASHTO Committee on Materials and Pavements (COMP)

### **Potential Panel Members**

Members of AASHTO COMP Technical Subcommittee 5d - Pavement Design,  
John Donahue (Chair), 573-526-4334, john.donahue@modot.mo.gov

**Person Submitting the Problem Statement**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, mfelag@hotmail.com

Note: This was ranked #3 for COMP Pavement related RPS.

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**NCHRP Review of C-06**Reviewed By:

Edward T. Harrigan  
eharriga@nas.edu

Comments:

The problem is potentially solvable through the proposed research. Sea level rise and the likely increase in extreme weather events in the interior United States suggests the research results will be generally applicable to all the states. The objective statement is clear and concise. The scope is ambitious but achievable. The suggested period of performance is 24 months. An increase to 30 months is recommended to (a) provide adequate time for data analysis and report preparation, review, and revision and (b) account for contingencies during the laboratory and field testing. The proposed budget is adequate.

Review Date:

12/2/2020

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**FHWA Evaluation of C-06**

Reviewed By: HRDI-20/Amir Golalipour

Comments:

This is a very useful study but might be a bit too much for the \$650K cost and the proposed study duration of 24 months is unrealistic. It should build on ongoing efforts, such as the ESLR FY21 work to study and document pavement deterioration and impacts from inundation. Resilient solutions to pavement design should be a focus. We have a few suggestions to improve the study. The detrimental effects of flooded pavements are relatively simple to understand. Identifying pavement properties that influence drainage performance leads to specific issues related the drainage capacity, and the time to drain within current design and construction practice; the problem

statement does not highlight these relevant issues. The statement should also look into the aspect of contaminated bases within the context of our aging roadways in terms of drainage capacity, and try to establish guidance on when is it appropriate to open a flood road to truck traffic after a flood event. Task 6 would be very helpful to update practioners on study findings and best practice recommendations.

Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for C-06**

Submitted By:

Casey Soneira

AASHTO Staff

Committee on Materials and Pavements

Priority #: 6

Comments: Knowing the impacts of flooding on our pavements will greatly help states with strategies to minimize the impacts in the short and long term through modifications in pavement design methods, specifications and guidelines. This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP. #3 for Pavements within COMP, 6th overall

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## **Submitter Response for 2022-C-06**

**From:** [email: mfelag@hotmail.com] for James Mack jamesw.mack@cemex.com]

**Comments:** Email sent was in Plan Text format, response is sent back in HTML to show changes better. Also, changes were made to the RPS as highlighted. If you would like us to resubmit it with the changes please let us know.

- **Comments to FHWA Comments:** I agree with the comments and recommendations from FHWA. Specifically, I agree that focus should be on pavement's resiliency and specifically it should focus on the features (rather than just properties) that impact flooding performance. As stated, we know that inundation flooding saturates the subgrade and base courses; reduces the density of the materials; and thus impacts performance. The commenter talked about how research on drainage performance and base impacts are needed, but I believe it should be more than that just these. Specifically, what needs to be researched is how different pavement components and designs, and the features of each (e.g. a doweled concrete pavement vs undoweled concrete pavement

performs or how asphalt pavement with stabilized base vs non-stabilized base vs geogrids) impact performance so that it can be quantified.

Having said all this, I did not want to get into specific properties to be investigated and it is hoped that Task 1 will identify the relevant features (e.g. I did not want to bias what was looked at in the hopes a fuller range of ideas would be found). For example, if we told the researchers to look at what impacts drainage performance / drainage capacity; they may not look CRCP pavements where “how fast drainage happens” does not seem to be an issue (at least per TxDOT research).

Re the comment recommending that the research be coordinated with ESLR FY 21 work, again, I agree. However, it is important to note that research is focused solely on Sea Level Rise and is meant to cover a much broader area than just pavements. As stated, this research is to be focused on pavement and improving pavement design; but I also wanted it to cover non-SLR inundation flooding..

Re the comment on cost and duration: Agree that higher budget and duration would result in a better product.

- **Comments to NCHRP Comments:** The primary thrust of these comments is that the duration of the project is too short; and agree with the recommendations.

Recommended Change to the RNS to address these comments:

Task 1. Conduct a literature review of the performance of pavements with respect to inundation and submergence. Summarize the information collected noting pertinent results as appropriate. Identify features and properties that impact flooding performance, as well as any gaps in the information. Document the results in a technical memorandum.

Task 2. Develop a detailed research plan to address the knowledge gaps issues identified in Task 1. It is anticipated this plan would include building several laboratory and/or full-scale, asphalt and concrete pavement test sections, with different features and properties, that can be inundated so that the differences in the short term responses (e.g. stress, strain and deflection, etc.) and accelerated load testing performances (faulting, cracking, deflection, material properties etc.) between the pavement sections with different features in the flooded and non-flooded test sections could be evaluated. Another portion of the research could entail doing pavement testing on pavements inundated by flooding from actual events from storms in order to compare the field results with the laboratory and full-scale test results. Finally, it is important that the research address / improving the resilience of both new pavements and existing pavements that are at risk.

Task 4. Execute the work plan approved in Task 3. Based on the results of this work, recommend a methodology for quantifying the impacts of flooding on pavements. Identify pavement properties that may influence performance and identify test methods and protocols (e.g., FWD, GPR or other tests/instrumentation) that can be used to evaluate and/or quantify the near-term load capacity and the long-term pavement damage / performance reduction caused by inundation. Define the procedures / features that can be used to design or improve the flood resiliency of pavements.

Recommended Funding: Estimated cost of research and development is ~~\$650,000~~ \$1,000,000. (The additional funding is to ensure enough laboratory and/or full-scale tests are built)

Research Period: 24 36 months.

Contact Info: Mark Felag, AASHTO COMP Secretary [mfelag@hotmail.com](mailto:mfelag@hotmail.com)  
for  
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Review Date: January 13, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-07**

**Problem Title**

Develop, fabricate, and test surrogate bogey vehicles and pendulum masses with noses for evaluating MASH breakaway performance of luminaire poles, signs, and work zone devices.

**Background**

Historically, roadside safety features have been subjected to crashworthiness evaluations using a variety of impact test specifications and/or guidelines.

With the AASHTO MASH guidelines, elimination of surrogate vehicle testing, the addition of a pickup truck test condition, the existence of numerous luminaire poles, sign supports, and work- zone traffic control devices, and the increased cost to certify these devices, crashworthiness evaluations and innovation have stagnated for many of these devices. As a result, there exists a need to re-examine the use of surrogate vehicle testing in the crashworthiness evaluations of luminaire poles, sign supports, and light-weight, work-zone traffic control devices. The development of robust, surrogate bogey vehicles, with an ability to largely capture vehicle deformation and penetrations as well as accurate system behavior, would reduce crash testing costs and promote greater innovation for new products for manufacturers and state Departments of Transportation. Motorist safety of U.S. roadways would be enhanced as more AASHTO MASH- compliant systems become available and are implemented.

**Literature Search Summary**

This research study would build upon historical bogey and pendulum apparatuses that were developed and used for impact testing and evaluating breakaway luminaire poles, sign supports, and lightweight WZTCs across the U.S. The noted test methods were used at the FHWA Federal Outdoor Impact Laboratory (FOIL), Southwest Research Institute (SwRI), Texas A&M Transportation Institute (TTI), Midwest Roadside Safety Facility (MwRSF), Valmont-UNL Pendulum Testing Facility, E-Tech Testing Services Inc. (E-TECH), and many other agencies. In recent years, the Florida Department of Transportation, in collaboration with the University of Florida, developed and used a crushable nose for a pendulum mass to evaluate the breakaway characteristics of highway signs for MASH 1100C vehicles. Further, researchers at George Washington University and the National Crash Analysis Center, now at George Mason University and the Center for Collision Safety and Analysis (CCSA), conducted research to develop a crushable nose for 1100C surrogate vehicles.

**Research Objective**

The main objective of the research study is to develop, fabricate, test, and evaluate surrogate bogey vehicles and pendulum masses (referred to as surrogate devices) for determining Test Level 3 MASH 2016 crashworthiness with passenger vehicles for breakaway luminaire poles, sign supports, and work-zone traffic control devices used in permanent and temporary applications. The surrogate devices should be capable of providing cost-effective, compliant, impact testing and evaluations of roadside safety hardware, while evaluating as many critical behaviors and failure modes as deemed feasible and reasonable. From this study, researchers will develop 3-D CAD details for the fabrication of prototype, surrogate, MASH 2016 bogey vehicles, which pertain to the 1100C and 2270P passenger vehicles. The study will also result in 3-D CAD details for the fabrication of a 1100C vehicle mass compatible with drop pendulums for use in low-speed impact testing on a subset of breakaway features. Surrogate devices will be fabricated and satisfactorily demonstrated under this study. Limited validations will be performed. Recommendations will be provided regarding the proper applications, test conditions, and limitations for the surrogate devices as well as which critical behaviors and failure modes can be evaluated. A list of major tasks required to successfully complete the research study is provided below.

Phase 1 – Background, Brainstorming, and Preliminary Plan

Task 1: Perform detailed literature review

Task 2: Identify, discuss, and rank important features, properties, dimensions, and structural characteristics for the design of surrogate devices.

Task 3: Identify, discuss, and rank critical system behaviors and failure modes that could be captured under impact testing with surrogate bogey vehicles and a pendulum mass.

Task 4: Brainstorm multiple concepts for surrogate devices. Select preferred concepts and prepare preliminary sketches.

Task 5: Prepare preliminary plan for developing and fabricating surrogate devices

Phase 2 – Develop Surrogate Devices and Prepare Validation Testing Plan

Task 6: Perform analysis and design to configure the surrogate devices.

Task 7: Prepare 3-D CAD details with material specifications.

Task 8: Prepare plan for conducting preliminary validation testing on surrogate devices.

Phase 3 – Fabricate Surrogate Devices and Conduct Validation Testing on Support Systems

Task 9: Fabricate 1100C and 2270P surrogate devices (bogeys, pendulum mass, etc.).

Task 10: Conduct vehicle handling testing and dynamic impact testing on support systems to validate surrogate devices.

Task 11: Redesign and/or modify surrogate devices and update 3-D CAD details as needed.

Phase 4 – Reporting, Dissemination, and Implementation

Task 12: Prepare and submit draft and final research reports with final 3-D CAD details

## **Urgency and Potential Benefits**

State DOTs are required to install crashworthy safety hardware along freeways, interstates, highways, and roadways. In recent years, AASHTO and FHWA agreed to a roadside safety hardware implementation plan corresponding to AASHTO's *Manual for Assessing Safety Hardware* (2016), which included breakaway luminaire poles, sign supports, and work-zone traffic control devices. Each hardware category consists of hundreds, maybe even thousands, of combinations that require crashworthiness testing and evaluations. In addition, many of these devices are provided by private industry and/or are proprietary. Further, a greater number of tests are required under MASH 2016 for these hardware categories, which increases overall crash testing costs using real vehicles. Today, crash testing is required on a greater number of system combinations as compared to many years ago. When considering these facts, a very limited number of these devices have been tested and evaluated under the MASH 2016 impact safety guidelines. Due to unavailability, our State DOTs have only implemented limited quantities of MASH-compliant breakaway luminaire poles, sign supports, and work-zone traffic control devices to date.

The development of surrogate testing devices would reduce complaint testing costs, increase innovation, and promote testing and evaluation of a greater number of devices in the noted roadside safety hardware categories. Over time, more MASH-compliant devices would be placed along U.S. highways and roadways, thus benefiting the motoring public and helping to reduce roadside fatalities and serious injuries.

## **Implementation Considerations and Supporters**

Research findings and results would be provided to state highway agencies, accredited crash testing laboratories, roadside safety hardware developers and manufacturers, as well as private industry. Design details and material specifications for the MASH 2016 surrogate devices would be available to the entire roadside safety community. Accredited testing laboratories as well as private R&D divisions would fabricate the surrogate devices for use in conducting compliant testing under MASH 2016 as well as low-cost R&D testing with pendulums. State DOTs would implement the crashworthy hardware resulting from the use of the new surrogate bogey vehicles and pendulum mass in safety evaluations. This information would be disseminated in national forums via PowerPoint presentations, research summaries, design manuals, and CAD plan sets, including at Pooled Fund Safety Program meetings, Task Force 13 meetings, AASHTO Technical Committee for Roadside Safety (TCRS) meetings, AASHTO T-12 meetings, and Transportation Research Board (TRB) AFB20 Committee on Roadside Safety Design meetings.

The following list includes organizations that would be interested in the research results and would support implementation:

- AASHTO Committee T-12, Sam Fallaha, P.E., (850) 414-4296, sam.fallaha@dot.state.fl.us
- AASHTO Committee T-7, Tim Keller, P.E., (614) 466-2463, tim.keller@dot.ohio.gov

- TRB Committee AKB10, Richard Dunne, P.E., (609) 468-7051, rdunne@gpinet.com
- TRB Sub-Committee AKB10(1), Carl Macchietto, P.E., (402) 359-6735, cmacchietto@valmont.com
- AASHTO TCRS Committee, Keith Kota, P.E., (603) 271-1615, kcota@dot.state.nh.us
- TRB Committee AFB20, Roger Bligh, Ph.D., P.E., (979) 317-2703, R-Bligh@tti.tamu.edu
- Task Force 13, John Durkos, (330) 346-0721, jdurkos@roadsystems.com

### **Recommended Research Funding and Research Period**

Research Funding: The recommended research funding for the proposed study is **\$850,000**, which includes: (1) \$50,000 for Phase 1; (2) \$250,000 for Phase 2; (3) \$450,000 for Phase 3 [\$75,000 to \$125,000 for boogies and mass and \$325,000 to \$375,000 for vehicle handling and validation testing]; and (4) \$50,000 for Phase 4.

Research Period: The recommended research period for the proposed study is **36 months**

### **Problem Statement Author(s)**

- Ronald Faller, Ph.D., P.E., Midwest Roadside Safety Facility, University of Nebraska-Lincoln, (402) 472-6864, rfaller1@unl.edu
- Carl Macchietto, P.E., Valmont Industries Inc., (402) 359-6735, cmacchietto@valmont.com

### **Others Supporting the Problem Statement**

- AASHTO Committee T-12, **Sam Fallaha**, P.E., 850-414-4296, sam.fallaha@dot.state.fl.us
- AASHTO Committee T-7, Tim Keller, P.E., (614) 466-2463, tim.keller@dot.ohio.gov
- TRB Sub-Committee AFF10(1), Carl Macchietto, P.E., (402) 359-6735, cmacchietto@valmont.com

### **Potential Panel Members**

- Sam Fallaha, P.E., Florida DOT, AASHTO T-12, 850-414-4296, sam.fallaha@dot.state.fl.us
- Carl Macchietto, P.E., Valmont Industries Inc., (402) 359-6735, cmacchietto@valmont.com
- Erik Emerson, P.E., Wisconsin DOT, AASHTO TCRS, 608-266-2842, Erik.Emerson@wi.gov
- Geoff Maus, P.E., TrafFix Devices Inc., 949-361-5663, gmaus@traffixdevices.com

- Bill Wilson, P.E., Wyoming DOT, 307-777-4216, bill.wilson@wyo.gov
- Dan Waddle, P.E., Nebraska DOT, 402-479-4594, dan.waddle@nebraska.gov
- Ali Hangul, P.E., Tennessee DOT, 615-741-0840, ali.hangul@tn.gov
- Doug Gabauer, Ph.D., Bucknell University, 570-577-2902, doug.gabauer@bucknell.edu

### **Person Submitting the Problem Statement**

Anne Rearick, P.E.  
(317) 46-3373  
arearick@indot.in.gov  
Chair AASHTO COBS T-11

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### **NCHRP Review of C-07**

Reviewed By:  
David M. Jared  
djared@nas.edu

#### Comments:

I consider this needed, albeit medium-priority research that would explore practical alternatives for determining the crashworthiness of various roadside safety features.  
1/5/2021

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### **FHWA Evaluation of C-07**

Reviewed By: HRDS/Eduardo Arispe

#### Comments:

This research is needed to provide another method of testing and is really important to reduce cost of MASH testing, as well as providing more products available to States.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for C-07**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: 1

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-08**

**Problem Title**

Development of Prefabricated Concrete Barrier Systems for Accelerated Bridge Construction

**Background**

A major knowledge gap in the world of Accelerated Bridge Construction is prefabricated barriers. The knowledge gap is a combination of limited pre-existing prefabricated barriers and the new MASH crash testing requirements.

Precast concrete barriers were previously crash tested to NCHRP 350 requirements. Some of these barriers were evaluated for Test Level 3. States are moving to higher level designs. Test Level 4 is common. Some agencies are moving to Test Level 5. The *AASHTO Manual for Assessing Safety Hardware* (MASH) provides current crash-testing requirements.

The goal of this research is not to develop a “new barrier shape.” The concept is to identify and MASH crash-test prefabricated versions of existing NCHRP 350 approved barriers. During the preliminary phases of the project, a questionnaire can be sent to owner agencies to determine which barriers are commonly used and what test levels are being specified. From that knowledge, the project panel can select the three most appropriate barriers and test levels for the crash testing portion of the project.

Due to durability concerns with exposed concrete surfaces, the researchers and panel may consider the use of non-corrosive reinforcing bars in one of the specimens.

The major challenges to address in this research include:

1. Accommodate various geometric configurations such as vertical curves, horizontal curves, and variable cross slopes
2. Accommodate tolerances
3. Develop durable (waterproof) connections
4. Accommodate accelerated construction schedules (operational in under 12 hours)

**Literature Search Summary**

An ongoing pooled-fund research project led by the Iowa DOT is MASH crash-testing a precast barrier connection detail developed in an ABC-UTC research project conducted at Iowa State University. This is helpful but does not fill the need for other designs. Different agencies use different barriers (F shape, single slope,

etc.). Therefore, a need exists for additional barrier designs that meet the current MASH barrier design/testing provisions.

### **Research Objective**

The objective of this research is to identify and MASH crash-test three non-proprietary prefabricated concrete barriers that can be used on ABC projects. The barriers need to be crash worthy, easy to install, practical, durable, and be able to accommodate variations in geometry.

Research tasks may include:

1. Investigate previous research and previous crash-tested barriers.
2. Research the current barrier needs of each state agency via a questionnaire. This will include the commonly used shapes and test levels for the designs.
3. Working with the project panel, the researcher will determine which three barriers will be used for testing.
4. Coordinate with the AASHTO COBS to obtain buy-in for the proposed barriers to ensure that the barriers will be used if successfully tested.
5. Develop three barrier designs (several may be similar but designed for different test levels). The design portion of the process shall address the deck connection, barrier to barrier connections, variable geometry, durability, and tolerances.
6. Obtain approval from project panel on details.
7. Conduct finite element analysis of connections to gain the most accurate assessment of the potential connection performance. This includes connection to deck and connection between barrier segments.
8. Crash test the three barriers in accordance with MASH testing criteria.
9. Write report including detailed drawings.

It is assumed that the barriers will mimic existing concrete barriers; therefore, testing of transitions should not be required.

### **Urgency and Potential Benefits**

Virtually every state DOT is using ABC at this time and has a need for MASH-tested prefabricated concrete barriers. This work will potentially be a value to all DOTs. Current ABC designs have had to resort to prefabricating barriers integral with prefabricated decks. There are currently no MASH-tested prefabricated concrete barriers in the market. Having several barrier designs that are crash tested and versatile will help fill a major gap in the ABC world.

### **Implementation Considerations and Supporters**

Upon successful testing, coordinate with AASHTO COBS Technical Committees to implement the use of these barriers. The following Technical Committees should be involved:

- T-4 Construction
- T-10 Concrete Design



- T-7 Guardrail and Bridge Rail

### **Recommended Research Funding and Research Period**

#### Recommended

Funding: \$1,000,000

Research Period: 24-

36 months

#### Implementation

Period: 8-12 months

### **Problem Statement Author(s)**

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Member of AFF20 (Steel Bridges), AFF30  
(Concrete Bridges), and AFF00(2) (Accelerated  
Bridge Construction Joint Subcommittee)

### **Others Supporting the Problem Statement**

Tim Keller, P.E.

Chair, AASHTO COBS Technical Committee on Guardrail and Bridge Rail (T-7)  
Administrator, Office of Structural Engineering, Ohio Department of Transportation  
614-466-2463; tim.keller@dot.ohio.gov

Cheryl Hersh Simmons, S.E.

Chair, AASHTO COBS Technical Committee for Construction (T-4)

Chief Structural Engineer

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Ahmad Abu-Hawash, P. E.

Chair, TRB ABC Joint Subcommittee (AKB00(2)) Chair, AASHTO Technical Committee  
for Software and Technology (T-19)

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TRB Roadside Safety Design Committee (AKD20)

Roger Bligh, Chair

TRB Innovative Highway Structures and Appurtenances Committee (AKB10) Dick Dunne,  
Chair

TRB Concrete Bridges Committee (AKB30) Sam Fallaha, Chair

TRB Construction of Bridges and  
Structures Committee (AKC40)

Travis Konda, Chair

**Potential Panel Members**

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**Person Submitting the Problem Statement**

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Chair AASHTO COBS -11

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**NCHRP Review of C-08**

Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem is suitable for funding under the FY 2022 NCHRP. The AASHTO COBS ranked this problem as the 2nd in a group of 5 high-priority problems from the problem statements reviewed this year. The objective of this project is consistent with the 2018 COBS Strategic Plan.

Review Date:  
12/15/2020

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### **FHWA Evaluation of C-08**

Reviewed By: HRDS/Eduardo Arispe, HRDI40/Ben Graybeal

Comments:

HRDS/Eduardo Arispe - This project will be useful, but question why the objective is to develop 3 different barriers. It would probably be more beneficial to let the research determine the number of barriers to develop/test.

HRDI40/Ben Graybeal - The lack of a validated prefabricated concrete barrier system is hindering the use of other ABC technologies. The Iowa DOT-led pooled fund study has developed some useful knowledge but is too limited to be of broad use to owners. Further advancement through completion of the proposed research is warranted.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for C-08**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: 2

Comments: N/A

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American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation

FY2022 NCHRP Problem Statement

**Problem Number:** 2022-C-09

**Problem Title**

“Estimating inelastic displacement demands for bridges under seismic forces”

**Background**

Large earthquakes impose substantial demands on bridge structures that can result in widespread interruption to service, and in extreme cases, collapse. This response is typically inelastic and results in structural damage that is intended to be sustainable with proper structural detailing. Design of common bridges using the AASHTO *LRFD Bridge Design Specifications* and the AASHTO *Guide Specification for LRFD Seismic Bridge Design* methodologies rely on elastic analysis from which inelastic demands are estimated. Accordingly, it is paramount that the estimates be reliable. Inaccurate estimates of demand could result in substantial service interruption and potentially bridge collapse if the actual inelastic response is significantly larger than the estimated design response.

Since the mid-1980's AASHTO has been using an empirically derived, simple coefficient method to estimate inelastic demands from elastic analyses. This method, and its more recent variant that was introduced with the Guide Specification, was based on earlier studies that used a computational damping methodology that has been shown to be unconservative as described in many of the references listed below. With this newer information, it is clear that the current AASHTO methodologies could put new bridges at greater risk of unacceptable damage, and this situation should be corrected.

Recently in an effort to better equip the bridge engineering community to achieve robust designs whose performance can be predicted in future earthquakes, extensive research effort had been directed towards ‘Performance-Based Seismic Design (PBSD)’. In this design process, bridges are designed to achieve prescribed levels of damage under prescribed levels of earthquake intensity. Ultimately PBSD will augment the basic AASHTO design methods and may someday replace these methods. However, accurate estimation of actual inelastic response of bridges will still be as important as they are in the current AASHTO methods.

There are three main components to PBSD: (1) Accurate means to define displacement capacities at key performance limit states; (2) Accurate means to define displacement demands; and (3) A design methodology that allows the engineer to connect the above two aspects. In 2009, AASHTO released the first edition of the *Guide Specification for LRFD Seismic Bridge Design* which aimed to provide initial guidance that achieved these three aspects of PBSD. Currently, through NCHRP 12-106, Proposed Guidelines for Performance-Based Seismic Bridge Design, a methodology has been proposed that

outlines the steps required to achieve PBSB, thus advancing the community beyond the current Guide Specification.

During the conduct of the work in NCHRP 12-106, inconsistencies were discovered regarding the estimation of inelastic displacement demands. The inconsistency was traced to the manner in which viscous damping is modelled in analysis, which subsequently impacts the simplified methods used by engineers to calculate displacement demands. It was shown that calculation of displacements using currently established procedures may severely underestimate the actual displacements that the bridge may be subjected to in future earthquakes. Regardless of whether the engineering community continues to use its conventional methods or transitions towards implementation of PBSB, such inaccuracies are unacceptable and must be addressed. This is a critical need in the bridge design community.

### **Literature Search Summary**

A snapshot of references related to the impact of damping models in structural response is shown below. The research described in this RNS will utilize the observations of past work on damping models and modify methods for simplified displacement demand estimation that incorporate appropriate damping models. Prior research, as shown below, has only focused on impacts of damping model choices (largely for SDOF systems)

Chai, Y.H., and Kowalsky, M.J. (2014). "An Examination of Non-Viscous Damping on Seismic Inelastic Displacements" *Journal of Structural Stability and Dynamics*, Vol. 15#5.

Charney, F. (2008). "Unintended consequences of modeling damping in structures". *ASCE Journal of Structural Engineering*. Vol. 134#4, pp581-592.

Hall, J. F. (2006). "Problems encountered from the use (or misuse) of Rayleigh damping," *Earthquake Engineering and Structural Dynamics*, Vol. 35, pp525–545.

Hall, J. F. (2018). "Performance of viscous damping in inelastic seismic analysis of moment-frame buildings," *Earthquake Engineering and Structural Dynamics*, Vol. 47, pp2756–2776.

Hardyniec, A. and Charney, F. (2015). "An investigation into the effects of damping and nonlinear geometry models in earthquake engineering analysis," *Earthquake Engineering and Structural Dynamics*, Vol. 44#15, pp2695-2715.

Hasgul, U. and Kowalsky M.J. (2014). "Impact of Viscous Damping Models on Nonlinear Response of SDOF Systems". *Proceedings of the 10th National Conference in Earthquake Engineering, Earthquake Engineering Research Institute, Anchorage, AK, 2014.*

Lanzi and Luco (2018). "Elastic velocity damping model for inelastic structures," *ASCE Journal of Structural Engineering*, Vol. 144#6.

Luco and Lanzi (2017). "A new inherent damping model for inelastic time history analysis," *Earthquake Engineering and Structural Dynamics*, Vol. 46, pp1919–1939

Otani, S. (1981). "Hysteresis models of reinforced concrete for earthquake response analysis," Journal of the Faculty of Engineering, The University Tokyo, Vol. 36#2, pp. 407-441.

Petrini, L., Maggi, C., Priestley, M.J.N. and Calvi, G.M. (2008). "Experimental Verification of Viscous Damping Modeling for Inelastic Time History Analyzes", Journal of Earthquake Engineering, Vol 12#1, pp125-145.

Priestley, M. J. N. and Grant, D. N. (2005). "Viscous Damping in Seismic Design and Analysis" Journal of Earthquake Engineering Vol. 9 #SP2, pp229–255.

Priestley, M.J.N., Calvi, G.M., and Kowalsky, M.J. (2007) "Direct Displacement-Based Seismic Design of Structures" IUSS Press, Pavia Italy, ISBN 978-88-6198-000-6. 740 pp.

### **Research Objective**

The objective of the research is to develop robust procedures for calculation of inelastic displacement demands in bridges while also providing guidance on how to best model damping in non-linear response history analysis.

Specific tasks of the research to accomplish the main objective include:

- Task 1: Identify and summarize the current literature on the impacts of damping models on non-linear response of structures.
- Task 2: Review current techniques for evaluating displacement demands and compare them against the results of non-linear response history analysis. This should be conducted for both single degree of freedom and multiple degree of freedom bridge systems.
- Task 3: Prepare an interim research report documenting the results of Tasks 1 and 2.
- Task 4: Develop recommendations for approaches to calculate inelastic displacement demands, as well as recommendations for appropriate damping models when non-linear response history analysis is deployed as part of design verification.
- Task 5: Address review comments and prepare final research report presenting the complete results of the research.
- Task 6: Develop draft AASHTO ballot language

The final products of this project will be (a) guidelines for simplified methods of evaluating displacement demands that are robust and accurate, (b) guidelines for the modelling of damping in non-linear response history analysis. (c) AASHTO ballot-ready language for the adoption of the model procedures in the AASHTO specifications for the seismic design of bridges.

### **Urgency and Potential Benefits**

Based upon observations developed during the conduct of NCHRP 12-106, current methods for evaluating displacement demands may be substantially non-conservative, leading to bridges that may sustain much higher displacements (and hence damage) than what was expected during the design phase. Implementation of PBSD requires accurate estimation of displacement demand, making this vitally important to the

engineering community. Even for lower seismic states, the assumptions used to obtain seismic design force levels are based on erroneous assumptions that need investigation. Failing to do so may lead to inferior bridge performance in the event of any earthquake.

### **Implementation Considerations and Supporters**

This research will be implemented by structural engineers within state DOTs. Implementation should be straightforward via individual state bridge design manuals, as well as updated language for both the AASHTO *Guide Specifications for LRFD Seismic Bridge Design* and the AASHTO *LRFD Bridge Design Specifications*. AASHTO T-3 is the most relevant committee to assist in implementation.

### **Estimate of Problem Funding and Research Period**

Recommended Funding: **\$450,000**

Research Period: The project will be completed in **thirty-six (36)** months.

### **Problem Statement Author(s)**

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Ian Buckle, Professor, University of Nevada Reno. Member AFF50. 775-784-1519. [igbuckle@unr.edu](mailto:igbuckle@unr.edu)

### **Others Supporting the Problem Statement**

Tom Ostrom, CALTRANS

Richard Pratt, Alaska DOT&PF, Chair AASHTO CBS T-3 seismic committee

Elmer Marx, Alaska DOT&PF, Chair TRB AFF50 seismic committee

Derek Soden, FHWA

### **Potential Panel Members**

AASHTO CBS T-3 Seismic Committee members

Dennis Heckman, MODOT, 573-751-4676, [Dennis.Heckman@modot.mo.gov](mailto:Dennis.Heckman@modot.mo.gov)

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TRB AFF-50 Seismic Committee Members

Elmer Marx, Alaska DOT&PF, 907-465-6941, [elmer.marx@alaska.gov](mailto:elmer.marx@alaska.gov)

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Derek Soden, FHWA, 720-413-7436, [derek.soden@dot.gov](mailto:derek.soden@dot.gov)

### **Person Submitting the Problem Statement**

Anne Rearick

Director of Bridge Management/ Chair AASHTO COBS T-11 Research

Indiana Department of Transportation

(317) 946-3373

## **NCHRP Review of C-09**

Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem is suitable for funding under the FY 2022 NCHRP. The AASHTO COBS ranked this problem as the 3rd in a group of 5 high-priority problems from the problem statements reviewed this year. The objective of this project is consistent with the 2018 COBS Strategic Plan.

Review Date:

12/15/2020

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## **FHWA Evaluation of C-09**

Reviewed By: HIBS10/Jia-dzwan Shen

Comments:

The evaluation of seismic displacement demand is becoming a major factor in the quality of seismic design as displacement-based design moves towards mainstream. This study addresses issues in the research leading to the design assumptions that have been questioned, and is therefore both important and urgent. This project will be an important stepping stone in the implementation of performance-based seismic design and possible incorporation into the AASHTO LRFD.

Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for C-09**

### **Estimating inelastic displacement demands for bridges under seismic forces**

Submitted By:

Patricia Bush



AASHTO Staff  
Committee on Bridges & Structures

Priority #: 3

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**PROBLEM NUMBER: 2022-C-10**

**PROBLEM TITLE**

Evaluation of Load Rating and Posting of Long-Span Bridges

**BACKGROUND**

The tragic collapse of the I-35W bridge over the Mississippi River in Minneapolis, MN raised a great deal of awareness of construction methods, inspection and gusset plates, among other things. However, once the resolution of these issues have become a part of the bridge specifications, and similar problems are found in the future, how should a bridge engineer analyze and restrict traffic on a structure as large as the I-35W bridge?

Bridge engineers typically restrict traffic by implementing a load restriction on a structure. This is usually embodied by a posted weight limit sign adjacent to the structure. The weight limit is usually based on a state's legal loads evaluated at the Operating level (i.e. the maximum load a bridge can safely support), and can range from 3 tons gross vehicle weight (GVW) up to the maximum legal load for a state, typically 40 tons GVW. Furthermore, a weight limit sign can also indicate limits for different vehicle configurations, such as a 15 ton GVW limit for a single unit vehicle, but 25 tons GVW for a 5 axle combination unit vehicle, as an example.

Although the current AASHTO Specifications provide sufficient direction for bridges with span lengths  $\leq 200$  feet, they are vague in the evaluation of structures with span lengths  $> 200$  feet. While LRFD/LRFR provides better direction than LFD/LFR, they both lack a complete and consistent approach to evaluating live loads, load ratings and postings.

The volume and composition of traffic vary with ADTT, speed, number of lanes, etc. Although span lengths do not directly affect traffic patterns, the probability of these patterns is affected which in turn affect live load force effects.

While long span bridges may commonly get special rigorous engineering and analysis in the design phase, this does not mean there are practical methods available for limiting loads in service when deterioration or other conditions warrant. Furthermore, the current load rating specifications absolutely do not address spans longer than 300 feet, with vague language addressing spans between 200 and 300 feet. Also, one of the top hoped-for outcomes of this research is a specification that helps owners post long span bridges if lane load controls, which is more likely the longer the span. For instance, how would lane load be modelled for a long span bridge to determine an allowable load capacity, and possible subsequent posting?

According to the NBI, 5845 bridges have span lengths greater than 200-ft. 3937 of these were built before 2000. As the structures continue to age and as states switch to implementing LRFR, the importance of a rational rating and posting method for these structures greatly increases. Additionally, these 5845 bridges have 530 Million square feet of deck area. While only 1% of bridges, they are 12% of the deck area, and therefore the importance is greater.

This research will assist states with safety and mobility.

## **LITERATURE SEARCH SUMMARY**

A brief search was performed with limited success.

1. AASHTO Manual for Bridge Evaluation, 3<sup>rd</sup> Edition, 2018.
  - a. LRFR
    - i. Legal Loads: 6A.4.4.2.1a: For span lengths > 200 feet, an additional legal load vehicle consisting of the AASHTO Type 3-3 or state legal load multiplied by 0.75 and combined with a lane load of 0.2 klf (Figure D6A-4).
    - ii. Permit Loads: 6A.4.5.4.1: For span lengths between 200 feet and 300 feet, an additional lane load of 0.2 klf shall be applied in each lane. Nothing is said for span lengths > 300 feet.
  - b. LFR
    - i. Legal Loads: 6B.7.2: For span lengths > 200 feet, the selected legal load should be spaced with 30 feet clear distance between vehicles to simulate a train of vehicles in one lane and a single vehicle load should be applied in the adjacent lane.
2. AASHTO LRFD Bridge Design Specifications, Eighth Edition, 2017.
  - a. 4.6.2.2.5: Special Loads with Other Traffic: Provides guidance and a formula to determine force effects resulting from heavy vehicles in one lane with routine traffic in adjacent lanes.
  - b. C4.6.2.2.5: States the formula given was developed from a similar formula presented without investigation by Modjeski and Masters, Inc. 1994, *Report to Pennsylvania Department of Transportation*, as was examined in Zokaie, T. 1998, *Private Correspondence*, neither of which are readily available.
3. AASHTO Standard Specifications for Highway Bridges, Seventeenth Edition, 2002.
  - a. 3.7.1: Standard lane load is used to emulate truck trains.
  - b. 3.22.4: LFD, gamma factor, from Load Factor Table 3.22.1A, should be increased for long span structures using Engineer's judgment.

## **RESEARCH OBJECTIVE**

The objective of this project is to develop a consistent and clear method to analyze live load force effects, load rating and load posting methods for structures with span lengths > 200 feet in length.

A possible scope may include some or all of the following tasks:

1. Critically review existing literature, including surveying the states' current practices.
2. Evaluate and compare 1) varying force effects, 2) load ratings and 3) posting methods caused by applying various live load configurations:
  - a. Design vs. Legal vs. Permit Vehicles.
  - b. Same Vehicle in all lanes of traffic.
  - c. Truck Train in Study Lane with Design Vehicle in Adjacent Lane(s).
  - d. Truck Train in Study Lane with Specified Vehicle in Adjacent Lane(s).
  - e. Truck Train in all Lanes.
3. Develop consistent definitions for:
  - a. Span Length or Influence Length
  - b. Truck Train
  - c. Study Lane
  - d. Adjacent Lane(s)
4. Develop method to account for reduced Adjacent Lane force effect when bridge needs to be posted. If the bridge will be posted to restrict vehicle weight, the same restriction will apply to the vehicle in the adjacent lane; thus, the analysis should consider this when calculating the load rating factor.
5. Develop method to incorporate state specific legal vehicles and routine permit vehicles.
6. Propose modifications to the AASHTO Manual for Bridge Evaluation for both LRFR & LFR methods.
7. Propose modifications to the AASHTO LRFD Bridge Design Specifications.
8. Prepare and submit final report.

### **URGENCY AND POTENTIAL BENEFITS**

Long-Span structures are a vital component of our infrastructure and are typically the most valuable assets we own. They also receive the most attention when something goes wrong. It's imperative, as bridge engineers, that we have consistent and clear methods to evaluate them for the safety of the motoring public. This research is necessary to achieve that goal.

### **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

This research will be used by state bridge load rating engineers to safely rate and restrict loads on long span bridges. Existing policies will need to be reviewed and load rating engineers trained. A potential option for training is a webinar.

### **RECOMMENDED PROBLEM FUNDING AND RESEARCH PERIOD**

**Recommended Funding:**

\$500,000

**Research Period:**

24 months

**PERSON(S) DEVELOPING THE PROBLEM**

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**OTHERS SUPPORTING THE PROBLEM STATEMENT**

AASHTO Subcommittee on Bridges T-18, Bridge Management, Evaluation and Rehabilitation

**Potential Panel Members**

Members of T-18

**PERSON SUBMITTING THE PROBLEM STATEMENT**

Anne Rearick, P.E.  
Chair, T-11  
Director of Bridge Management  
Indiana Department of Transportation  
Phone (317) 232-5152  
arearick@indot.in.gov

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**NCHRP Review of C-10**

Reviewed By:  
Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem is suitable for funding under the FY 2022 NCHRP. The AASHTO COBS ranked this problem as the 5th in a group of 5 high-priority problems from the problem statements reviewed this year. The objective of this project is consistent with the 2018 COBS Strategic Plan.

Review Date:  
12/15/2020

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### **FHWA Evaluation of C-10**

Reviewed By: HIBS10/Lubin Gao

Comments:

Appropriate load rating and posting of long-span bridges is crucial for safe operation of these essential assets. However, current evaluation specifications lack clear and definite guidance for these bridges. It is of great importance and high priority to investigate the issues discussed in the problem statement and propose modifications and improvements to MBE. This problem statement is anticipated to facilitate the developmet of guidance that is much needed by state DOTs and other bridge owners.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for C-10**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: 5

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-11**

**Problem Title**

Improved Demand Predictions on Shear Studs for Composite Steel Bridge Design

**Background**

To ensure full composite action in a steel-girder bridge, shear studs must be provided along the length of a bridge at the interface between the concrete deck and the steel section to resist the interface shear and prevent slip along the interface. Currently, designers determine the stud proportions and the required stud pitch to satisfy both the fatigue and strength limit states. There have been instances where some designs have appeared to have an excessive number of shear studs. Shear stud quantity and subsequent installation increases steel bridge fabrication cost. In addition to undesirable increases in costs, an excessive number of shear studs produces unsafe conditions since the studs can pose a tripping hazard for iron workers.

In 2019, the National Steel Bridge Alliance (NSBA) created a task group to review recent and historical research conducted on shear studs and to develop a ballot of recommend changes to the shear stud design provisions within the AASHTO LRFD Bridge Design Specifications (BDS). The NSBA shear stud task group identified a number of proposed.

Aside from modifying pitch provisions for clustered shear studs, the changes mostly reflect proposed revisions to the resistance of a shear stud. The task group also determined that the demand on shear studs for composite steel-girder bridges warranted further investigation. The group identified the following two areas in which further research is necessary to understand the demand on shear studs for steel-girder bridges at the fatigue limit state:

- Allowing friction and cohesion as mechanisms to assist in transferring the horizontal shear force between a concrete deck and the top flange of a steel girder
- Further investigation of the applicability of the current AASHTO LRFD BDS horizontal shear flow equation ( $VQ/I$ ) to shear studs

Currently Section 6 of the AASHTO LRFD BDS only allows the horizontal shear force between a concrete deck and steel girder to be transferred through the shear studs. However, field studies on steel girder bridges designed as noncomposite have indicated that some level of unintended composite action is present despite having no shear studs. Further, AASHTO LRFD BDS Section 5 allows for the horizontal shear force to be transferred through the steel reinforcing bars as well as through friction and cohesion between the concrete deck and the top flange of concrete girders. Given that some shear force appears to be transferred between the concrete deck and girder through friction and cohesion, it seems logical to

account for this behavior in determining the stud demand for steel-girder bridges, which may further decrease the number of shear studs that are required at the fatigue limit state.

The current specified method of determining the fatigue shear force range on shear studs is by using the classic shear flow equation, where shear force per unit length =  $VQ/I$ . In a composite girder, this shear flow equation assumes that shear is continuously transferred between the concrete deck and steel girder even though shear studs are placed at discrete locations along the girder length. A recent analytical study showed that when shear studs were placed at a large spacing, significant differences were found between the shear stud demands predicted by the AASHTO LRFD BDS and those predicted by a calibrated finite element model<sup>1</sup>. In order to evaluate this postulate further, shear studs must be instrumented on newly designed bridges, and controlled load tests must be conducted after the bridge is in service to determine the measured demands on shear studs.

By investigating the above topics, it is anticipated that the demand on shear studs at the fatigue limit state will be reduced, which will reduce the quantity of required shear studs without compromising the safety of steel girder bridges. A reduction in the number of shear studs will also increase the efficiency of fabrication and erection as well as decreasing the number of tripping hazards during construction.

### **Literature Search Summary**

The following are the previous studies that are referenced in this Research Needs Statement: <sup>1</sup>Ovuoba, B., and Prinz, G.S. (2018). "Analysis of shear stud fatigue demands in composite bridge girders having varied stud pitch, girder depth, and span length." *Journal of Bridge Engineering*, ASCE, 23(11).

<sup>2</sup>Hillhouse, B., and Prinz, G.S. (2020). "Effects of clustering and flange surface friction on headed shear stud demands." *Journal of Bridge Engineering* (ASCE), [Accepted for Publication].

### **Research Objective**

The objective of this research is to develop more accurate demand predictions on shear studs for composite steel bridge design. Results from this research are anticipated to reduce the specified demand on shear studs at the fatigue limit state, which should lead to a further decrease in the number of shear studs required on composite steel girder bridges.

The following tasks are anticipated for this research:

1. Task 1 – Literature Review – The research team will perform a literature review to find and evaluate relevant past studies.
2. Task 2 – Laboratory Experimental Testing – The research team will perform experimental tests in a laboratory to evaluate the effect of friction on shear stud demands for different concrete deck and steel girder top flange combinations. The concrete contact surfaces to be tested should include cast-in-place concrete, precast concrete, and grout. The steel girder surfaces to be tested should include mill scale, blast cleaned, and coated. Zinc rich primers are believed to represent a lower bound on the



- friction coefficient of coated steel surfaces.
3. Task 3 – Field Testing – The research team will perform controlled load testing on bridges in service to determine the actual demand on shear studs when also accounting for friction and cohesion shear force transfer between the deck and steel girder.
  4. Task 4 – Develop Specification Language – Based upon the research findings, the research team will propose revisions to the AASHTO LRFD BDS in the form of draft specifications and commentary.
  5. Task 5 – Design Examples – The research team will prepare design examples using the proposed specifications to illustrate the change in the required number of shear studs to satisfy the strength and fatigue limit states.
  6. Task 6 – Final Report – The research team will document and submit the findings and recommendations in a final report.

### **Urgency and Potential Benefits**

Proposed changes from this research should further reduce the number of shear studs required on steel girder bridges, which will reduce engineering costs, improve fabrication and construction efficiency, and improve erection safety.

Reducing the number of shear studs will also facilitate the use of Accelerated Bridge Construction with precast concrete full-depth deck panels. In some cases, the number of required studs cannot be met without very large pockets in each panel.

These benefits will be applicable to all bridge agencies.

### **Implementation Considerations and Supporters**

The findings in this study will be implemented through potential modifications to the AASHTO LRFD Bridge Design Specifications. It will be used by all designers of composite steel bridges.

### **Recommended Research Funding and Research Period**

This research effort is anticipated to cost approximately \$900,000. This research is anticipated to last approximately 48 months.

### **Problem Statement Authors**

1. Jamie Farris, PE; Texas Dept. of Transportation; Jamie.Farris@txdot.gov
2. Jason Provines, PE, Virginia Transportation Research Council, jason.provines@vdot.virginia.gov
3. Justin Ocel, PhD, PE, Federal Highway Administration, justin.ocel@dot.gov
4. Gary Prinz, PhD, PE, University of Arkansas, prinz@uark.edu

### **Others Supporting the Problem Statement**

The AASHTO Technical Committee T-14 maintains a research priority list. This proposed research is number 2 on the T-14 list.

This Research Needs Statement was the number one priority for the TRB Steel Bridge Committee AKB20 (formerly AFF20).

## **Potential Panel Members**

A specific recommended panel has not yet been developed. Proposed panel members would most likely include members of the TRB Steel Bridge Committee AKB20 and members of AASHTO Technical Committee T-14.

## **Person Submitting the Problem Statement**

Anne Rearick, PE; Indiana Dept. of Transportation; arearick@indot.in.gov

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## **NCHRP Review of C-11**

### Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem is suitable for funding under the FY 2022 NCHRP. The AASHTO COBS ranked this problem as the 4th in a group of 5 high-priority problems from the problem statements reviewed this year. The objective of this project is consistent with the 2018 COBS Strategic Plan.

### Review Date:

12/15/2020

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## **FHWA Evaluation of C-11**

Reviewed By: HRDI40/Justin Ocel

### Comments:

The AASHTO CBS T-14 committee is currently considering revisions to the AASHTO LRFD BDS that will partially mitigate the perception of an unnecessarily high number shear connectors between steel girders and concrete bridge decks. The viability of friction as part of composite action appears to be warranted and would reduce the required number of shear connectors. This RNS is addressing the knowledge gaps so that T-14 can take future actions pertaining to friction in composite action.

### Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for C-11**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: 4

Comments: N/A

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-12**

**Problem Title**

Guidance for Including Right-Of-Way and Utilities in Value Engineering Studies

**Background/ Needs Statement**

According to 23 CFR 627, a *Value Engineering (VE) analysis* is the systematic process of reviewing and assessing a project to identify the needed project functions, optimize the value and quality of the project; and reduce the time to develop and deliver the project. It also indicates that state transportation agencies (STAs) must conduct VE studies for projects on the National Highway System (NHS) receiving Federal assistance with an estimated total cost of \$50 million or more; and bridge projects on the NHS receiving Federal assistance with an estimated total cost of \$40 million or more. It is not necessary to conduct VE studies for design/build projects, but the federal regulations provide guidance for construction manager/general contractor (CM/GC) projects. STA policies and requirements typically mirror those at the federal level. VE studies have been effectively incorporated into the STA project development process. A valuable consideration would be to enhance the VE concept by providing focused guidance for the specialties of right of way and utilities will be valuable.

The VE studies body of knowledge is largely silent on the topic of right-of-way and utilities. At the national level (both federal regulations and FHWA guidance documents), there are only casual references to right-of-way or utilities in VE studies. Something similar happens at the state level. STA manuals typically include guidance on how to conduct VE studies, but any reference to right-of-way or utilities is brief and without any practical guidance. This lack of documented knowledge increases the risk that VE study teams will lack the kind or level of right-of-way and utility information they need to do their job properly. It also means that VE studies might be missing unique opportunities to add value to a project.

Considering that right-of-way and utilities are frequently considered two of the top three reasons that projects experience delays (the third reason is the environmental process), it is important to identify and implement ways to include right-of-way and utility topics more effectively in the scope of and procedures for conducting VE studies.

**Literature Search Summary**

The body of knowledge is silent on the topic of right-of-way and utilities in VE studies. At the national level (both federal regulations and FHWA guidance documents), there are only casual references to right-of-way or utilities in VE studies. Something similar happens at the state level. STA manuals typically include guidance on how to conduct

VE studies, but any reference to right-of-way or utilities is brief and without any practical guidance.

### **Research Objective**

The proposed research objective is to complete the following tasks:

- Conduct online survey of STAs to examine practices to conduct VE studies, with a specific focus on right-of-way and utilities.
- Conduct follow-up interviews with select STAs.
- Review sample VE study reports and conduct interviews with the corresponding STA officials and VE study teams that.
- Develop guidelines for the inclusion of right-of-way and utilities in VE studies.
- Test the guidelines on pilot VE studies.

### **Urgency and Potential Benefits**

Utility and right of way issues are repeatedly documented as causes for project delay and increased costs. It is imperative to the tenants defined in value engineering to consider these aspects of project development and delivery. They are critical factors in project costs, potentially offsetting the VE benefits garnered through the VE process. The research would have a number of benefits including, but not limited to, the following:

- Earlier and more effective identification of right-of-way issues that might have been overlooked by a project team reduces project risk in terms of cost and schedule.
- Earlier and more effective identification of utility issues that might have been overlooked by a project team reduces project risk in terms of cost and schedule.
- Construction delay claims will be reduced with fewer right-of-way and utility issues
- Lower right-of-way acquisition and utility relocation costs are expected.

### **Funding Requested and Time Required**

It is estimated that this research will take 24 months to complete and will require \$400,000.

### **Others Supporting the Problem Statement**

The AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Controls supports this Research Needs Statement.

Contact: Casey Soneira, csoneira@ashto.org, 202-624-5824

### **Potential Panel Members**

Rob Stapley, AASHTO Right of Way Technical Subcommittee Vice Chair,  
rostapley@mt.gov, 406-444-6063

Patrick Allen, AASHTO Utility Project Scoping & Coordination Technical Subcommittee Chair,  
paallen@dot.ga.gov, (404) 631-1380

Dean Serna, AASHTO Utility Project Scoping & Coordination Technical Subcommittee  
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### **CONTACT PERSONS**

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### **Person Submitting the Problem Statement**

Casey Soneira, AASHTO (on behalf of the Committee on Right of Way, Utilities, and  
Outdoor Advertising Controls), 202-624-5824, csoneira@ashto.org

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### **NCHRP Review of C-12**

#### Reviewed By:

Christopher T. McKenney  
CMcKenney@nas.edu

#### Comments:

Value engineering (VE) is a systematic method to improve the "value" of goods or products and services by using an examination of function and that value is the ratio of function to cost. VE at times is mistaken for Lean Construction (LC), which is a combination of operational research and practical development in design and construction with an adaption of lean manufacturing principles and practices to the end-to-end design and construction process. Construction is a project-based production process and LC is concerned with the alignment and holistic pursuit of concurrent and continuous improvements in all dimensions of the build including but not limited to design, construction, and maintenance. This problem statement should be considered as a Guidance for Including Right-Of-Way and Utilities in Lean Construction Analysis. Since this problem statement reads more about "state-of-practice" it should be considered for Synthesis rather than a formal research project.

Review Date:  
12/22/2020

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**Submitter Response for 2022-C-12**

re factored into the overall project "value". The most value to be garnered from effective right of way and utilities can be found early in the project's development, and we seek to understand effective means of incorporating these into the 'value' analysis. Ergo we do not wish to move this research into Lean Construction (LC). The second comment recommended that this become a Synthesis rather than a formal research project. The objectives identified in bullet points 4 and 5 are not synthesis tasks and are critical to developing the guidance needed. In order to retain this tasks, we feel the RNS should remain as drafted.

**Contact Info:**

Patrick Allen, Georgia DOT  
AASHTO Utility Project Scoping & Coordination Technical Subcommittee Chair  
AASHTO Committee of Right of Way, Utilities and Outdoor Advertising  
Utilities Subcommittee  
Email: paallen@dot.ga.gov  
Phone: (404) 631-1380

Review Date:

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-C-13**

**Title**

Guideline for Depicting Existing and Proposed Utility Facilities in Design Plans

**Background**

The collection and depiction of utility information has been a long-standing need within the transportation industry. Utility information varies in degree of accuracy, source and timeframe collected which makes it difficult to depict correctly and with an indicated level of confidence. Generally surveyors only pick up marked or visible facilities on the ground and make no effort to determine whether that information is complete or accurate.

It is critical for this research to document a sound understanding of utility data, managing that data, and documenting data confidence obtained from various sources, such as; One Call marking system, utility records, engineering and survey collection, subsurface utility investigation methods (as documented in the second Strategic Highway Research Program (SHRP2) R01B) and others as identified. Data management as investigated in SHRP2R01A proposed to implement a state-of-the-art 3D storage and retrieval data model to accommodate data, interface with existing design software, and provide designers with a tool to use captured data on underground utilities. This research should evaluate the benefits of implementing R01A in regards to project delivery and improved records. Complete and reliable existing utility data is valuable information for all including Subsurface Utility Engineering investigation, designers, utility coordinators and utility owners; enabling them to identify alternative design solutions to prevent the costly relocation of the utilities.

FHWA has promoted the appropriate use of utility investigations and depiction of utility information in proposed project design plans, as explained in the American Society of Civil Engineering (ASCE) 38 Guidelines. During a recent FHWA Utility Program Review, it was discovered that many STAs can improve in developing and establishing best practices for the collection and depiction of sufficient existing utility information. It was also concluded that there is some insufficient effort depicting proposed or relocated utility information for contractors. Without adequate existing utility data efforts like identifying utility conflicts becomes increasingly difficult. If the proper utility data is collected and depicted products like SHRP2 R15B and the concept of the Utility Conflict Matrix (UCM) can be leveraged. The use of UCM will improve cooperation among highway agencies and utility companies for faster and more efficient project delivery.

Other STAs who do use advanced utility investigations, don't clearly delineate a confidence level of the utility information collected. Most STAs also don't show any proposed utility relocations on the project plans other than perhaps attaching utility



relocation drawings as information or reference. The approach in communicating utility information collected needs guidelines for improved practice.

This project will unify the above concepts to identify best practices for retrieving data (including R01A and R01B), depicting data (including ASCE 38) and identifying conflicts (including R15B) for all of the collected information about utilities. The practice of better utility records, proper depiction and conflict analysis will allow for better decision making for STAs and their consultants who perform design and utility coordination for transportation projects.

### **Research Objective**

The objectives of this research is to develop guidance for STAs on best practices for retrieving data (including R01A and R01B), depicting data (including ASCE 38) and identifying conflicts (including R15B),. The research should have a primary objective focus on how information is depicted. For example, if a design team has a collection of point files, how is that information shared with a potential bidder so that risk is minimized.

These goals include defining approaches to:

- Reconcile conflicting utility information from various sources
- Prioritize the depiction of data from multiple sources,
- Depicting existing, proposed and relocated facilities
- Depicting data indicative of confidence level with design standards

The research objective will be achieved through the completion of research tasks to be described by the research team that best addresses the research questions and goals.

Recommended tasks include:

1. Survey of stakeholders from across the country should be included.
2. Examination of case studies and best practices, e.g. SHRP2 products RO1A, R01B, R15B and ASCE 38 Guidelines, and SHA Implementation Efforts Underway
3. Development of guidance documents addressing
  - a. Retrieving and Managing Data (i.e. GIS, SUE, raster files, Point Files (CADD or CSV coordinate data, etc.)
  - b. Depicting data (i.e. line styles, utility plan sheets, use of color, etc.)
  - c. Conflict analysis of data (i.e. 3D design, UCM techniques, etc.)
4. Conduct an exploratory workshop for refinement
5. Implement a proof of concept trial on a state DOT project

The following research questions should be considered for this study:

1. How should utility information from multiple sources be stored and retrieved based on SHRP2, RO1A research?
2. How should utility information from multiple sources be depicted per ASCE 38 standards? Is a record drawing to be considered in the same as surveying One Call markings?

3. Can we identify STAs that have exemplary practices documenting utilities information from utility company records and other sources on their plans? What utility information should be shown on the STA design plans? How should they be depicted and how does data source impact the depiction? Should existing and proposed utilities be depicted and how so?

### **Urgency, Payoff Potential, and Implementation**

The use of inaccurate data contributes to the \$50 billion drain on the United States economy caused by utility and highway coordination. The proper denotation and use of utility information will eliminate substantial risk from STA projects. STAs are highlighting the importance of utility coordination just as more utilities are being installed within ROW. These standards are needed before these trends exacerbate the previous defined problems.

Without best practices and specifications in collection, management and the depiction of utility information, many STAs will simply force utilities to relocate that might not truly be in conflict with the project. This research is needed to combat this practice. This project reduces risk to the delivery of timely projects, and millions of dollars in unnecessary costs to project budgets or utility ratepayers.

### **Estimate of Problem Funding and Research Period**

The estimated cost is \$550,000 and duration is 36 months.

### **Problem Statement Authors**

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### **Others Supporting the Problem Statement**

AASHTO Committee on Right-of-Way, Utilities and Outdoor Advertising Control

- Contact info: Casey Soneira, AASHTO, csoneira@ashto.org , 202-624-5824

AKD60, TRB Standing Committee on Utilities

### **Person Submitting the Problem Statement**

Casey Soneira on behalf of the Committee on Right of Way, Utilities, and Outdoor Advertising Controls, 202-624-5824, csoneira@ashto.org

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### **NCHRP Review of C-13**

#### Reviewed By:

Christopher T. McKenney  
CMcKenney@nas.edu

#### Comments:

The collection and depiction of existing and proposed utility information has been a need with the transportation industry. Fortunately, technology is assisting in this effort. One FY16 research study conducted by ARDOT utilized Ground Penetrating Radar (GPR), which contributed to finding unmarked lines that were not on the original construction drawings. It is the recommendation that problem statement 2022-C-13 and 2022-D-07 be combined into one problem statement that could be "Guidance for Depicting Existing and Proposed Utility Facilities in Design Plans by Incorporating electromagnetic (EM) sensors and GPR. The reasoning for both EM and GPR is due to the fact not all piping is metallic as piping can also be nonmetallic which may be detected by EM sensors. With potentially combining two problem statements, the other recommendation is extend the period to at least 36 months and increase the budget starting at \$750,000 to \$900,000.

#### Review Date:

12/22/2020

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### **FHWA Evaluation of C-13**

#### Reviewed By: HRDI/Morgan Kessler

#### Comments:

Although the needs of this RNS are valid and prudent, effort should be made to ensure that this research is in lockstep with national BIM for Infrastructure and GIS-T

work. The proposed research involves marking and defining utility features, and this has similar goals to future BIM for Infrastructure modeling efforts, particularly with IFC protocols. Overall, this is a good, needed RNS, but it must not be performed in a vacuum, considering all of the national-level movement towards model and object-based infrastructure management.

Review Date:

12/18/2020

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### **AASHTO Committee Evaluation for C-13**

Submitted By:

Casey Soneira

AASHTO Staff

Committee on Right of Way, Utilities, and Outdoor Advertising Control

Priority #: 1

Comments: The collection and depiction of existing and proposed utility information is a significant need for the transportation industry. Depiction of utilities on plans is an underserved point of study and has value to impart to the industry in terms of plan preparation guidance. As designed, this study will provide guidance that DOTs can implement immediately.

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### **Submitter Response for 2022-C-13**

*[Submitter provided an updated problem statement but that has not been included since it has not gone through the review process.]*

**From:** [email: csoneira@aaashto.org]

#### **Comments:**

Response to FHWA Comments. We agree that national BIM for Infrastructure and GIS-T work should be a consideration in the development of this research. The depiction, marking and defining utility features on plans, will undoubtedly play a key role in future BIM for Infrastructure modeling and object-based infrastructure management techniques. We will ensure the RNS is amended to include this requirement in the objectives.

#### **Comments:**

Response to NCHRP Comments. The collection and depiction of existing and proposed utility information is a significant need for the transportation industry. We believe that depiction of utilities on plans is an underserved point of study and has value to impart to the industry in terms of plan preparation guidance. As a result, we wish to

move forward with 2022-C-13 independently of 2022-D-07. We have recommended to pull the 2022-D-07 proposal from consideration until ongoing on subject research is complete.

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Review Date: 1/11/21

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022-C-14**

**Problem Title**

Advancing multi-sensor weigh-in-motion (WIM) for improving weight data accuracy and reliability

**Background**

Accurate weigh-in-motion (WIM) data is essential for a multitude of design and management activities related to pavement and bridge infrastructure. To support the significant needs and investment in infrastructure, as well as the needs to assess changes in travel patterns and loading during transformational change from pandemic and other disruptive challenges including wildfires, data on truck and traffic patterns allow DOTs to be nimble and well informed through the installation and maintenance of WIM systems. WIM sensors vary from instrumented metal plates to piezoelectric, quartz, and strain gauge strip sensors. Their accuracy is evaluated with reference to static loads (ASTM E1318) and as a result, it is affected by the interaction between roadway roughness and vehicle dynamics/speed. This affects more the narrow strip WIM sensors that sample a smaller part of the dynamic axle loads applied to the road. This shortcoming can be mitigated by utilizing multiple strip sensors (two or more), strategically spaced to capture more data points of the dynamic axle load. The result will be more accurate estimates of the static axle loads applied. Another benefit is the improvement in reliability, since failure of one of the sensors will not render the WIM system inoperable.

**Literature Search Summary**

The proposed research will complement the following relevant studies and documents:

Cebon, D and C.B. Winkler (1991), "Multiple-sensor weigh-in-motion: theory and experiments", Transportation Research Board Record No. 1311, pp 70-78.

COST 323 (1996). "Portable and Multiple-Sensor WIM System Trial"  
[http://wim.zag.si/reports/trappes/trappes\\_report.html](http://wim.zag.si/reports/trappes/trappes_report.html) (accessed 10-16-2020)

Gonzalez, A., A.T. Papagiannakis and E.O'Brien, (2003) "Evaluation of an Artificial Neural Network Technique Applied to Multiple-Sensor Weigh-In-Motion Systems" Journal of the Transportation Research Board Record No. 1855, pp 151-159.

Qin, T.; Lin, M.; Cao, M.; Fu, K.; Ding, R. (2018) Effects of Sensor Location on Dynamic Load Estimation in Weigh-in-Motion System. Sensors, 18, 3044.

Liu, X., Feng, Z., Chen, Y. and Li, H. (2020), Multiple optimized support vector regression for multi-sensor data fusion of weigh-in-motion system". Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, Volume 234, Issue 12, 2020, pp 2807-2821

NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, 2020.

Traffic Monitoring Guide (2016), Federal Highway Administration, <https://www.fhwa.dot.gov/policyinformation/tmguide/>

### **Research Objective**

The objective of this project is to determine the feasibility of utilizing multiple (i.e., more than 2) sensors for improving the accuracy and reliability of WIM systems and quantify costs and benefits of multi-sensor arrays. The project should involve the following tasks:

Task 1. Review the literature on work that deals with the use of multi-sensor WIM systems.

Task 2. Perform vehicle-pavement interaction simulations to resolve any issues mentioned in the literature in relation to the optimum number of sensors and their spacing.

Task 3. Develop the methodology for programming controllers to optimize the output and record weights from multiple WIM sensors. This should consider various analytical approaches including weighed average, curve fitting, and/or neural networks. This methodology should include provisions for the case where one or more of the multiple sensors fails or provides erroneous readings and accommodate split sensor (left/right wheel-path) measurements.

Task 4. Test the improved system in the field with at least two strip sensor technologies and establish its potential accuracy in comparison to currently available single/dual threshold sensor systems (i.e., both those equipped with plate and strip sensors).

Task 5. Conduct economic comparisons between system and sensor types. Quantify costs and benefits (i.e., accuracy improvement) associated with multi-sensor arrays WIM systems and compare them with other WIM systems utilizing different sensor types.

Task 6. Develop recommendations for designing optimum sensor array depending on WIM technology, road type and surface condition, length of data collection, and user needs for weight data accuracy and consistency.

Task 7. Document the findings and the methodology developed.

### **Urgency and Potential Benefits**

Reducing the cost while improving the quality of WIM data is an urgent priority for highway traffic monitoring. Multi-sensor WIM are a cost-effective approach for doing so. Reduced system cost will allow more WIM system installations and their improved reliability will reduce maintenance costs and data gaps.

### **Implementation Considerations and Supporters**

It is anticipated that for Tasks 3 and 4, there will be cooperation between the researchers and one or more of the WIM vendors to ensure that the products of this study are readily implementable. At the study conclusion, the methodology and/or algorithm developed will be placed in the public domain. The research team will provide a well thought out testing and business plan for conducting this study within the available budget.

### **Recommended Research Funding and Research Period**

\$450,000 over a 2.5 year period

### **Problem Statement Author(s)**

- Thomas Papagiannakis, University of Texas San Antonio,  
AT.Papagiannakis@utsa.edu

### **Others Supporting the Problem Statement**

- Steven Jessberger, FHWA, steven.jessberger@dot.gov
- TRB Committee ACP70 Highway Traffic Monitoring
- TRB Committee AED70 Freight Transportation Data
- TRB Committee AKP20 Design and Rehab of Concrete Pavements
- TRB Committee AKP30 Design and Rehab of Asphalt Pavements
- TRB Committee AKP50 Surface properties and Vehicle Interaction
- TRB Committee AKT50 Bridge and Structures Management

Other potential partners include state highway agencies (traffic and enforcement divisions), city and local government agencies, and ports-of-Entry

### **Potential Panel Members**

- FHWA, Steven Jessberger, (202) 366-5052, Steven.Jessberger@dot.gov
- Kent Taylor, NCDOT, (919) 345 9829, kltaylor@ncdot.gov
- Anne-Marie McDonnell, CTDOT, (860) 594-3451,  
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### **Person Submitting the Problem Statement**

- Kent Taylor, NCDOT, (919) 345 9829, kltaylor@ncdot.gov

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### **NCHRP Review of C-14**

#### Reviewed By:

William C. Rogers  
wrogers@nas.edu

#### Comments:

This project has merit and the budget seems adequate.



Review Date:  
1/5/2021

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## **FHWA Evaluation of C-14**

Reviewed By: HPPI/Steven Jessberger, HRDI/Deborah Walker

Comments:

HPPI/Steven Jessberger - This is a highly desired research effort as it has significant effect on a host of issues including design and asset management.

HRDI/Deborah Walker - The proposed project has great merit with practical results that can be immediately implemented by highway agencies in collecting quality traffic data. It also aligns with ongoing traffic data collection programs within FHWA.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-C-14**

**From:** [email: kltaylor@ncdot.gov]

**Comments:** Please convey to the reviewers our appreciation for the positive feedback on this important research need.

**Contact Info:** Kent Taylor  
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Review Date: 1/16/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-15**

**Problem Title**

Updated design guidance for pull-off bays along public roadways

**Background**

- Current design guidance for bus bay/pull-off areas was created in 1996 with TCRP Report 19.
- Current design guidelines require that bus bay/pull-off areas along high-speed roadways (i.e. 45 or 55 mph speed limit) be excessively long, from one-quarter to one-half mile or longer.
- With the emergence of TNCs, new autonomous shuttles, and other technologies, curb space will be at a premium in the future. Pull-off areas could become critical as a shared-use space for a variety of transportation solutions.
- This research will evaluate and update current design standards for modern vehicles and modes to minimize right-of-way needs while ensuring the safety of riders/users and the general traveling public.

**Literature Search Summary**

Current research and standards appear to be limited to TCRP Report 19. More recent design standards, such as those produced by NACTO and various transit agencies throughout the country, all reference TCRP Report 19. Many have chosen to adopt their own standards due to the extensive burden of designing to standards identified in TCRP Report 19.

**Research Objective**

The objective of this research is to provide design guidance to local public entities and State DOTs on safe design for pull-off areas, specifically for buses and other shared-use vehicles.

Major tasks of this research may include:

- 1) Review of current research and design guidelines and an assessment of assumptions that may have been used at the time to develop guidelines.
- 2) Analysis of deceleration and acceleration speeds for a variety of modal vehicles, including buses, shared-use vehicles, and autonomous shuttles.
- 3) Development of design guideline scenarios for analysis for a variety of roadway applications based on speed and roadway typology. These scenarios should also focus on pull-off placement, frequency, and when pull-offs should be used.

- 4) Modeling of traffic flow impacts under a variety of scenarios, particularly focused on entering and exit speeds of vehicles relative to traffic speed and the impact on traffic flow and safety during peak and non-peak times.
- 5) Development of a decision-matrix of when and why pull-offs should be designed and implemented. In addition, guidance on how pull-offs may be implemented in a variety of settings, including existing roadways, in constrained right-of-way situations, and new construction.
- 6) Development of guidelines document to outline findings of research for implementation by public roadway owners and state DOTs.

Research results should be presented in a design guidance document, with corresponding presentations to national organizations to raise awareness and answer specific questions to interested stakeholders.

### **Urgency and Potential Benefits**

- Current guidelines are outdated and impractical in most situations. This leaves state DOTs and other organizations to either design in conflict with current research guidelines, or to choose not to construct pull-offs. As state DOTs look to increasingly integrate bicycle and pedestrian infrastructure into traditional roadway projects, pull-offs are a logical extension to create a truly multi-modal approach to corridor construction.
- Not conducting this research will mean that 25-year old design guidelines will continue to be the only national guidance on the topic and potentially leave state DOTs behind in planning for the future of safe, shared-ride focused mobility options.

### **Implementation Considerations and Supporters**

- This research could be used by a variety of groups within a state DOT, including roadway design units, planning and programming groups, as well as public transportation groups.
- State DOTs could choose to incorporate the design guidelines into a variety of work products, ranging from guidance and best practices documents to eventual incorporation into design manuals.
- The primary hurdle to implementation is institutional inertia related to incorporating multi-modal transportation elements into roadway design projects. However, having current guidelines in place should increase the comfort level of design engineers both in new projects and in reconstruction efforts.
- Successful implementation will revolve around knowledge transfer and promotion within state DOTs to promote new guidelines, as well as educate on the safety and operation benefits of using pull-offs in key areas as identified in the research.

List the AASHTO Committee(s) and/or Council(s) – and any other organization – that might be interested in the research results and could help support implementation.

- TBD

### **Recommended Research Funding and Research Period**

Research Funding: \$400,000

Research Period: 1.5 years for research, documentation, and publication. 1 year for promotion and education.

**Problem Statement Author(s)**

- Andrew Batson, AICP  
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Bureau of Public Transportation  
Pennsylvania Department of Transportation  
717-214-8785  
abatson@pa.gov

**Others Supporting the Problem Statement**

List organizations, including AASHTO Committees or Councils, which support this problem statement, and provide contact information.

- TBD

**Potential Panel Members**

- N/A

**Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Andrew Batson, AICP  
Chief, Planning and Programming  
Bureau of Public Transportation  
Pennsylvania Department of Transportation  
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abatson@pa.gov

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NCHRP Review of C-15 Reviewed By: Camille Crichton-Summers

Comments: This research will update current outmoded guidance related to roadside pull-offs and aid planning and design professionals charged with project development and traffic safety. The scope is reasonable for the budget amount allotted and the project timeframe is reasonable. Review Date:12/21/2020

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**FHWA Evaluation of C-15**

Reviewed By: HSA/Jeff Shaw

Comments:

Updated guidance in this area would be helpful when considering how to make intersection design transit-friendly. Given the scope of the effort and the requested funding, suggest the following areas also be covered: alternative/innovative intersection scenarios (including roundabouts); median pull-out scenarios (such as along high-volume/high-speed arterials); BRT considerations; and, use of shoulders as pull-out and/or for accel/decel. Alternatively, perhaps this could be pursued first as a Synthesis to then inform research needs for a full project.

Review Date:  
12/18/2020

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### **Submitter Response for 2022-C-15**

**From:** [email: abatson@pa.gov]

Comments: Thank you for the feedback and comments regarding creating updated design guidance for pull-off bays along public roadways. I agree that expanding the scope to include median pull-out scenarios, incorporating BRT considerations, and the use of shoulders as pull-out and/or for acceleration and deceleration are great additions to the scope of the research. At this time, I believe including intersection design may dilute the intent of the guidance and exceed the budget as there will need to be significant effort to create a research base of acceleration and deceleration characteristics of different types of vehicles. Additionally, intersection design appears to be well covered through other existing resources, especially as it relates to signal preemption, BRT, and safe streets design.

**Contact Info:**

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Review Date: 02/05/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-16**

**Problem Title**

Analyze Effects of Connected and Automated Vehicles (CAVs) on Freeway Capacity and Operations

**Background**

With the latest investments made by the United States Department of Transportation (USDOT) and major vehicle manufacturers, connected and automated vehicle (CAV) technologies have evolved and are projected to be incorporated on our roadways within the next decade. Automated Vehicles (AVs) and Connected Vehicles (CVs) have some differentiating characteristics. CVs utilize sensors and the Internet Protocol (IP) suite, which is capable of exchanging information with other vehicles (V2V) or infrastructure (V2I) to communicate with each other and/or the infrastructure. Driver control is necessary for CVs since they do not have the self-driving capability. CVs contain a wireless system or other communication means to share information such as vehicle speed, distance from neighboring vehicles, distance to intersections, with some of the equipment located outside of the vehicle. This outside equipment includes roadside base stations, traffic signal controllers, and other surrounding vehicles. Furthermore, CVs provide the driver with precise information regarding their trip, such as the most efficient routes, travel duration, safety alerts, traffic signal phasing and timing information, and upcoming traffic situations.

In comparison, AVs are vehicles capable of operating with minimal to no human control. According to the National Highway Traffic Safety Administration (NHTSA), there are five levels of automation, ranging from Level 0 (no automation) to Level 5 (full automation). Some have already been achieved with the current technology. For example, the features for Level 2 automation (combined-function automation; i.e., speed and lane position at the same time) are already included in some fleets of major automobile manufacturers. In addition, at least four U.S. states (Florida, Nevada, California, and Michigan) already allow road-tests for AVs. It is anticipated that AVs will likely be connected, having direct communications to other AVs and potentially the infrastructure.

Considering these rapid changes in CAVs, the Institute of Electrical and Electronics Engineers (IEEE) predicts that up to 75 percent of fleet vehicles in the United States will be self-driving at an automation Level 4 by 2040. Undoubtedly, the CAV technologies and the new vehicle capabilities will change traffic stream characteristics, which will impact the way transportation engineers design and evaluate roadways. There is an apparent need to address the operational and capacity impacts of CAVs on freeways and revisit the freeway capacity values for different CAV market penetration rates in order for these capacity values to be accounted for in future revisions of the Highway Capacity Manual. CAVs can influence parameters, such as vehicle headways, free flow speed,

speed-flow-density relationships, cooperative merging characteristics, lane changing behavior, weaving characteristics, and the relationships of capacity with respect to lane widths, geometric design and clear zone

### **Literature Search Summary**

A considerable amount of research proposes capacity estimates as a function of the market penetration rates, most of which is focused on fully automated and connected vehicle technology. These results also are primarily based on simulation models that have not been necessarily calibrated with field data, as expected, since there are none available. As such, these results offer a wide range of capacity values that reflect the variability in simulated CAV parameters and models and modeling assumptions that exist today. However, researchers and agencies (including FHWA) have been developing car-following algorithms for CAVs, and calibrating these algorithms based on field tests. To date, there are multiple test beds nationwide, e.g., Michigan, Virginia, and Texas, that explore the microscopic behavior of CAVs. Also, with the newly funded USDOT automated driving system demonstration grant, more CAV data will be collected in the near future to build simulation models. These datasets can be used as the “verified” basis for simulating the impact of CAVs on the road.

In addition, research efforts currently underway are developing capacity adjustment factors considering CAVs for transportation planning applications (Problem statement B-33 and pooled fund study led by the Oregon Department of Transportation).

### **Research Objective**

The objectives of this research are to analyze the impacts of the CAVs on freeway capacity, particularly at bottleneck locations, such as merging, diverging, and weaving segments. This research will focus on both automated vehicles and connected vehicle technology and investigate the impact of the various vehicular operational characteristics (e.g., car-following discipline, vehicle and truck platooning, emergency braking, lane-changing and gap acceptance logic) on freeway operations. In addition, the research will consider a range of vehicular technology, namely automated passenger cars (considering different levels of automation), automated trucks, passenger cars and trucks that include V2V, and V2I technology, passenger cars and trucks with both automation and connectivity capabilities, as well as passenger cars and trucks with no automation or connectivity capabilities. In addition, the impact of dedicated CAV lanes (similar to managed lanes) on the traffic stream, especially at the egress/ingress locations will be evaluated. Different market penetration rates considering all possible connectivity and automation levels will be evaluated using traffic simulation. The results of this research will be used to improve methodologies related to freeways operational performance and quality of service in the Highway Capacity Manual.

### **Urgency and Potential Benefits**

High. This research will produce capacity adjustment factors and modifications to the HCM methodologies, as a function of automated and connected vehicle technology and market penetration. The proposed research will specifically address how CAV technologies are expected to alter planning and operational analysis procedures. The

research results can help agencies analyze the impacts of AVs and CVs and conduct scenario-based analysis for the deployment of these technologies.

### **Implementation Considerations and Supporters**

As this research will result in adjustments to the Highway Capacity Manual methodologies, the target audience includes transportation engineers and planner, freeway management personnel, and educators. Ultimately, the addition of CAV will lead to more accurate analyses of future freeway systems and improved decision making.

### **Recommended Research Funding and Research Period**

Research Funding: \$500,000

Research Period: 36 months

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

TRB Standing Committee on Highway Capacity and Quality of Service Committee (ACP40)  
Chair: Tom Creasey, tom@caliper.com

### **Potential Panel Members**

N/A

### **Person Submitting the Problem Statement**

William Knowles, P.E.  
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## **NCHRP Review of C-16**



Reviewed By:  
B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. This will continue the work begun under the Pooled Fund Study led by the Oregon DOT to increase the HCM's usefulness in analyzing the effects of CAV technologies on operational performance measures. The HCM is integral to many planning and design activities that cannot use simulation approaches due to the number of alternatives and the limited budget for analysis. The results of the research would be broadly applied by state and local transportation agencies.

Review Date:  
12/18/2020

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## **FHWA Evaluation of C-16**

Reviewed By: HOTM/Doug Laird

Comments:

There is substantial work being conducted on CAV modeling, primarily at the moment throughout the CAV pilot studies. Those projects focus primarily on rural weather and on small urban zones. A broader and stronger effort looking at bottlenecks and other merging, diverging, and weaving segments on freeways is needed. Such analyses cannot be conducted with deterministic HCM methods. The use of simulation modeling to support CAVs is an important focus area to the agency and the support of our State partners is vital to moving the program area forward.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-C-16**

**From:** [email: bill.knowles@txdot.gov] **NOW:** knowleswe@cdmsmith.com

**Comments:**

FHWA:

There is substantial work being conducted on CAV modeling, primarily at the moment throughout the CAV pilot studies. Those projects focus primarily on rural weather and on small urban zones. A broader and stronger effort looking at bottlenecks and other merging, diverging, and weaving segments on freeways is needed. Such analyses cannot be conducted with deterministic HCM methods. The use of simulation modeling to support CAVs is an important focus area to the agency and the support of our State partners is vital to moving the program area forward.

Response:

Thank you for your review. We agree that, given the scarce field data, current efforts should focus on simulating bottlenecks to evaluate the operational impacts of CAVs, and this RNS is also recommending the use of simulation to achieve its objectives. We believe that the role of the HCM is not to replace simulation models, but rather help practitioners, decision-makers and transportation agencies in translating the simulation outputs into usable and practical planning-level results and guide them through analyzing the effects of CAVs.

NCHRP:

The proposed research is appropriate for the NCHRP and the expected benefit is high. This will continue the work begun under the Pooled Fund Study led by the Oregon DOT to increase the HCM's usefulness in analyzing the effects of CAV technologies on operational performance measures. The HCM is integral to many planning and design activities that cannot use simulation approaches due to the number of alternatives and the limited budget for analysis. The results of the research would be broadly applied by state and local transportation agencies.

Response:

Thank you for your comments. We agree with the reviewer that the urgency and expected benefit of developing capacity ranges is high. We also agree that this problem statement needs to continue the work begun under the Oregon DOT pooled fund study.

Contact Info: William Knowles, P.E.  
knowleswe@cdmsmith.com

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-17**

**Problem Title**

Approach Slab participation in Seismic Resiliency of Multi-Span Continuous Bridges

**Background**

Approach slabs are used for most multi-span continuous bridges. The main purpose of approach slabs is to eliminate the potential for settlement at bridge abutment by providing a gradual transition between the roadway and the bridge deck. Concrete approach slabs are often used to provide a smooth transition between the bridge deck and the roadway pavement. Approach slabs are designed to withstand embankment settlement near the abutment support.

The AASHTO LRFD Guide Specifications for Bridge Seismic Design (SGS) considers the abutment longitudinal response providing design recommendations for Earthquake-Resisting System (ERS) with or without abutment contribution. However, the SGS do not consider the participation of approach slab in seismic resiliency of bridges. With constantly increasing the seismic demand, and bridge owner's desire for post-earthquake functionality, it becomes preferable for bridge designers to account for approach slab participation in seismic resiliency of bridges. The friction between the approach slab and the backfill, passive resistance provided by shear keys at bottom and end of approach slabs could significantly reduce the seismic demand on bridge intermediate piers, columns and foundations. There is a need to determine methodology and design recommendations for considering approach slab participation in seismic resiliency of multi-span continuous bridges.

**Literature Search Summary**

The proposed research differs from the existing body of research found in a review of relevant literature. None of the available literature match the title or address the objectives of the proposed research statement in the suggested websites:

<http://trid.trb.org> - No results found.

<http://rip.trb.org/> - No results found

**Research Objective**

The objective of this research is to develop design guidelines and design methodology considering the participation of approach slabs in seismic resiliency of multi-span bridges. This research should include bridge embankment materials, MSE supported embankments, effect of bridge end skew angles, connections of approach slab and bridge ends, abutment types, surface condition and friction between bottom of approach

slab and backfill, shear keys at bottom of approach slabs, end walls at the end of approach slabs, pile supports at the end of approach slabs, anchoring approach slab ends, etc.,. The following steps will be considered in this proposed research project:

1. Domestic and international literature study to determine current practice of bridge ends and approach slab in earthquake regions. Identify parameters that that could be beneficial in reducing seismic demand on bridge intermediate piers, columns and foundations.
2. Develop design methodology, design guidelines, and design multi-span bridges in high seismic regions with consideration of approach slab in seismic resiliency.
3. Submit a final report that identifies additional data required to capture unseating and fragility curves that can be used to calculate risk of unseating for bridges. The final report shall include proposed design and detailing recommendations to the AASHTO SGS for consideration of approach slab in seismic design of bridges.

### **Urgency and Potential Benefits**

This research can be seen as addressing three topics in the AASHTO Highway Subcommittee on Bridges and Structures “Grand Challenges: A Strategic Plan for Bridge Engineering”:

- Grand Challenge 1: Extending Service Life
- Grand Challenge 2: Optimizing Structural Systems
- Grand Challenge 4: Advancing The AASHTO Specifications

This project should be implemented through NCHRP.

### **Implementation Considerations and Supporters**

State DOTs and transportation agencies Bridge engineers, and asset managers and planners will be using the research results.

State DOTs can implement the research within their own organization through asset management identifying bridges in immediate need for retrofit.

Categorizing bridges per their type, size and location seismicity could be used to support implementation.

Additional products such as presentations, training workshops, peer exchanges, and webinars will help create awareness and facilitate implementation of the research results.

AASHTO Committee(s) T-3 seismic and T-15 Foundation and Substructure might be interested in the research results and could help support implementation.

Bijan Khaleghi, (360) 705-7181, Bijan.Khaleghi@wsdot.wa.gov, Amy Leland, Amy.Leland@wsdot.wa.gov

### **Recommended Research Funding and Research Period**

Recommended Funding: The cost to complete the research proposed is estimated to be approximately \$250,000.

Research Period: Time needed to accomplish the proposed research will be on the order of 24 months.

**Problem Statement Author(s)**

Bijan Khaleghi, PhD, PE, SE  
State Bridge Design Engineer  
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Amy Leland, PE, SE  
State Bridge Seismic and Foundation Specialist  
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Olympia, WA 98504-7340  
Amy.Leland@wsdot.wa.gov

**Others Supporting the Problem Statement**

AASHTO Committee(s) T-3 seismic and T-15 Foundation and Substructure

**Potential Panel Members**

State DOTs seismic and foundation specialists, bridge designers, universities and consultants specialized in seismic performance of bridges

**Person Submitting the Problem Statement**

Bijan Khaleghi, PhD, PE, SE  
State Bridge Design Engineer  
WSDOT, Bridge & Structures Office  
Olympia, WA 98504-7340  
Bijan.Khaleghi@wsdot.wa.gov

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**NCHRP Review of C-17**

Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem statement is well written, and the research objective is well-defined. However, it's applicable to a few states that are in a seismic zone.

Review Date:

12/15/2020

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## **FHWA Evaluation of C-17**

Reviewed By: HIBS10/Jia-dzwan Shen

Comments:

The inclusion of approach slab can change the seismic performance assessment of a bridge in relation to the arching effect caused by the abutment; this behavior is considered in the fragility method currently used in FHWA's seismic risk assessment. From a resilience standpoint, we would be interested in expected vs. actual approach slab behavior during seismic events. During the 2018 Anchorage earthquake, there were several issues at the approach slab-to-roadway joint.

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**PROBLEM NUMBER  
2022-C-18**

**PROBLEM TITLE**

Calibration of Load and Resistance Factors for Segmentally Constructed Bridges

**RESEARCH PROBLEM STATEMENT**

The load and resistance factors of the AASHTO LRFD Bridge Design Specifications (LRFD) are used by the State Department of Transportation and other Transportation agencies for design of segmental bridges. The load and resistance factors used in the LRFD are, for the most parts, for common bridges and have not been calibrated for segmentally constructed bridges. Furthermore, the LRFD reliability-based design concepts that serve as a basis for load and resistance factors was performed for common bridges. Without proper calibration, it is uncertain to ensure the safety of segmentally constructed bridges in terms of strength, stiffness, deformations, and stability of each component and the whole structural system.

A reliability-based design concept and calibration study needs to be completed prior to the final selection of load and resistance factors used in the LRFD for segmentally constructed bridges. Data for developing the statistical parameters needed to conduct these analyses are to be gathered for reliability analyses to estimate load and resistance factors for service and strength limit states. In addition, the statistical parameters used in the calibration process need to be documented consistent with recently developed design and construction standards. In particular challenges in calibration of segmentally constructed bridges such as a proper understanding of the calibration methods used to arrive at load and resistance factors, and the proper interpretation of the data required carrying out this process need to be studied and documented. The calibration of the AASHTO Load & Resistance Factor Ratings (LRFR) for the load rating of segmentally constructed bridges shall be included in this project. (Not sure if LRFR to be included in this proposal. Open to discussions)

**RESEARCH OBJECTIVE**

The objective of this research is to develop the reliability-based recommended load and resistance factors for inclusion in the LRFD and LRFR Specifications. The reliability-based load and resistance factors analyses shall be performed for segmentally constructed bridges using the LRFD. The calibration should preferably be performed for components and for segmentally constructed bridges system. It is believed that overall system consideration rather than individual member behavior is essential in segmentally constructed bridges. Accomplishment of the project objective will require at least the following tasks.

1. Perform domestic and international literature search of segmentally constructed bridges and basis for loads, load factors, load combinations, resistance factors, and calibration methodologies used in their specifications.
2. Review the original calibration procedure and input data of the LRFD and LRFR for segmentally constructed bridges. Review the statistical database and develop segmentally constructed bridges consistent with the LRFD and LRFR, including statistical parameters of segmentally constructed bridges-specific loads and resistance. Develop an outline and criteria for data collection and documentation for data set analysis.
3. Prepare a detailed description of reliability analysis procedure suitable for segmentally constructed bridges. Perform a sensitivity analysis illustrating the interdependency of the reliability index and load and resistance factors.
4. Review and revise the related articles of the LRFD and LRFR to include the results completed in the above tasks and so that the following questions are clearly and concisely addressed:
  - a. Which target  $\beta$  should be used for the determination of the load and resistance factor combinations? Consider element reliability and system reliability for the segmentally constructed bridges
  - b. What load and resistance factors do the data indicate should be used as corresponding to the acceptable risk of the estimated loads and deformations being exceeded by the actual (measured) load?
  - c. What are the recommended load, load combinations, and resistance factors, and what  $\beta$  do they represent?
  - d. For the target  $\beta$  and load factor selected, are the resistance factors needed for the various service limit states within a reasonable range, and is the end result more or less conservative than previous practice, and by approximately how much?
5. Prepare a final report documenting the entire research effort.
6. Recommend necessary revisions to the LRFD and LRFR Specifications for segmentally constructed bridges

#### **ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

**Recommended Funding:** The cost to complete the research proposed is estimated to be approximately \$250,000

**Research Period:** Time needed to accomplish the proposed research will be approximately 24 months.

#### **URGENCY, PAYOFF POTENTIAL, IMPLEMENTATION AND SUPPORT FOR BUSINESS NEEDS**

This research addresses three topics in the AASHTO Highway Committee on Bridges and Structures “Grand Challenges: A Strategic Plan for Bridge Engineering”:

- Grand Challenge 1: Extending Service Life



- Grand Challenge 2: Optimizing Structural Systems
- Grand Challenge 4: Advancing the AASHTO Specifications

This project should be implemented through NCHRP.

#### **PERSON(S) DEVELOPING THE PROBLEM STATEMENT**

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Bridge and Structures Office  
Washington State DOT  
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10 S Riverside Plaza  
Phone: (312) 930-5100  
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#### **AASHTO MONITOR**

To be determined by TRB.

#### **DATE AND SUBMITTED BY**

August 15, 2020,  
submitted by:  
Bijan Khaleghi PhD, P.E., S.E.  
State Bridge Design Engineer  
Bridge and Structures Office  
Washington State DOT  
Phone: (360) 705-7181  
Email: khalegb@wsdot.wa.gov

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#### **NCHRP Review of C-18**

##### Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem statement is well written, and the research objective is well defined. However, the problem statement does not discuss the critical design issues with the existing AASHTO LRFD Bridge Design Specifications. In addition, NCHRP Project 12-123: "Proposed AASHTO Guideline for Load Rating of Segmental Bridges" is currently in development and is related to the subject project. The recommendation is to complete NCHRP Project 12-123 before funding another related project. In addition, work with the AASHTO COBS to discuss the urgency of this problem statement.

##### Review Date:

12/15/2020

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## **FHWA Evaluation of C-18**

Reviewed By: HIBS10/Reggie Holt

Comments:

The research problem statement is proposing that segmentally constructed bridges should have a unique set of load and resistance factors. This approach is contradictory to AASHTO's current direction toward simplifying the bridge design specification, one aspect of which is an intention to limit multiple design provisions that account for how a bridge was constructed.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for C-18**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: N/A

Comments: COBS recommends there be more discussion to determine if the approach laid out in the problem statement is the correct one.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-C-19**

**Problem Title**

Developing of Fragility Curve for Multi-Span Precast Girder Concrete Bridges in Seismic Regions

**Background**

There are significant number of multi-span precast girder concrete bridges in high seismic regions and long duration earthquakes that have been designed and constructed at a time when seismic resiliency requirement were nonexistent or inadequate by today's standards. To avoid bridge collapses, reduce the risk of extensive damage in future earthquakes, and most effectively allocate the financial resources, the vulnerability of bridges to earthquakes must be identified by developing appropriate fragility curves with consideration to bridge superstructure, substructure and foundation complexity. The fragility curves are required to relate the hazard to the likelihood of bridge closure as the expansion joints open and to collapse when the opening becomes too large. These curves should relate spectral acceleration and spectral displacement to the likelihood of collapse for different structural periods and for different structure types.

Fragility curve is one of the widespread methods used in seismic evaluations of existing bridges. The fragility curves provide conditional statements of probability of a bridge reaching or exceeding a particular damage level for a given intensity level. The fragility analysis generally includes simulation of bridge, simulation of ground motions, and generation of fragility curves from the seismic response data of the bridge models. The seismic response data can be obtain from elastic spectral analysis, or nonlinear static analysis, or nonlinear time history analysis. There is a need to determine fragility curves to capture the seismic vulnerability of multi-span precast girder concrete bridges in high seismic regions and long duration earthquakes.

**Literature Search Summary**

The proposed research differs from the existing body of research found in a review of relevant literature. None of the available literature match the title or address the objectives of the proposed research statement in the suggested websites: TRID (<http://trid.trb.org>),

1. PROJECT: Performance of Existing ABC Projects – Inspection Case Studies (University of Washington), Accelerated Bridge Construction University Transportation Center (ABC-UTC), \$70000, 2019, Active2019-01-01
2. Comparison of Curved Prestressed Concrete Bridge Population Response Between Area and Spine Modeling Approaches Toward Efficient Seismic

Vulnerability Analysis Engineering Structures, Volume 150, Issue 0, 2017, pp 176-1892017-11-01

3. Vulnerability Sensitivity of Curved Precast-Concrete I-Girder Bridges with Various Configurations Subjected to Multiple Ground Motions, Journal of Bridge Engineering, Volume 22, Issue 2, 2017, Content ID 040161182017-02
4. A THEORETICAL ANALYSIS OF THE MOMENT-CURVATURE RELATIONSHIP IN REINFORCED PRESTRESSED CONCRETE BEAMS, Giornale del Genio Civile, Volume 116, 1978, p. 3-14

<http://rip.trb.org/>

5. PROJECT: Performance of Existing ABC Projects – Inspection Case Studies (University of Washington), Accelerated Bridge Construction University Transportation Center (ABC-UTC), 2019

### **Research Objective**

The objective of this research is to develop fragility curves to capture the vulnerability of multi-span precast girder concrete bridges in long duration earthquake regions and associated seismic hazards. The first step in this effort would be to address the collapse vulnerability of multi-span precast girder concrete bridges. The support length is required, but the relative stiffness of adjacent frames, pier skews, and abutment types effects cannot be readily captured for each bridge. The following steps will be considered in this proposed research project:

1. Domestic and international literature study to determine current state of knowledge on fragility curves of Multi-span precast girder concrete bridges in long duration earthquake regions.
2. Identify parameters that need to be considered to accurately predict the seismic hazards due to end and in-span support unseating, pier skews, and abutment types.
3. Develop a range of fragility curves that relate ground motion to increased probability of collapse for different periods and different bridge types. Test fragility curves using database of bridge inventories and bridge damage from previous earthquakes.
4. Submit a final report including design guidelines and design examples demonstrating that fragility curves can be used for multi-span precast girder concrete bridges in mega and long duration earthquake regions.

### **Urgency and Potential Benefits**

Concisely explain:

Currently there is little work on calculating the probability and risk of multi-span precast girder concrete bridges in long duration and mega earthquakes despite it being the most common cause of bridge collapse. Therefore, this research can be seen as addressing three topics in the AASHTO Highway Subcommittee on Bridges and Structures “Grand Challenges: A Strategic Plan for Bridge Engineering”:

- Grand Challenge 1: Extending Service Life
- Grand Challenge 2: Optimizing Structural Systems
- Grand Challenge 4: Advancing The AASHTO Specifications

This project should be implemented through NCHRP.

### **Implementation Considerations and Supporters**

State DOTs and transportation agencies Bridge engineers, and asset managers and planners will be using the research results.

State DOTs can implement the research within their own organization through asset management identifying bridges in immediate need for retrofit.

Categorizing bridges per their type, size and location seismicity could be used to support implementation.

Additional products such as presentations, training workshops, peer exchanges, and webinars will help create awareness and facilitate implementation of the research results.

AASHTO Committee(s) T-3 seismic and T-9, and T-18 – and precast concrete organization might be interested in the research results and could help support implementation.

Bijan Khaleghi, (360) 705-7181, Bijan.Khaleghi@wsdot.wa.gov, Amy Leland, Amy.Leland@wsdot.wa.gov , and Anthony Mizumori, Anthony.Mizumori@wsdot.wa.gov

### **Recommended Research Funding and Research Period**

Recommended Funding: The cost to complete the research proposed is estimated to be approximately \$250,000.

Research Period: Time needed to accomplish the proposed research will be on the order of 24 months.

### **Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

AASHTO Committee(s) T-3 seismic and T-9, and T-18 – and precast concrete organization

**Potential Panel Members**

State DOTs seismic specialists, bridge designers, universities and consultants specialized in seismic performance of bridges

**Person Submitting the Problem Statement**

Bijan Khaleghi, PhD, PE, SE  
State Bridge Design Engineer  
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Olympia, WA 98504-7340  
Bijan.Khaleghi@wsdot.wa.gov

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**NCHRP Review of C-19**Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The problem statement is well written, and the research objective is well defined. However, the return on investment is expected to be very low and it's applicable to a few states that are in a seismic zone.

Review Date:

12/15/2020

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**FHWA Evaluation of C-19**

Reviewed By: HIBS10/Jia-dzwan Shen

Comments:

This is a very timely proposal that is supporting FHWA's efforts in risk-based bridge management with the consideration of the revised National Bridge Inventory data. The proposed study will contribute to making good use of the enhanced inventory data, applying to a large population of bridges. Along with development efforts like this,

AASHTO should consider a synthesis to catalog of known fragility relationships and other work to address knowledge gaps in the topic area.

Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for C-19**

Submitted By:  
Patricia Bush  
AASHTO Staff  
Committee on Bridges & Structures

Priority #: N/A

Comments: COBS does not view this as a high priority.

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# **Research Field D**

MATERIALS AND CONSTRUCTION



**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-D-01**

**Problem Title**

Evaluation and Selection of 3D Model Viewers for Construction Inspection

**Background**

In the last decade, we have seen advances in technology that have introduced equipment and tools to leverage 3D engineered models for construction. Most notably is the use of automated machine guidance (AMG) for grading and excavating, fine grading and base preparation, and concrete paving. Until most recently, contractors had been using the contract plan sets to create their own 3D models. Over the last few years, there has been a shift to deliver digital data as a supplement to the plan sets. However, a few states, including Iowa, New York, Michigan and Utah have started piloting model-based deliverables by changing the medium of construction contract documents from paper or 2D PDF plans to include 3D model-based, digital information that is contractually-binding.

This shift to model-based project delivery has started to redefine how we communicate and coordinate project details with contractors and construction inspection teams. Model-based design enables project teams to communicate design intent to downstream users more effectively, and offers opportunities to improve overall efficiency of the road and bridge project delivery process. However, changing the medium of construction contract information also creates a procedural challenge for field inspections. While more state DOTs are interested in expanding the benefits of the model-based approach to project delivery, there are two distinct, but related barriers:

1. A lack of understanding of the tools currently available in the market to support the use of 3D models for inspection; and
2. A lack of guidance for setting technical requirements for the procurement and selection of commercial off-the-shelf (COTS) tools, or development of custom mobile applications.

Construction inspection staff currently use 2D plans (either paper or PDF-based) to understand the design intent and verify the contract requirements are being met. If we suddenly replaced those 2D plan sheets with 3D models, it would be very difficult for inspectors to know how to verify contract requirements in the field. Inspectors need easy to use tools specifically designed for construction inspection tasks to review contract requirements in a new, digital medium. The tools to perform inspection tasks should have an easy to use interface via mobile applications, have the capabilities to connect with construction administration systems, and work without internet or WiFi connection. Guidance should be developed to help state DOTs with establishing technical requirements for tools to be implemented for model-based inspection tasks.

## **Literature Search Summary**

Previous research has identified the wider issues related to the creation and use of 3D models. However, these prior studies have not examined how to perform detailed quality assurance checks without the use of plan sheets. Some efforts have been made to understand how high accuracy equipment (e.g. GPS) can be used to check location and elevations of specific points and record those points to create surfaces that are used for cutting cross-sections in the office for verifying earthwork quantities. However, to-date not much has been done to use tablets with mobile applications that show the 3D model in a way the inspector can read the same information he/she was getting from the plan sheets.

In addition, it is clear from the literature that when contractors choose to use 3D modeling technology in their means and methods, it makes it difficult for inspection staff to access the same type of information. Practices for using e-Construction applications for the most part are based on digitized 2D plans and documentation forms in PDF format. However, if 3D models are to replace plan sheets all together, there needs to be a repeatable and reliable way to executing and documenting quality assurance checks using 3D model viewers that are simple to use. State DOTs would benefit greatly from a study that evaluates what is available in the market place – or if not available, a set of technical requirements to develop such applications.

## **Research Objective**

The objective of this research is twofold:

1. Perform an evaluation of current commercial off-the-shelf (COTS) tools for viewing 3D engineered models in the field to inspect highway and bridge projects.
2. Develop recommendations for procurement and selection of 3D model viewing mobile applications to perform construction inspection of highway and bridge projects.

The outcomes of this research should include:

- A criteria-based assessment of the capabilities of currently COTS tools for viewing 3D engineered models for field inspection, including an evaluation component to determine alignment with DOT specifications.
- Webinar presentations to demonstrate the capabilities of COTS tools being evaluated.
- A webinar presentation to market the findings of the research.
- A short (up to 10 page) technical brief outlining general recommendations for setting technical requirements for procuring and selecting (or developing) construction inspection 3D modeling viewing tools.
- Final report documenting the findings of the research including, a summary of the criteria-based assessment of the capabilities of COTS tools, and final conclusion and recommendations for future work.

The major tasks of this research are:

1. Explore available literature to identify current and emerging technology to support construction inspection using 3D engineered models.
2. Facilitate educational webinars for software vendors to provide demonstration of their tools to the project panel members and any other designated AASHTO members.
3. Secure software evaluation licenses to perform a criteria-based assessment.
4. Work with 2-5 state DOTs to explore desired functionality.
5. Create a final report outlining (1) literature review, (2) criteria-based assessment approach, (3) agnostic comparison of capabilities of the COTS tools evaluated, (3) and recommendations for setting technical requirements for procurement and selection (or development) of tools to support model-based inspection.
6. Create a technical brief and conduct a webinar.

### **Urgency and Potential Benefits**

While there is progress towards using 3D engineered models for project delivery, performing construction inspection without plan sheets is a serious concern for many agencies and engineering consultants. Owners are unable to fully implement 3D engineered models as contract documents without knowing they can completely eliminate plan sheets for construction inspection. A suitable substitute for viewing the same type of information contained in plan sheets is needed to move forward with models as contract documents. Technology is changing rapidly, so it is important for this study to be conducted under an accelerated timeline.

### **Implementation Considerations and Supporters**

State Construction Engineers would use the research to provide tools that construction inspectors and construction management staff can use for model-based inspection. The research should provide a thorough assessment of the software currently available, its capabilities and limitations. Understanding what is commercially available will enable state DOTs to procure and select tools that meet their immediate needs for viewing 3D models in construction for inspection tasks.

The research could be deployed through conference presentations (e.g. TRB Annual Meeting, IHEEP, AASHTO), webinars (e.g. TRB, AASHTO Innovation Initiative), AASHTO TC3 course materials, or a future FHWA Every Day Counts activity to deploy the practice of 3D model-based construction contract documents.

Research products could include: a technical brief, case studies, short instructional videos, conference presentations and a webinar.

This research is of interest to the following committee and committee members:

- AASHTO COC
- AED80 Visualization Committee

### **Recommended Research Funding and Research Period**

Recommended funding: \$300-400K  
Recommended period: 15 months

**Problem Statement Author(s)**

Alexa B. Mitchell, PE (HDR Inc., 602-245-7056, alexa.mitchell@hdrinc.com)  
Amlan Mukherjee (Michigan Tech University)  
Bharathwaj Sankaran (WSP)  
John Hancock (Georgia DOT)

**Others Supporting the Problem Statement**

- AASHTO COBS, T-19 Software and Technology Committee
- AASHTO COD, Joint Technical Committee on Electronic Engineering Standards

**Potential Panel Members**

- John Hancock, Georgia DOT, AASHTO COC, 404-631-1970  
jhancock@dot.ga.gov
- Derek Fuller, Indiana DOT, 317-234-7984, [dfuller@indot.in.gov](mailto:dfuller@indot.in.gov)
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**Person Submitting the Problem Statement**

- Casey Soneira, AASHTO (on behalf of the Committee on Construction), 202-624-5824, [csoneira@ashto.org](mailto:csoneira@ashto.org)

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**NCHRP Review of D-01****Reviewed By:**

Christopher T. McKenney  
[CMcKenney@nas.edu](mailto:CMcKenney@nas.edu)

**Comments:**

3D modeling is a discipline needing attention within the industry. As more state DOTs gravitate towards 3D modeling Quality Management (meaning both QA and QC), it is important any issues are addressed during the predesign and preconstruction phases. Too many times have documents been taken for face value within the design portion of construction plans. Construction inspection relies on quality plans that are produced from the Roadway Design Division. This problem statement tends to run parallel to 2022-D-01 (Evaluation and Selection of 3D Model Viewers for Construction Inspection). Quality Construction Inspection tends to rely on Quality Design. Recommend that 2022-D-11 and 2022-D-01 be combined into one problem statement, because quality construction inspection tends to rely on the quality of the design plans

that construction uses. The recommendation is to increase the project period to 36 months from 24 months and increase a combined budget to \$600,000.

Review Date:  
12/21/2020

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## **FHWA Evaluation of D-01**

Reviewed By: HRDI/Matt Corrigan RC/David Unkefer

### Comments:

There is a very high need for this study as there is a huge gap area that has not been adequately researched nationally. It is a timely and important subject to States to increase efficiency of dwindling numbers of construction staff and inspectors and little guidance on "strong" off the shelf options that is field proven. A suitable substitute for viewing the same type of [model] information contained in plan sheets is needed to move forward with models as contract documents. Providing tech requirements and a how-to document for States looking to implement is needed. In addition to entities already listed, this would also be of interest to the AASHTO Joint Tech Committee on Electronic Engineering Standards, ACEC AGC, and ARTBA. There are a number of existing NCHRP projects not yet completed that will likely impact this effort and will require coordination. Projects include NCHRP synthesis: 52-14 3D models as contract documents, 51-01 Practices for Construction-Ready Digital Terrain Models; and NCHRP project 10-110 3D Modeling Guide for Construction Inspection. There may be some potential duplication of the 10-110 effort that will need to be resolved.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-D-01**

**From:** [email: csoneira@ashto.org]

### **Comments:**

#### **Re: FHWA Review**

I agree that coordination is likely needed with the specific efforts listed by the reviewer. It is important to note that the scope of this research need statement is specific to evaluation of model viewing tools only while the NCHRP project 10-110 is looking at a guidebook that describes best practices for developing the right competencies and information needs. Where these two project intersect is how the information is

accessed. So, in project 10-110, they will define the information that is extracted from the 3D model and the competencies needed to do so, one of which may be the ability to use a 3D model viewer app. The new research statement specifically is set out to determine technical requirements for an agency to procure such a tool.

As far as the other two projects mentioned (syntensys 52-14 and 51-01, they also are a bit different. 3D models as contract documents focuses on the design aspects of the model as a contractual document, the only connection is that for models to be contractual documents, construction inspectors need to have the proper tool to access information. 51-01 practices for construction-ready digital terrain models is more related to NCHRP 10-110 than 2022-D-01 in the sense that digital terrain models are often viewed using surveying equipment rather than 3D model viewers, and I feel like the scope of NCHRP 10-110 is more relevant to 51-01.

**Re: NCHRP Review**

While I agree that 3D modeling quality management is important for the delivery of construction plans, it is important to recognize that D-01 is strictly an effort to help DOTs to set technical requirements to procure 3D modeling views and not necessarily to evaluate the quality of a model that comes from design. DOTs are currently looking at procuring or developing their own 3D viewing apps that they cannot wait another year to get those technical requirements. So I would suggest to keep them separately as their scopes are not truly related.

Contact Info: email: [csoneira@aaashto.org](mailto:csoneira@aaashto.org)

Alexa Mitchell, 602.245.7056, [alexa.mitchell@hdrinc.com](mailto:alexa.mitchell@hdrinc.com)

Review Date: 12/18/20 (FHWA), 12/21/20 (NCHRP) Review Date:

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022-D-02**

**Problem Title**

Guidelines for digital technologies and systems for remote construction inspection for highway infrastructure projects

**Background**

Over the past few decades, many State Highway Agencies (SHAs) have been experiencing an expanding highway construction program concurrently with a reduction in the amount of construction project staff that are available to administer these projects. Existing State Inspection personnel have to rely on innovative technologies and strategies for addressing the increasing demand and discharge their responsibilities in an efficient way. The adoption of mobile devices and modern surveying equipment for construction inspection have proven timely and beneficial for SHA Inspectors, who play a critical role overseeing and managing several moving parts of a construction job. A wide variety of digital tools are available to support construction inspection activities onsite and collect digital data for estimation of quantities, verification and acceptance, and creation of as-built records. These tools offer numerous benefits including improved data quality and consistency, enhanced communication, improved transparency, and improved safety of the site personnel.

Most of the recent research efforts have focused on developing guidelines and documenting effective practices for digital inspection. Emerging technologies such as small Unmanned Aerial Systems (sUAS) and remote imaging and video tools provide opportunities for enabling visual inspection (both offline and real-time) that can be conducted remotely. Remote inspection can offer safety and efficiency enhancements while providing accurate digital data for verification and as-builts. It is important to note that the construction inspection on federally funded projects is often governed by federal regulations that offers oversight guidelines for SHAs. Under their guidance, SHAs can select the tools and processes that aligns best with their situation. Frequent enhancements being made in the technologies enabling remote inspection in conjunction with their increasing cost-effectiveness calls for more integrated research in this area. There is need to develop guidelines for SHAs in evaluating and successfully integrating the tools enabling remote-inspection and the support they offer in meeting verification and acceptance requirements for various elements of highway construction, while complying with governing regulations.

**Literature Search Summary**

Advancements in sensing technologies for data collection, design processes, and on-field positioning systems are providing opportunities to utilize digital information for project delivery and asset management. In particular, recent studies and industry

surveys indicate increased adoption of 3D model-based design and deployment of Automated Machine Guidance (AMG) for performing various activities in highway projects including earthwork, grading, paving, and structural elements, among others. Consequently, a variety of tools have come to the forefront to enable digital construction inspection and creation of as-built records.

Literature emphasizes that a common challenge shared among several SHAs is insufficient resources for their construction inspection and they rely on various strategies to manage their workload including outsourcing CE&I activities for consultants, adopting a risk-based prioritization approach for inspection, and transitioning to efficient digital-data based workflows. Technologies enabling digital data for inspection can play a vital role in complementing the objectives of all of the identified strategies. A few SHAs such as the DOTs of Iowa, New York, Oregon, Wisconsin, and Michigan have started moving towards aligning their enterprise data management systems and updating their construction manuals and Standard Specifications with considerations for 3D digital data for inspection. Training programs focusing on deploying mobile devices and modern surveying equipment have also been implemented in some agencies.

While recent research has focused on developing technological and process-related guidelines to institutionalize digital inspection practices, there has been increased interest to evaluate the tools that enable inspection of construction activities remotely. Some of the agencies are conducting pilot initiatives to test the technological capabilities of small Unmanned Aerial Systems (sUAS) equipped with a variety of sensor payloads to support construction inspection of various activities in highway construction. Strategically positioned CCTVs, Augmented Reality (AR), and Virtual Reality (VR) are also being tested to monitor construction progress and inspection activities onsite. Complementary advancements are also being made in software solutions to process the collected data and retrieve necessary deliverable that meets the accuracy and quality requirements for inspection. Nonetheless, there is lack of understanding and national consensus on the type of highway construction activities that can be inspected remotely using these tools, particularly for verification testing and acceptance. The proposed research attempts to bridge this gap by developing guidelines for SHAs in evaluating and integrating these tools for construction inspection of highway projects.

### **Research Objective**

The scope of this research concerns with developing guidelines for the application of enabling digital technologies that support remote construction inspection. The specific objectives of this research are to

1. Evaluate the state-of-the-art technologies and systems available in the market for remote inspection of highway construction activities
2. Identify the activities and elements of highway construction that can be inspected remotely using the technologies
3. Document potential implementation challenges from technological, procedural and legal standpoint and propose mitigation strategies



4. Develop an implementation framework for SHAs to incorporate remote inspection technologies for corresponding activities in highway construction and identify the future trends for these emerging technologies.

The outcomes of this research should include:

- An interim Webinar presentation and/or an interim task report to demonstrate the capabilities of the tools and matching inspection activities.
- An interim webinar presentation and/or an interim task report to present the implementation challenges, implementation framework for SHAs and future trends.
- A compact guidebook that offers implementation framework for utilizing technologies that enable remote construction inspection.
- Final research report documenting the findings of the research

The major tasks of this research are:

1. Conduct a literature review of relevant research and current state of practice related to digital technologies enabling remote inspection for highway construction. The review shall include published and unpublished research conducted through the NCHRP, FHWA, and other national, international, state, and pooled-fund sponsored research (e.g. ***NCHRP 03-140, FHWA's research on "Construction Inspection for Digital Project Delivery"***)
2. Conduct a survey of DOTs to identify technologies and current trends on remote construction inspection.
3. Based on results from Task 1 and 2, develop mapping between available technologies and inspection activities that can be managed remotely.
4. Conduct an interim webinar to present the findings from tasks 1 to 3 and incorporate feedback from NCHRP.
5. Conduct candidate case studies of projects from State DOTs that have demonstrated successful integration of digital tools for remote inspection
6. Document potential implementation challenges from technological, procedural and legal standpoint and develop mitigation strategies
7. Develop implementation framework for SHAs to guide integration of digital technologies to support remote inspection
8. Conduct an interim webinar to present the findings from tasks 5 to 7 and incorporate feedback from NCHRP.
9. Develop a guidebook that documents implementation framework and implementation challenges
10. Create a final research report outlining the key findings from literature review, research objectives, methodology, survey results and case studies.

### **Urgency and Potential Benefits**

Digital technologies offering remote inspection capabilities provide opportunities to offset the challenges faced by the SHAs owing to resource constraints they face with limited inspection personnel to manage their expanding construction program. Guidelines for systematically evaluating and integrating these tools to support inspection requirements

would benefit SHAs considerably by equipping their personnel with skillsets required to transition to efficient digital workflow, ultimately making them future-ready. It will also act as a valuable reference for other stakeholders including contractors and consultants that work with the SHAs.

### **Implementation Considerations and Supporters**

State Construction Engineers, Inspectors, and Program Management Staff can use the research to understand the tools available for remote inspection of construction activities. The guidebook should of interest to the Departments/Divisions within the SHAs that administers the deployment of the modern technologies (e.g. Division of Aeronautics for UAS program, Research on Technological Innovation). The research should provide a thorough assessment of the current remote inspection technologies and systems and potential implementation challenges in practice. Understanding what is commercially available will enable state DOTs to procure and select tools that meet their immediate needs for remote inspection. The research could be deployed through conference presentations (e.g. TRB Annual Meeting, IHEEP, AASHTO), webinars (e.g. TRB, AASHTO Innovation Initiative), AASHTO TC3 course materials, or a future FHWA Every Day Counts activity. Additional research products could include: a technical brief, case studies, short instructional videos, conference presentations and a webinar.

This research is of interest to the following committee and committee members:

- AASHTO COC
- AED80 Visualization Committee
- AKD70 Standing Committee on Geospatial Data Acquisition Technologies\*

\*- Committee not contacted on this RNS yet

### **Recommended Research Funding and Research Period**

Recommended funding: \$400-500k

Recommended period: 18-24 months

### **Problem Statement Author(s)**

Bharathwaj Sankaran, Ph.D. (WSP, 737-703-3873,  
bharathwaj.sankaran@wsp.com)

Alexa B. Mitchell, P.E. (HDR Inc)

Amlan Mukherjee, Ph.D., P.E. (Michigan Tech University)

Daniel Tran, Ph.D., P.E. (University of Kansas)

### **Others Supporting the Problem Statement**

- AASHTO Committee on Construction

### **Potential Panel Members \***

- John Hancock, Georgia DOT, AASHTO COC, 404-631-1970  
jhancock@dot.ga.gov
- Chris Pucci, Oregon DOT, 503-986-3542, Christopher.Pucci@odot.state.or.us
- David Unkefer, FHWA, (404) 764-7498, David.Unkefer@dot.gov

- Chase Wells, Ohio DOT, 614.466.4789, Chase.Wells@dot.ohio.gov
- \* - *Members not contacted on this RNS yet*

### **Person Submitting the Problem Statement**

- Casey Soneira, AASHTO (on behalf of Committee on Construction), 202-624-5824, csoneira@ashto.org
- 

### **NCHRP Review of D-02**

#### Reviewed By:

Christopher T. McKenney  
CMcKenney@nas.edu

#### Comments:

Many state DOTs have embraced this technology or have proceeded with caution due to regulations and guidelines for operating UAS. However, this technology could provide more efficient and effective ways for state DOTs to accomplish certain tasks that would require more man hours and money. Case studies have been performed, including a recently funded research project with ARDOT and the University of Arkansas Fayetteville, who are looking to use UAS to conduct bridge inspections. Other DOTs, such as South Carolina DOT have shown how this technology was useful in mitigating wetland impacts. This project would be useful. Recommend funding of \$500,000 a research duration of 24 months.

#### Review Date:

12/22/2020

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### **FHWA Evaluation of D-02**

Reviewed By: HRDI/Matt Corrigan RC/Kathryn Weisner

#### Comments:

This project is a great idea if the effort does focus on remote construction inspection technologies, and not repeat related efforts; by supplementing information from NCHRP synthesis Topic 52-01 and forthcoming FHWA research effort publication "Construction Inspection for Digital Project Delivery". Effort needs to build on that previous work, not duplicate or re-phrase it. There should be an in-depth effort on how we make this a viable solution that works. There needs to be more breadth, depth, detailed How-to and actionable steps provided as outcomes. The effort is needed, as

there are a few "dipping their toe" in this area, but no sustained or coordinated success. Leveraging these technologies more effectively is a good idea. Effort may be a good complement to previous FHWA EDC efforts: EDC2-3 with 3D models, EDC3-4 with e-Construction, EDC5-UAS.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for D-02**

Submitted By:  
Casey Soneira  
AASHTO Staff  
Committee on Construction

Priority #: 1

Comments: Several states are evaluating the possibility for remote construction inspection concurrently. Increasing opportunities to harness and implement technology has far reaching benefits to safety and efficiency within construction projects. This research is of a high level of importance for the Committee on Construction. This will eliminate duplication of efforts of many states. This is the COC's highest ranked problem statement.

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## **Submitter Response for 2022-D-02**

**From:** [email: csoneira@aaashto.org]

### **Comments:**

Thank you for the review of our Problem Statement 2022-D-02, titled "Guidelines for digital technologies and systems for remote construction inspection for highway infrastructure projects". Both the NCHRP's and FHWA's comments highlighted the significance of this topic and concurred with the need for additional guidelines at national level on tools enabling remote inspection for various construction activities (while navigating the relevant federal regulations and overcoming procedural challenges). There were requests to include references to existing/ongoing research in this area to ensure that this RNS requests the effort to build up on their findings.

To address these comments, please include the following highlighted additional references under Section 5 (Research Objectives), Task no. 1, "...pooled-fund sponsored research (e.g., NCHRP synthesis Topic 52-01, NCHRP 03-140, FHWA's research on "Construction Inspection for Digital Project Delivery", and other specific DOT guidelines on remote construction inspection)."

**Contact Info:**

[email: [csoneira@aaashto.org](mailto:csoneira@aaashto.org)]

Bharathwaj Sankaran, Ph.D, WSP USA ([bharathwaj.sankaran@wsp.com](mailto:bharathwaj.sankaran@wsp.com))

Review Date:

12/22/2020 (NCHRP); 12/28/2020 (FHWA)

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022–D-03**

**Problem Title**

Considering Binder Availability of Recycled Asphalt Materials

**Background**

To promote sustainability and ensure adequate performance, there is a need to consider the amount of asphalt binder available from asphalt-based recycled materials, such as reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS). The use of recycled materials is growing due to economic and environmental benefits, yet there is no accepted method to quantify or account for the effective binder content available from these materials. AASHTO guidance on the design of asphalt mixtures with RAP and/or RAS assumes that 100% of the recycled binder is available to blend with virgin binder and any additives such as recycling agents or warm mix asphalt products. In reality, the amount of recycled binder available is somewhere between 0% availability and near 100% availability, with lower availability for heavily aged RAP binder or RAS binder and mixtures produced at lower temperatures. Thus, the assumption of 100% availability leads to less overall effective binder content, yielding a dry mixture with insufficient coating that may be difficult to compact and exhibit inadequate durability and cracking performance in-service. These poor-performing pavements cost agencies due to reduced life and increased maintenance expenditures. This research will identify or develop a method to quantify or account for binder availability from recycled asphalt materials and provide guidelines for their efficient use.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

**Literature Search Summary**

Based on a recent national survey of state departments of transportation (DOTs) (TxDOT project 0-7062), all but nine states (of 38 respondents) assume 100% recycled binder availability. Many research projects have utilized both rheological and chemical properties and advanced imaging and microscopy to evaluate this assumption. These indicate that partial availability values for RAP range from 16% to 96% and for RAS from 36% to 61% depending on a number of potential factors that are unique to each mixture including production parameters and properties and proportioning of component materials. These wide ranges reflect the need for a standard methodology to quantify this parameter or account for it with an alternate approach.

A number of recently completed and ongoing studies address this need but with some limitations including the need to compare many varied sources:

- NCHRP 09-58 developed a RAP binder availability factor for use in mix design that simulates field conditions. The method is limited to a specific fraction and requires using specific virgin materials.
- RILEM Technical Committee 264 provides a preliminary method to characterize 100% RAP with a simple mixture test. The method can likely be simplified. This group also differentiates between the active recycled binder inherent in the RAP/RAS and the available recycled binder that blends with virgin binder and any additives in a mixture.
- FHWA Dongre Workability Test (DWT) assesses RAP quality using its resistance to compaction and predicts the performance grade of the RAP binder through an artificial neural network model. Additional development is needed to quantify recycled binder availability.

The TxDOT synthesis study compared the outcomes of these studies and found good agreement between the NCHRP and RILEM relative recycled binder availability factors.

Thus, research is needed to explore a practical method to quantify recycled binder availability for RAP and RAS so agencies can apply it in specifications and mix design procedures. Alternate approaches to account for reduced binder availability of recycled materials include increasing total binder content by requirement or by coarsening aggregate gradations, decreasing air voids, lowering the number of gyrations, or increasing voids in the mineral aggregate in volumetric mix design. Interactions within each unique combination of component materials need to be understood and captured by this method to provide an implementable solution. Without a method to quantify or account for recycled binder availability, all recycled materials are considered equal despite the many factors that affect their contribution to recycled asphalt mixture performance.

### **Research Objective**

The objective of this research is to identify or develop a method to quantify or account for binder availability from recycled asphalt materials that can be used by agencies to improve mix design procedures and specifications. Important factors affecting the active binder inherent in recycled materials and/or the available binder that contributes to the recycled mixture include the following to be considered when producing guidelines for efficient use of RAP/RAS:

- recycled materials: type and source (aging state), content (%), binder content, and gradation;
- virgin binder: performance grade and flexibility;
- virgin aggregate: gradation;
- optional additive(s) including recycling agents or Warm Mix Asphalt additives: type and dose; and
- production: plant type, mixing and storage times and temperatures.

Required tasks to meet these objectives include:

- Review current practices of U.S. and international agencies to estimate and incorporate reduced recycled binder availability.

- Evaluate coatability and rutting and cracking performance of typical dense-graded mixtures considering 100% recycled binder availability and 0% recycled binder availability to assess the impact on mixture performance.
- Identify or develop a method to quantify or account for recycled binder availability that is sensitive to the factors listed above.
- Develop reporting format for characterizing RAP/RAS in terms of binder availability.

Research results should include:

- User-friendly method to incorporate binder availability factors for RAP and RAS into mix design processes.
- Proposed revisions to specifications and mix design procedures for recycled mixtures to account for recycled binder availability.

### **Urgency and Potential Benefits**

Improved assessment of binder availability from recycled materials in asphalt mixtures should yield improved compactability, durability, and cracking performance. The National Asphalt Paving Association (NAPA) estimated that in the U.S. in 2018 the cost savings of using recycled materials totaled approximately \$2.9 billion with 82 million tons of RAP and more than 1 million tons of RAS replacing virgin materials in asphalt mixtures. Since these recycled materials are used on a large scale, it is critical to understand their contribution to improved rutting resistance and compromised durability and cracking performance, which may be exacerbated by an assumption of 100% binder availability. Recycled binder availability is important to engineering each unique asphalt mixture so that sustainability goals and expected significant economic benefits are realized while producing mixtures with balanced engineering performance.

Without the results of this research, economic advantages that range from state to state to a maximum of approximately \$152 million annually would not be realized due to agency reluctance to absorb the risk of unacceptable performance. In addition, public perception of sustainability efforts of the state DOTs could be negatively impacted if the performance of asphalt mixtures with recycled materials is inadequate due to the assumption of 100% recycled binder availability.

### **Implementation Considerations and Supporters**

The results of this research will be used by state DOTs (specifically state DOT materials engineers) and other owner-agencies, asphalt mixture designers, and asphalt paving contractors to produce asphalt mixtures with balanced performance for pavements with recycled contents that are environmentally sustainable and economically viable.

Implementation activities may include:

- review of the proposed changes in specifications and mix design procedures by the FHWA Asphalt Pavement and Materials Technical Feedback Group (Asphalt P&M-TFG) for comment and identification of champions for national implementation



- a national workshop or webinar with invited participants for discussion on implementing the inclusion of reduced recycled binder availability factors (or alternate approaches) for RAP and RAS
- production of guidelines to help state DOTs implement the inclusion of reduced recycled binder availability factors (or alternate approaches) for RAP and RAS
- partnership with state DOTs currently conducting field demonstration projects to assess the impact of the assumption of 100% recycled binder availability on performance

This work is applicable to the AASHTO COMP and indirectly to the AASHTO Committee on Construction.

### **Recommended Research Funding and Research Period**

Research Funding: \$500,000 for research and \$250,000 for initial implementation

Research Period: 36 months for research and 18 months for initial implementation

### **Problem Statement Author(s)**

- Amy Epps Martin, Texas A&M University, (979) 317-2304, [a-eppsmartin@tamu.edu](mailto:a-eppsmartin@tamu.edu)
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### **Others Supporting the Problem Statement**

- TRB Committees AKM30, Stacey Diefenderfer, Virginia Transportation Research Council, (434) 293-1933, [stacey.diefenderfer@vdot.virginia.gov](mailto:stacey.diefenderfer@vdot.virginia.gov)
- AKM40, Silvia Caro, Uni. de los Andes, (+57-310) 767-4276, [scaro@uniandes.edu.co](mailto:scaro@uniandes.edu.co)
- AASHTO Committee on Materials and Pavements (COMP)
- AASHTO Committee on Construction (COC)

### **Potential Panel Members**

- Amy Epps Martin, Texas A&M University, (979) 317-2304, [a-eppsmartin@tamu.edu](mailto:a-eppsmartin@tamu.edu)
- Stacey Diefenderfer, Virginia Transportation Research Council, (434) 293-1933, [stacey.diefenderfer@vdot.virginia.gov](mailto:stacey.diefenderfer@vdot.virginia.gov)
- Brian Pfeifer, Illinois DOT, (217) 782-7202, [brian.pfeifer@illinois.gov](mailto:brian.pfeifer@illinois.gov)

### **Person Submitting the Problem Statement**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, [mfelag@hotmail.com](mailto:mfelag@hotmail.com)

Note: This was ranked #1 for COMP Materials related RPS.

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## **NCHRP Review of D-03**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

Comments:

A. The problem is solvable through the proposed research. B. The topic of research should be of interest to the majority, if not all, state DOTs. C. The objective, as stated in the problem statement, provides a clear intent of the research. D. The stated scope appears specific and should yield the expected product. However, it includes further work on rutting and cracking performance that appears beyond the intended objective of the research. E. The estimated duration of 36 months is more than adequate. The proposed initial implementation time is not part of the proposed scope; the duration allocated to this work should not be included in the project duration (i.e., project duration should be no more than 36 months). F. The estimated budget of \$500,000 seems somewhat high; could be reduced. The proposed initial implementation is not part of the proposed scope; the budget allocated to this work should not be included in project budget (i.e., project budget should be no more than \$500,000). G. A few relevant studies have been cited; further literature review, surveys, and other information gathering should be performed as part of this research. Note: This problem statement is one of 6 problem statements submitted by the AASHTO Committee on Materials and Pavements (3 related to Materials and 3 related to Pavements); it was ranked the highest priority among the 3 material-related problem statements.

Review Date: 12/14/2020

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## **AASHTO Committee Evaluation for D-03**

Submitted By:

Casey Soneira  
AASHTO Staff  
Committee on Construction

Priority #: N/A

Comments: The Committee on Construction supports this research need and recognizes its importance.

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## **Submitter Response for 2022-D-03**

**From:** [email: mfelag@hotmail.com] for Author Amy Epps Martin, PhD, PE, FASCE (minor edits by Mark)

## **Comments:**

Author's Response to Comments A., B., and C: We appreciate the positive comments by NCHRP. Thank you.

NCHRP Comment D: The stated scope appears specific and should yield the expected product. However, it includes further work on rutting and cracking performance that appears beyond the intended objective of the research.

Author's Response to Comment D: Part of the research objective is to provide guidelines for the use of recycled asphalt materials from which the binder availability is determined. In order to provide useful guidance, the effect of these materials on mixture performance deterioration or durability in terms of cracking and rutting resistance must be addressed. Guidance for any sort of binder requirement or usage must be tied to balanced mixture performance in order to be meaningful.

NCHRP Comment E: The estimated duration of 36 months is more than adequate. The proposed initial implementation time is not part of the proposed scope; the duration allocated to this work should not be included in the project duration (i.e., project duration should be no more than 36 months).

Author's Response to Comment E: To address Special Notes D in the RFP, implementation is included as an ongoing process to emphasize the express need for the outcomes to be practical and implementable by agencies and others. The implementation of the outcomes must be considered during the entire project in order to achieve the most benefit, even though specific efforts will occur after the project is complete. The finalized work plan should consider providing implementation steps and aids (such as recorded webinars). The 36 month duration is in line with other NCHRP projects whose scope requires laboratory, field, and validation efforts.

NCHRP Comment F: The estimated budget of \$500,000 seems somewhat high; could be reduced. The proposed initial implementation is not part of the proposed scope; the budget allocated to this work should not be included in project budget (i.e., project budget should be no more than \$500,000).

Author's Response to Comment F: The estimated project budget is in line with other NCHRP projects of similar scope. The scope of the project may require significant laboratory, field, and verification efforts.

NCHRP Comment G: A few relevant studies have been cited; further literature review, surveys, and other information gathering should be performed as part of this research.

Author's Response to Comment G: In order to provide a concise problem statement, not all relevant studies are cited; it is expected that all necessary efforts to identify relevant information will be undertaken within the scope of the project.

Contact Info:

Mark Felag AASHTO COMP Secretary

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Review Date: January 13, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**Problem Number: 2022–D-04**

**Problem Title**

Leverage Long-Term Pavement Performance (LTPP) program Falling Weight Deflectometer (FWD) Data to Guide Effective use of Traffic Speed Deflection Measurements for Pavement Management and Design Applications

**Background**

Traditionally, State Highway Agencies (SHAs) Pavement Management Systems (PMS) have primarily been based on surface condition data, and surface cracking is mainly used as an indicator of the pavement structural condition. However, with effective pavement preservation activities that intervene early to preserve and extend the life of pavements and increasingly thicker long-life pavements, the surface cracks can no longer be relied on as a reliable indicator of structural condition or “health” of the pavement structure. This is because most preservation treatments correct surface cracks but do not correct bottom-up fatigue cracking, instead concealing them, while the bottom-initiated cracks continue to develop. In addition, the prevalence of top-down cracking in thicker pavements also makes it difficult to distinguish bottom-up fatigue cracking which is the common indicator of structural deterioration. To address this need, traffic speed deflection devices (TSDD) that can measure pavement deflection at traffic speeds have been developed and, with favorable findings from recent national research efforts that focused on assessment and validation of TSDDs, SHAs have shown increased interest in incorporating deflection testing to consider structural adequacy as part of their PMS activities. A new NCHRP project, 10-105, is focused on the verification of TSDD measurements. However, methodologies for analysis and effective use of TSDD data for pavement management and design applications are still being developed.

LTPP test sections have a significant amount of FWD data collected over time. While FWD testing has largely ceased given current LTPP funding levels, testing has continued on selected projects, and many sites have sufficient time histories to determine whether measurements are or are not varying over time. While ideally FWD testing and TSDD measurements would be done as close together as possible, regardless, the LTPP database will provide a source of quality FWD data for comparison purposes.

Utilizing FWD and TSDD data to perform similar computations on LTPP pavement sections (where layer thicknesses and material properties are known) will leverage extensive knowledge and experience pavement engineers have in the use of FWD data for pavement structural assessment to provide insight into how best to utilize TSDD data for pavement management and design applications.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards, Goal 2 – Develop and Maintain Pavement Design Guides, and Goal 3 – Develop and Champion Research for COMP.

### **Literature Search Summary**

Several SHAs are participating in the Virginia Department of Transportation led Transportation Pooled Fund Study TPF-5(385) "Pavement Structural Evaluation with Traffic Speed Deflection Devices" and looking at how to incorporate TSDD data within pavement management and design process, but limited information has been published to date. As noted above, most TSDD literature to date describes the data collection process and assesses data validity but limited in the data utilization. While the literature search should include a summary of FWD and TSDD comparison studies, it should focus on how TSDD has been applied (e.g., delineating structurally sound and weak pavement sections, remaining service interval, backcalculation of pavement layers, deflection indices, effective structural number, overlay thickness) to assist agencies in pavement management and design evaluations, and what elements are most critical in current SHA pavement management and design methodologies. The literature review should also consider the threshold values based on pavement type and structure.

### **Research Objective**

Develop guidance that would be the basis for a Recommended Practice for incorporating network level structural information into pavement management and pavement design practices.

This research would address the following objectives: (1) Assess utility of TSDD data across range of pavement types and structures; (2) Assess comparability and accuracy of various commonly used pavement structural condition indices determined from TSDD to those based on FWD measurements; (3) Create adjustment factors to account for variance in climatic conditions; (4) Develop methodologies for establishing thresholds for TSDD based indices as a function of traffic levels to assist pavement rehabilitation decisions; (5) Develop methodologies and approaches for developing pavement structural performance models from historical TSDD data similar to that used for surface distresses; and (6) Develop frameworks for incorporating network level structural information into pavement management and pavement design practices.

This research should include the following tasks:

#### Task 1: Literature Search

Conduct a literature search as described in Section 3 above.

#### Task 2: Create a database with TSDD and FWD available across a variety of pavement types and structures.

- Assess available information
- Identify data needed for pavement management and design applications
- Collect additional data as practical

Task 3: Calculate structural properties based on TSDD and FWD data.

- AC, PCC, composite (bound, unbound, and subgrade layers)
- Pavement structural indices
- Critical stresses and strains
- Adjustments based on climatic factors
- Develop structural condition indices thresholds

Task 4: Determine utility of TSDD data in pavement management.

- Structural performance modeling and prediction for treatment timing
- Remaining service interval

Task 5: Determine utility of TSDD data in pavement design.

- Estimation of effective structural number (S<sub>Neff</sub>)
- Prediction of overlay thickness
- Identification of localized pavement failure

Task 6: Recommended Practice

Prepare an AASHTO Recommended Practice from the guidance developed incorporating network level structural information into pavement management and pavement design practices.

**Urgency and Potential Benefits**

The vast majority of SHAs do not have network level structural data, not because it is not desired, but because it has not been practical to collect. Instead, structural data is collected on a project level based on agency practices. Having the ability to collect network level data using the TSDD is not going to be sufficiently compelling; there is also a need to prove the utility of this information. It also may be that TSDD measurements are critically important for some pavement structures, and less so for others.

**Implementation Considerations and Supporters**

Users will be Pavement Management and Pavement Designers within State DOT's.

In addition to SHAs support for having answers to the questions identified above, the following organizations, committees, and champion groups are expected to support this project:

- TRB Standing Committee on Pavement Condition Evaluation (AKP10)
- TRB Standing Committee on Design and Rehabilitation of Concrete Pavements (AKP20)
- TRB Standing Committee on Design and Rehabilitation of Asphalt Pavements (AKP30)
- TRB Standing Committee on Pavement Structural Testing and Evaluation (AKP40)
- TRB Standing Committee on Pavement Management (AKT10)
- AASHTO Committee on Materials and Pavement (COMP)
- FHWA

- Deflection at Road Traffic Speed (DaRTS) group

**Recommended Research Funding and Research Period**Research Funding:

The estimated cost to complete this research is \$450,000. This includes 2 person/year.

Research Period:

The estimated time to complete this research study is 24 months which includes the review time of the interim and draft final reports.

**Problem Statement Author(s)**

TRB Expert Task Group on Pavements a subsidiary committee of the TRB Long-Term Infrastructure Performance Committee; administered by Larry Wiser, FHWA, Research Civil Engineer, 202-493-3079, [Larry.Wiser@dot.gov](mailto:Larry.Wiser@dot.gov).

**Others Supporting the Problem Statement**

The problem statement addresses a concern to the groups listed in item 6 above.

**Potential Panel Members**

FHWA, Nadarajah Sivanewaran (Siva), (202) 493-3147, [Nadarajah.Sivanewaran@dot.gov](mailto:Nadarajah.Sivanewaran@dot.gov)

Texas DOT, Jenny Li, (512) 832-7319, [Jenny.Li@txdot.gov](mailto:Jenny.Li@txdot.gov)

Indiana DOT, Tommy Nantung, (765) 463- 1521 Ext. 248, [tnantung@indot.in.gov](mailto:tnantung@indot.in.gov)

TRB Board Long-Term Infrastructure Performance (LTIP) Pavements Expert Task Group members

TPF-5(385) "Pavement Structural Evaluation with Traffic Speed Deflection Devices" panel members

Deflection at Road Traffic Speed (DaRTS) members

**Person Submitting the Problem Statement**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, [mfelag@hotmail.com](mailto:mfelag@hotmail.com)

Note: This was ranked #2 for COMP Pavement related RPS.

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**NCHRP Review of D-04**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)



Comments:

A. The majority, if not all, Traffic Speed Deflection measurements currently available in the United States were produced by one vendor using own proprietary equipment and procedures. This raises a concern about conducting a national research project with this limited data and developing recommended practices based on one vendor's data and procedures. Added to that is the lack of rigorous practices for the verification of these measurements; these are being developed under NCHRP Project 10-105, Verification of Traffic Speed Deflection Devices? (TSDD) Measurements. There are also concerns about availability of adequate data in terms of quantity and quality as FWD and TSSD measurements were most likely were not made on the same locations at the same time to provide meaningful comparisons. All these issues raise a concern about the quality of conclusions derived from such research and its nationwide applicability. The proposed research appears premature for consideration at this time. B. The topic of research should be of interest to the majority, if not all, state DOTs but reliable findings cannot be achieved at this time. C. The objective, as stated in the problem statement, provides a clear intent of the research. However, achieving unbiased, well-supported conclusions cannot be expected at this time. D. The stated scope appears to be extensive; covers many topics that cannot be adequately addressed and should not be considered at this time because of the concerns noted above. However, limiting the scope to evaluating the feasibility of using TSSD measurements for (a) characterizing pavement deflection and (b) use in pavement design and performance evaluation may be appropriate. E. The estimated duration of 24 months seems excessive and should be reduced to 12 months if the scope is limited to the feasibility evaluation suggested above. F. The estimated cost of \$450,000 seem excessive and should be reduced to \$100,000 if the scope is limited to the feasibility evaluation suggested above. G. Only one study has been cited; further literature review, surveys, and other information gathering should be performed as part of this research. Note: This problem statement is one of 6 problem statements submitted by the AASHTO Committee on Materials and Pavements (3 related to Materials and 3 related to Pavements); it was ranked the second highest priority among the 3 pavement-related problem statements.

Review Date: 12/14/2020

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**FHWA Evaluation of D-04**

Reviewed By: HRDI/Jane Jiang/Nadarajah Sivaneswaran

Comments:

There is significant interest and demonstrated need among State DOTs in collecting and utilizing network level pavement structural data (currently 26 State DOTs and FHWA are participating in TPF-5(385)); however, robust approaches for effectively using TSDD data for various pavement management and project level applications are

still lacking. Pavement engineers have significant experience using FWD data for project level applications; while they are related, not directly transferrable to TSDDs, and this effort will build upon that knowledge and adopt them to TSDDs. FHWA LTPP InfoPave™ and InfoMaterials™ web portals contain both FWD and TSDD data. Currently TSDD data collected for Federal Lands Highways (~2,100 miles so far) are made available on InfoMaterials in January 2021. TPF-5(382) pooled fund states have also expressed interest in sharing the data collected via FHWA InfoMaterials.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for D-04**

Submitted By:  
Casey Soneira  
AASHTO Staff  
Committee on Materials and Pavements

Priority #: 5

Comments: To understand pavement conditions using devices that measure at traffic speeds will greatly enhance our knowledge of pavement structural analysis in a safer environment. This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards, Goal 2 – Develop and Maintain Pavement Design Guides, and Goal 3 – Develop and Champion Research for COMP. #2 for Pavements within COMP, 5th overall

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## **Submitter Response for 2022-D-04**

**From:** [email: mfelag@hotmail.com] Mark (minor edits) for Larry Wiser - FHWA

### **Comments:**

Author General Comment: We appreciate the positive comments from FHWA. Our responses to NCHRP are below:

NCHRP Comment A: The majority, if not all, Traffic Speed Deflection measurements currently available in the United States were produced by one vendor using own proprietary equipment and procedures. This raises a concern about conducting a national research project with this limited data and developing recommended practices based on one vendor's data and procedures. Added to that is the lack of rigorous practices for the verification of these measurements; these are being developed under NCHRP Project 10-105, Verification of Traffic Speed Deflection Devices' (TSDD) Measurements.

Author Comment for A: It is true that the TSDDs currently available and in use in the US (also most, if not all, around the world) were produced using deflection measuring system (DMS) produced by one vendor using own proprietary equipment and procedures. It is also agreed that, normally, we wouldn't pursue a NCHRP research effort that may benefit or applicable to only one device or manufacturer. However, network level pavement structural data is of high interest, the need is now, the states are needing and collecting this data and the data has been proven to be beneficial for network and project level decisions. There are 26 states and Federal Highway Administration (FHWA) participating in the Transportation Pooled Fund TPF-5(382) "Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs)" being led by Virginia Department of Transportation with commitments over \$4.2M and more states expressing interest. This national level interest is also evidenced from several TSDD workshops during each of the last several Transportation Research Board (TRB) annual meetings except in 2020. It will be a missed opportunity for National Cooperative Highway Research Program (NCHRP) to not help a majority of the states who need and are collecting TSDD data and would greatly benefit from a nationally led NCHRP research project focused on developing guidance on effective use of TSDD data for Pavement Management and Design Applications.

It is unlikely that there will be another device by a different vendor becoming available in the next several years (there was another device by a different vendor in the process of being introduced but has since been dropped). It should also be noted that, while there is only one vendor producing deflection measuring system being used in current TSDDs, that vendor doesn't provide services but offers the system to other pavement data collection vendors who integrate it along with other systems (GPR, imaging, etc.) for comprehensive data collection.

In summary, if the fact that there is only one type of system available limits NCHRP projects related to TSDDs, there likely will not be a NCHRP project to support the many State DOTs having interest and investing in TSDD data collection for the next several years. It appears that an exception is warranted when the benefit to the agencies is clearly evident. As noted earlier, there are other national level efforts focused on TSDD data use for pavement analysis, including transportation pooled fund projects and several TRB workshops and webinars and a NCHRP project is no different.

NCHRP Comment A (cont.): There are also concerns about availability of adequate data in terms of quantity and quality as FWD and TSSD measurements were most likely were not made on the same locations at the same time to provide meaningful comparisons. All these issues raise a concern about the quality of conclusions derived from such research and its nationwide applicability. The proposed research appears premature for consideration at this time.

Author Comment for A (cont.): This needs to be assessed as part of the research initial tasks. The premise is, given the TSDD data collected in several states, there is going to be sufficient overlap of LTPP pavement sections and pavements where TSDD data has been collected. It's not available at the time of development of this Problem Statement

(PS) as it has not been investigated and is an expected part of this effort. Also, TSDD will continue to collect data and the proposed project can have them collect data on LTPP sections when they are in the vicinity for minimal or no cost.

In terms of collecting falling weight deflectometer (FWD) and TSDD data at the same time, there may be some need for limited side by side data collection but in general this project is not premised on that. Rather, incorporate adjustment procedures for climate and M-E based damage to account for time difference. This procedure is indeed required to use the deflection data for a pavement management system (PMS) as well.

NCHRP Comment B: The topic of research should be of interest to the majority, if not all, state DOTs but reliable findings cannot be achieved at this time. Author Comment for B: As noted in the last response, there are 26 State DOTs and FHWA participating the TSDD TPF committing significant funds and more are expected to join. That is indeed a majority of the state DOTs. Also, research efforts on adopting a few existing FWD data based methodologies to TSDD data have proven to be feasible and reliable as demonstrated through limited validation using FWD and TSDD field data collected on limited pavements sections. For example, please see references - <https://doi.org/10.1080/10298436.2018.1546858>, <https://doi.org/10.1177/0361198118825122>.

NCHRP Comment C: The objective, as stated in the problem statement, provides a clear intent of the research. However, achieving unbiased, well-supported conclusions cannot be expected at this time.

NCHRP Comment D: The stated scope appears to be extensive; covers many topics that cannot be adequately addressed and should not be considered at this time because of the concerns noted above. However, limiting the scope to evaluating the feasibility of using TSDD measurements for (a) characterizing pavement deflection and (b) use in pavement design and performance evaluation may be appropriate. Author Comment for C and D: Agree that there may be opportunity to limit or revise the scope but our understanding is that it is left to the panel members to deliberate and decide if this PS is approved.

NCHRP Comment E: The estimated duration of 24 months seems excessive and should be reduced to 12 months if the scope is limited to the feasibility evaluation suggested above. Author Comment for E: As proposed it appears the effort would require the estimated duration and funds. If the scope is reduced and/or revised, this may change and our understanding is that it would follow panel's scope review/revision.

NCHRP Comment F: The estimated cost of \$450,000 seem excessive and should be reduced to \$100,000 if the scope is limited to the feasibility evaluation suggested above. Author Comment for F: Please see last response.

NCHRP Comment G: Only one study has been cited; further literature review, surveys, and other information gathering should be performed as part of this research.  
Author Comment for G: Agree.

**Contact Info:**

Larry J. Wiser | FHWA

Research Highway Engineer, Long-Term Infrastructure Performance Team

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Turner-Fairbank Highway Research Center

6300 Georgetown Pike, HRDI-30, McLean, Virginia 22101-2296

Review Date: January 14, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP Problem Statement**

**PROBLEM NUMBER: 2022–D-05**

**PROBLEM TITLE**

Recommended Minimum Qualifications for Transportation Project Quality Management Roles

**BACKGROUND**

Effective management of quality during the design and construction of public transportation projects is a critical, yet often overlooked part of the successful delivery of these projects. Owner agencies, designers, contractors and material suppliers all require specific quality roles and functions to assure that the project meets design requirements and long-term performance expectations. Typical quality roles include owner quality assurance engineers/managers; design quality managers; construction quality managers; quality control plan administrators and quality control managers. These roles and functions will vary depending on project delivery method specified by the owner or their organizational structure. While the minimum qualifications for roles such as lead designer, project manager or construction engineer are usually well-defined to include specific levels of education, experience and professional licensure, minimum requirements for quality-related roles often do not include specific training or certification in quality management principles. This may be due to an assumption that education and experience in a particular design or construction discipline provides the skills necessary to provide effective quality management; this ignores the fact that quality management is itself a specialized discipline that requires training and experience. It is also critical that individuals in these roles understand the overall project quality efforts and how their functions support those efforts. The pervasive lack of training in quality management principles leads to compromised overall short and long-term quality of projects.

Some owner agencies specify or recommend minimum qualifications for personnel filling key management roles focused on quality engaged on public construction projects. For example, the Army Corps of Engineers (USACE) and U.S. Naval Facilities Engineering Command (NAVFAC) require QC managers/administrators working on their projects to hold a certificate in *Construction Quality Management for Contractors*, that is offered as a partnership between those agencies and two national contractor associations. The Federal Transit Authority (FTA) “Quality Management System Guidelines” recommends that certain project personnel hold certifications through the American Society for Quality including *Manager of Quality/Organizational Excellence*; *Quality Engineer*; and *Quality Auditor*. Several state DOTs in the northeast require QC plan administrators to hold the Quality Assurance Technologist certification administered by the NorthEast Transportation Training and Certification Program (NETTCP). However, most agencies do not require certification for quality management roles. Instead they rely on minimum

educational and experience levels that may or may not include training on or experience with quality management principles.

Increased knowledge of quality management principles will lead to improved outcomes on transportation projects, including well defined and understood roles, less rework, shorter project completion times, extended facility life, reduced operating costs, and fewer traffic delays.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

### **LITERATURE SEARCH SUMMARY**

Several published reports and articles discuss quality management approaches on public transportation projects (many specific to design-build contracting). However, none discuss in detail the qualifications needed to effectively conduct various quality roles. This research will provide those qualifications needed for quality roles.

**Kraft, E. and Molenaar, K.: “Fundamental Project Quality Assurance Organizations in Highway Design and Construction” – ASCE Journal of Management in Engineering, July 2014.**

Gransberg, D., Molenaar, K.: “Analysis of Owner's Design and Construction Quality Management Approaches In Design/Build Projects” – American Society of Civil Engineers, 2004.

Baabak Ashuri, Ph. D., Yashovardhan Jallan, Jung Hyun Lee: “Materials Quality Management for Alternative Project Delivery” - Georgia Department of Transportation, May 2018.

Ghada M. Gad, Simon A. Adamtey, Douglas D. Gransberg: “Trends in Quality Management Approaches to Design–Build Transportation Projects” - Transportation Research Record: Journal of the Transportation Research Board, No. 2504, Transportation Research Board, Washington, D.C., 2015, pp. 87–92.

Gransberg, D., and K. Molenaar: “Analysis of Owner's Design and Construction Quality Management Approaches in Design/Build Projects” - Journal of Management in Engineering, Vol. 20, No. 4, 2004, pp. 162–168.

Gransberg, D., Datin, J., and Molenaar, K. (2008). NCHRP Synthesis 376: Quality Assurance in Design-Build Projects, Transportation Research Board, Washington, DC.

### **RESEARCH OBJECTIVE**

Develop recommended minimum qualifications for design and construction quality management roles on public transportation projects.

Possible tasks include:

Task 1 – Literature review. Include public transportation agency specifications related to quality management for design and construction.

Task 2 – Survey of public transportation agencies to determine current requirements for quality management roles (including agency, designer, and contractor roles), for both traditional delivery and alternative delivery projects.

Task 3 - Identify existing training/certification programs for quality management roles that are related to transportation project delivery, or other related industry sectors. Review the prerequisites, course content, intended audience guidelines, examination process, and recertification requirements.

Task 4 – Develop suggested minimum qualifications for various quality management roles, including education, certification, and experience requirements. Consider both traditional and alternative project delivery methods.

Task 5 – Publish an AASHTO Recommended Practice for agencies to use to develop minimum qualification/certification requirements for various quality management roles for public transportation projects.

## **URGENCY AND POTENTIAL BENEFITS**

Ineffective quality management in the transportation project delivery process can lead to project delays and cost escalation due to constructability problems, rework, and disputes, as well as reduced service life and increased maintenance costs of completed facilities. Published reports have estimated that rework on construction projects can account for as much as 25 percent of total project cost. Given the total cost of delivering public transportation projects in the United States, improved quality management in design and construction could result in millions of dollars in annual savings to taxpayers.

## **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

Implementation of the guidelines will be accomplished through presentations at the AASHTO Committee on Materials and Pavements, AASHTO Committee on Construction, and through presentation at various regional and national meetings and conferences (including the TRB annual meeting), as well as a TRB webinar. Potential challenges will be similar to those encountered when organizations worked to improve safety. It will require a shift in cultural beliefs for agencies and industry to invest in additional training and/or certification of quality management staff. Inconsistent terminology related to QA will present challenges by inhibiting effective communication at the national level.

Appropriate roles and responsibilities will benefit the entire construction community. AASHTO Committee on Materials and Pavements (COMP) and Committee on Construction (COC) will especially benefit from the results of this research.



## **RECOMMENDED RESEARCH FUNDING AND RESEARCH PERIOD**

**Recommended Funding:** \$250,000      **Research Period:** 18 months

## **PROBLEM STATEMENT AUTHOR**

Rick Bradbury, Maine Department of Transportation, Tel: (207) 624-3482,  
Richard.bradbury@maine.gov

Robert Lauzon, Connecticut Department of Transportation, Tel: (860) 258-0312,  
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## **OTHERS SUPPORTING THE PROBLEM STATEMENT**

TRB Committee AKC30 – Quality Assurance Management  
AASHTO Committee on Materials and Pavements (COMP)  
AASHTO Committee on Construction (COC)

## **POTENTIAL PANEL MEMBERS**

Maine DOT, Rick Bradbury, (207) 624-3482, Richard.bradbury@maine.gov  
Members of AASHTO COMP Technical Subcommittee 5c, Curt Turgeon (Chair),  
(651) 366-5535, curt.turgeon@state.mn.us.

## **PERSON SUBMITTING THE PROBLEM STATEMENT**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-  
245-1327, mfelag@hotmail.com

Note: This was ranked #3 for COMP Materials related RPS.

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## **NCHRP Review of D-05**

### **Reviewed By:**

Christopher T. McKenney  
CMcKenney@nas.edu

### **Comments:**

Licensure and certification demonstrates a certain level of knowledge (especially for technicians) needed to ensure a project is being not only built but ensuring standards and specifications are being met according to the contract. Many state DOTs have developed, promoted and required those working on job sites have certain certifications to ensure they are accomplishing tasks correct. Technicians and non-engineers need to

be held at a level that engineers are held to. Recommend increasing to \$300,000 and extending the project duration to 24 months.

Review Date:  
12/21/2020

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## **FHWA Evaluation of D-05**

Reviewed By: HRDI20/Matt Corrigan

### Comments:

Funding level appears low if intended to develop and publish a guide for agency use. This is an important need and often overlooked. Quality roles have traditionally only emphasized materials testing and have ignored other project quality management roles in design and construction and associated quality management principles. AASHTO COMP again ranked this project need very high this round and was also highly ranked for the 2021 submission as well! Submission of this topic twice by AASHTO COMP warrants the importance of the topic and need to have it funded and advanced.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-D-05**

**From:** [email: mfelag@hotmail.com]

### **Comments:**

Reply to FHWA Comments - The authors appreciate the positive feedback from the FHWA reviewer.

Reply to NCHRP Comments - The authors appreciate the positive feedback from the NCHRP reviewer. We agree that the project would benefit from additional funding and time in order to develop the AASHTO Recommended Practice.

**Contact Info:** Mark Felag for Richard Bradbury (Richard.bradbury@maine.gov)

Review Date: January 11, 2021

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**PROBLEM NUMBER: 2022–D-06**

**PROBLEM TITLE**

Recommended Procedures for Verifying Material Quantities at Asphalt Mix Plants

**BACKGROUND**

Asphalt mixtures produced in the United States in 2018 contained over 82 million tons of reclaimed asphalt pavement (RAP) and over 1 million tons of reclaimed asphalt shingles (RAS). Public transportation agencies typically specify maximum percentages of RAP and RAS that can be used to produce asphalt mixes, based on factors such as mix type and application. These maximums are needed to ensure good performance of the pavement. These maximum values can be based on total percentage of the RAP or RAS by weight, or on a calculated value such as reclaimed binder ratio. Regardless of the specification method, it is necessary to verify the percentage of RAP or RAS being introduced into the asphalt mix plant in order to determine specification compliance. This is further complicated with the fact that RAP and RAS contain both asphalt binder and aggregate, so, the verification process must include the quantity added as well as the percentages of asphalt binder and aggregate comprising each material. Verification of RAS content can be especially challenging because it often does not flow freely when using traditional cold feed bins, so is often mixed with another material (such as RAP or sand) before introduction into the plant. Excess RAP or RAS in a pavement can lead to insufficient new binder and increased stiffness of the mastic, potentially resulting in reduced mixture durability.

States have used various approaches to verify RAP and RAS percentages using techniques such as stockpile measurements or plant recordation. Also, plant manufacturers have introduced new equipment to monitor flow from individual cold feeds or improved plant calibration equipment, but there are no national guidelines in the use of these approaches.

In addition to RAP and RAS, materials introduced at asphalt plants include asphalt binder, aggregate, and many additives such as latex, ground tire rubber, warm mix additives, anti-strip additives, fibers, and mineral fillers. Addition of these materials is done with many different types of equipment and control systems. The additions must be accurately controlled and interlocked in order to meet job mix formula requirements and agency specifications. Often, these additives are introduced using systems that do not provide good means to verify the quantity being added.

Transportation agencies and asphalt mix producers would benefit from guidelines recommending best practices for verifying quantities of materials including RAP, RAS and

other additives into asphalt mixtures. Improved information will lead to better specification compliance and potentially improved pavement performance.

This relates to AASHTO Committee on Materials and Pavement's (COMP's) Strategic Plan - Goal 1.1 – Update Materials Standards and Goal 3 – Develop and Champion Research for COMP.

## **LITERATURE SEARCH SUMMARY**

Several published reports and articles discuss production of asphalt mixes containing RAP and RAS. However, none provide specific guidance on verifying RAP/RAS or additive content during mix production. This research will provide that guidance.

**William R. Vavrik, Samuel H. Carpenter, Steve Gillen, Jay Behnke, Fred Garrott: “Evaluation of Field-produced Hot Mix Asphalt (HMA) Mixtures with Fractionated Recycled Asphalt Pavement (RAP): 2007 Illinois Tollway Field Mix Trials” - Research Report ICT-08-030, Illinois Center for Transportation, Oct. 2008.**

Mansour Solaimanian and Maghsoud Tahmoressi: “Variability Analysis of Hot-Mix Asphalt Concrete Containing High Percentage of Reclaimed Asphalt Pavement” – Transportation Research Record 1543, 1996.

Randy West, Fabricio Leiva, Grant Julian, Adam Taylor, Elton Brown, James R. Willis: “Using Recycled Asphalt Shingles with Warm Mix Asphalt Technologies” – NCHRP Research Report 890, 2018.

Fujie Zhou: Best Practices for Using RAP/RAS in HMA/WMA Mixes Including Workshop and Workshop Materials” – Texas A&M Transportation Institute, 2013.

## **RESEARCH OBJECTIVE**

Develop recommended practices/standards updates to verify quantities of materials being introduced into asphalt mixtures at production facilities. Possible tasks include:

Task 1 – Literature review. Include public transportation agency specifications and inspection procedures related to asphalt mix plant and production requirements and AASHTO M 156, *Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures*.

Task 2 – Survey of public transportation agencies asphalt mix producers and plant manufacturers to determine current procedures for verifying raw material quantities including RAP, RAS and other additives during mix production.

Task 3 - Identify best practices for verifying raw material quantities used including RAP, RAS and additive, as well as any knowledge gaps in this area.

Task 4 – Develop suggested specification language and inspection procedures. Include plant calibrations and procedures, accuracy requirements for various additive types, and documentation/recording procedures for both batch plants and drum mix plants. Staffing, timing and frequency of these activities should be addressed. There may not be one approach. There may be a variety of approaches from which a state could choose.

Task 5 – Publish a guide for agencies to use to develop specifications and inspection procedures for verification of materials including RAP, RAS and additive content of asphalt mixes. Develop proposed updates to AASHTO M 156.

### **URGENCY AND POTENTIAL BENEFITS**

Inability to accurately verify the percentage of RAP, RAS and other materials during asphalt mix production can lead to production of mixes that do not meet the job mix requirements or material specifications. Current test methods cannot identify the RAP, RAS or additive content; these must be verified through monitoring of plant operations during production. Excessive RAP or RAS in a pavement can lead to decreased durability and premature failure. Incorrect percentages of additives such as hydrated lime, warm mix chemicals or fibers can also lead to performance problems. Given that 94 percent of the nation's highway network is paved with asphalt, even a small increase in pavement life will result in millions of dollars in savings.

### **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

Implementation of the guidelines and proposed revisions to AASHTO M 156 will be accomplished through presentations to the AASHTO Committee on Materials and Pavements, the AASHTO Committee on Construction, and through presentation at various regional and national meetings and conferences (including the TRB annual meeting), as well as a TRB webinar. Successful implementation will require working with agency materials and construction engineers, and with asphalt mix producers through various industry associations, including the National Asphalt Pavement Association and the Asphalt Institute. Potential challenges will be resistance by mix producers, lack of physical controls on existing asphalt mix plants, as well as reluctance by agencies to implement new requirements which may increase costs. Agency staffing will be an important aspect effecting implementation.

### **RECOMMENDED RESEARCH FUNDING AND RESEARCH PERIOD**

**Recommended Funding:** \$400,000.00

**Research Period:** 24 months

### **PROBLEM STATEMENT AUTHOR**

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**OTHERS SUPPORTING THE PROBLEM STATEMENT**

TRB Committee AKC30 – Quality Assurance Management

AASHTO Committee on Materials and Pavement (COMP)

AASHTO Committee on Construction (COC)

**POTENTIAL PANEL MEMBERS**

MA DOT, Mark Brum, (617) 866-8516, mark.brum@dot.state.ma.us

Members of AASHTO COMP Technical Subcommittee 2c, Allen Myers (Chair),  
(502) 564-3160, allen.myers@ky.gov.

**PERSON SUBMITTING THE PROBLEM STATEMENT**

Mark E. Felag, AASHTO COMP Secretary on behalf of AASHTO COMP, 401-245-1327, mfelag@hotmail.com

Note: This was ranked #2 for COMP Materials related RPS.

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**NCHRP Review of D-06**

Reviewed By:

Edward T. Harrigan

Comments:

The problem is potentially solvable through the proposed research. The objective is clear. The scope is reasonable. The research can be accomplished in the proposed 24 months. The proposed budget of \$400,000 is adequate.

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**FHWA Evaluation of D-06**

Reviewed By: HRDI20/Matt Corrigan

Comments:

Verification of RAP and especially RAS materials during asphalt mix production and construction has a significant effect on long term pavement performance. Consideration should be made for existing CalTrans requirements in place for metering materials and

the equipment requirements, calibration, accuracy, and plant integration in place for items such as fibers, zeolites @ waxes used as WMA technologies and other additives that are "blown" into plants via supplemental equipment, etc.

Review Date:  
12/18/2020

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**Submitter Response for 2022-D-06**

**From:** [email: mfelag@hotmail.com]

**Comments:**

Reply to FHWA Comments - The authors appreciate the positive feedback from the FHWA reviewer. We agree that the selected research team should look at existing specifications as part of their work plan.

Reply to NCHRP Comments - The authors appreciate the positive feedback from the NCHRP reviewer.

**Contact Info:** Mark Felag for Richard Bradbury (Richard.Bradbury@maine.gov)

Review Date: January 11, 2021

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**WITHDRAWAL**

(This problem statement has been withdrawn by the submitter.)

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number:**  
**2022-D-07**

**Problem Title**

Reconnaissance Scanning of Underground Utilities in the Right-of-Way

**Background/ Needs Statement**

Mapping of buried utilities using QLB SUE (i.e., use of geophysical tools) as is frequently performed or recommended can be costly, particularly in the case of long, complex projects in rural areas. A conventional QLB investigation can also result in inconclusive answers for unknown utilities (i.e., utilities that are discovered but no other information is available). If undiscovered until construction, these unknown pipes cause serious scheduling disruptions, as well as higher construction costs and safety and environmental risks.

This issue is particularly common and problematic in areas where rural utility infrastructure has been accumulating for decades (e.g., areas of oil and gas operations). For a long transportation project in this kind of environment, a person using a pipe and cable locator (standard QLB tool) would only be capable of covering a small fraction of the project area. However, a full-fledged QLB investigation would be cost prohibitive. State transportation agency (STA) districts are aware of these limitations, particularly in the case of long projects, and frequently decide not to conduct a geophysical investigation at all.

There is a need for a faster, less expensive method of scanning the right-of-way for unknown pipelines and other similar infrastructure in situations where there is a risk a project manager or designer might decide not to conduct a QLB investigation, but identifying those pipelines is critical, particularly during the construction phase.

**Literature Search Summary**

Strategic Highway Research Program 2 (SHRP2) R01B, Mapping the Underworld project in the UK. Previous research developed multiple geophysical sensors for mapping underground utilities. They had good results with EM sensors. Implementation of the SHRP2 results was tested by a few DOTs in the US. The EM sensors were particularly promising in rural areas.

**Research Objective**



This project will test the application of two newly available geophysical measurement systems for quickly and cheaply detecting and mapping unknown metallic pipelines in the right-of-way. One system consists of a ground-based array of electromagnetic (EM) sensors towed by an ATV type vehicle. Previous research by the SHRP2 R01B project demonstrated that this type of system can detect any metal down to at least six feet of depth, depending on pipe diameter. Deeper detection is possible under certain circumstances. The research will test recently developed, commercially available systems. The second system is an airborne (drone) passive magnetic sensor that can detect ferrous metal down to six feet or more, depending on pipe diameter. Although passive magnetic sensors have been in use for years, newly developed micro magnetic sensors are now becoming available on drone platforms, which is the facet of the system to be investigated.

The research will determine if either or both of these systems can be deployed effectively on transportation projects. The variables to be tested include working within the constraints of a typical highway project, such as height and thickness of vegetation, and presence of fences, overhead utilities, passing traffic, and nearby structures. The cost and effectiveness of the deployment will be compared to the those of a standard QLB investigation, with modifications for the types of right-of-way tested. If one or both of the systems are technically successful and can be deployed for a reasonable cost, then deployment strategies, parameters and guidelines will be developed and documented.

The research deliverables will include:

- Report describing the research and the results
- A set of guidelines, including an operating manual or draft revisions to existing manuals
- Recommendations on how to merge these results with utility data generated from the standard SUE process.

### **Urgency and Potential Benefits**

The research would have several benefits including, but not limited to, the following:

- Fewer construction delays.
- Lower construction costs resulting from fewer delays, change orders, and claims.
- Mitigation of the construction safety risk of encountering unknown pipes.
- Mitigated environmental risk of a fluid leak from an accidentally breached pipe whose presence was previously unknown.

### **Funding Requested and Time Required**

It is estimated that this research will take 24 months to complete and will require \$600,000.

### **Others Supporting the Problem Statement**

The AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Controls supports this Research Problem Statement.

Casey Soneira, csoneira@ashto.org, 202-624-5824

**CONTACT PERSONS**

Patrick Allen, Georgia DOT  
AASHTO Utility Project Scoping & Coordination Technical Subcommittee Chair  
AASHTO Committee of Right of Way, Utilities and Outdoor Advertising  
Utilities Subcommittee  
Email: paallen@dot.ga.gov  
Phone: (404) 631-1380

Dean Serna, New Mexico DOT  
AASHTO Utility Project Scoping & Coordination Technical Subcommittee Vice-Chair  
AASHTO Committee of Right of Way, Utilities and Outdoor Advertising  
Utilities Subcommittee  
Email: dean.serna@state.nm.us  
Phone: (505) 795-1608

**Person Submitting the Problem Statement**

Casey Soneira, AASHTO on behalf of the Committee on Right of Way, Utilities, and Outdoor Advertising Controls, 202-624-5824, csoneira@ashto.org

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**NCHRP Review of D-07**Reviewed By:

Christopher T. McKenney  
CMcKenney@nas.edu

Comments:

Recommend that problem statement 2022-C-13 and 2022-D-07 be combined into one problem statement that could be "Guidance for Depicting Existing and Proposed Utility Facilities in Design Plans by Incorporating electromagnetic (EM) sensors and GPR. Extend the period to 36 months and increase the budget.

Review Date:

12/22/2020

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**FHWA Evaluation of D-07**

Reviewed By: HRDI/Morgan Kessler, HEPR/Maggie Duncan-Augustt

Comments:

This RNS may have overlap with two current efforts. One such effort is underway through TFHRC, led by Frank Jalinoos, and is looking at new subsurface detection technologies. The second is a major project being performed by the US DOE through their ARPA-e program. This project chose advanced EM technology for subsurface imaging. The one area where there is no overlap is the use of UAS-borne detection equipment. This may be worthy of study by itself.

Review Date:

12/18/2020

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**AASHTO Committee Evaluation for D-07**

Submitted By:

Casey Soneira

AASHTO Staff

Committee on Right of Way, Utilities, and Outdoor Advertising Control

Priority #: N/A

Comments: This was withdrawn by the authors.

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**Submitter Response for 2022-D-07**

**From:** [email: csoneira@ashto.org]

**Comments:**

Response to FHWA Comments. Upon consideration, we agree that the scope of this RNS may overlap with current active efforts. We wish to pull this proposal from consideration until the US DOE ARPA-e program research is complete minimally. At that point, we will redraft this RNS with refinements or minimize the scope to address the use of UAS equipment.

**Comments:**

Response to NCHRP Comments. We wish to pull this proposal from consideration until the US DOE ARPA-e program research is complete minimally. We believe that depiction on plans is an underserved point of study and wish to move forward with 2022-C-13 independently.

**Contact Info:**

Patrick Allen, Georgia DOT

AASHTO Utility Project Scoping & Coordination Technical Subcommittee Chair

AASHTO Committee of Right of Way, Utilities and Outdoor Advertising

Utilities Subcommittee  
Email: [paallen@dot.ga.gov](mailto:paallen@dot.ga.gov)  
Phone: (404) 631-1380

Review Date:  
1/11/2021

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-08**

**Problem Title**

Beneficial Reuse of Lightly Contaminated Material from Transportation Construction, Maintenance, and Operation Activities

**Background**

Transportation agencies generate and then pay to dispose of large quantities of lightly contaminated materials such as street sweepings, gravel shoulder cuttings, ditch spoils, stormwater debris, and other roadside materials. These lightly contaminated materials are generated as part of routine maintenance or encountered during construction projects. Reuse, rather than landfilling these materials, is an environmental and economic benefit. Unfortunately due to regulations, specifications, stockpiling restrictions, inconsistent testing requirements, and long-term liabilities, there is a lack of reuse of these materials even though there is a high cost savings potential. Due to unfavorable regulations, uncertainty in environmental impact, and unknown engineering properties, there are many detractors to the reuse of these materials. Transportation agencies are generating increasing volumes of such materials, since new testing protocols detect contaminants in materials that had been previously thought of as clean. For example, due to improved contaminant detection technology many agencies are required to increase the frequency of street sweeping to meet Municipal Separate Storm System (MS4) standards, which in turn generates more lightly contaminated material. Once these materials have been deemed contaminated, the materials must be properly disposed of in regulated landfills; therefore, more money is being spent on disposal. DOT's from across the country are interested in solutions to this costly and mounting lightly contaminated material problem.

**Literature Search Summary**

The TRB TRID and RIP databases, as well as others, were used to search for research and literature related to specifications and reuse options for lightly contaminated transportation material. This literature search resulted in some research dealing with these materials, such as Washington State University's Evaluation of On-site and In-situ Treatment Alternatives for Contaminated Soils for the Illinois Center for Transportation and Washington DOT. However, the focus of most research has been on testing and characterization of materials, not on potential reuse. Extensive research has been conducted on chemical composition, gradation of sediment, and health hazards associated with such material. Most management practices suggested involve treatment and disposal options. There are, however, some instances in which lightly contaminated materials have been reused successfully. A handful of DOTs (Oregon's DOT, for example) have performed analyses of beneficial reuse and potential implementation

within their own states. Other states have developed guidance documents, such as the Virginia DEQ Guidance Memo No. LPR-SW-04-2012 for the Management and Reuse of Contaminated Media. However, these analyses and guidance documents lack regional and nationwide applications and recommendations. There is no comprehensive document that provides technical guidance and justification for beneficial reuse of contaminated materials that spans varying regions across the nation, but state-specific documents may prove useful in developing this work. The proposed research project statement aims to fill this gap by providing specific technical guidance to DOTs for potential reuse opportunities of lightly contaminated materials including cost benefit information and case studies of successful reuse based on the materials' physical properties.

## **Research Objective**

The objective of this research is to provide proposed technical guidance and justification to DOTs on selecting and implementing potential reuse opportunities for lightly contaminated materials generated through transportation practices. The research objectives will be met through the following tasks and related activities:

*Task I: Comprehensive literature review of existing specifications and regulations related to the beneficial reuse of lightly contaminated transportation materials*

- Identification of states with favorable specifications, regulations, and testing through means such as a survey, online search, or other measures that encompass several DOTs from each of the four AASHTO regional associations
- Comparison of how different states define lightly contaminated materials, i.e. materials generated from routine maintenance practices, materials discovered during construction processes, etc.
- In-depth discussions with states with successful reuse protocols through interviews, workshops, or other means
- Analysis of what makes favorable specifications, regulations, and testing protocols function
- Synthesis of potential end uses as well as cost benefit information, life cycle cost, and mechanical and environmental risk for these end uses, based on both contaminant levels and physical properties

*Task II: Case studies highlighting successful implementation of beneficial reuse of lightly contaminated transportation materials*

- Compilation of detailed case studies of states with successful reuse implementation identified during Task I
- Inclusion of several DOTs from each of the four AASHTO regional associations
- Detailing of factors that made reuse implementation successful as well as how similar reuse could be implemented in other states

*Task III: Decision-making tree regarding beneficial reuse of lightly contaminated transportation materials*

- Identification and development of a decision-making protocol regarding available material and potential end uses
- Development of guidance regarding regulations, specifications, and testing based on desired reuse application

*Task IV: Dissemination of results in a manner that will facilitate reuse of lightly contaminated transportation materials*

- Synthesis of findings to produce a guidance and justification document
- Incorporation of technological tools to encourage access to findings, e.g. a web-based document, GIS-based portal, or other innovative ideas
- Production of final report synthesizing results of Tasks I through IV.

## **Urgency and Potential Benefits**

With DOTs generating increasing amounts of lightly contaminated materials and spending more money on their disposal, it is becoming an urgent need to implement reuse. Industrial by-product reuse in many states has shown that proper reuse of lightly contaminated materials is a benefit because: 1) using lightly contaminated materials reduces the need for virgin materials, and 2) using lightly contaminated materials reduces the need to use valuable landfill space. Due to the many different regulations across the country, DOT's have no agreed upon standards, testing methods, or guidelines in place for the reuse of lightly contaminated transportation materials. Potential benefits enabled through the proposed technical guidance measures include:

- Cost reduction associated with the use of less virgin raw material, less landfill tipping fees, and less hauling costs
- Greater predictability for construction and maintenance costs
- Reduction in carbon footprint
- Potential for public-private partnerships, as private industries may want to utilize lightly contaminated material in select commercial products

## **Implementation Considerations**

The primary drivers of implementation for the proposed work will be DOT staff involved in environmental management, sustainability, and waste management. Another important target includes regulatory agencies that are responsible for approving reuse of lightly contaminated materials. Deliverables shall be created with both of these end users in mind, as DOTs will likely need to present technical justification to regulatory agencies to gain approval for material reuse.

## **Recommended Research Funding and Research Period**

\$200,000 over a 36 month period

## **Problem Statement Authors**

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## **Other Supporting the Problem Statement**

AASHTO Committee on Environment & Sustainability;  
AASHTO Subcommittees on Construction, Maintenance, & Materials;  
TRB Committee on Resource Conservation & Recovery

## **Potential Panel Members**

- David Wilson, Virginia DOT; David.Wilson@vdot.virginia.gov
- Shawn Rapp, Oregon DOT; Shawn.r.rapp@odot.state.or.us
- Andrew Graettinger, University of Alabama; andrewg@eng.ua.edu

## **Person Submitting Problem Statement**

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## **NCHRP Review of D-08**

Reviewed By:  
Edward T. Harrigan

### Comments:

The problem is potentially solvable through the proposed research. The objective is clear. The scope is reasonable. The research can be accomplished in the proposed 36 months or sooner. Staff recommends an increase in the budget to \$300,000 based on experience with similar projects.

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## **FHWA Evaluation of D-08**

Reviewed By: HEPN/Connie Hill Galloway

### Comments:

The proposal provides a clear need for and potential value of this research. The proposed study identifies and addresses an area of concern faced by transportation agencies across the country. The results could provide solutions that would have environmental and economic benefits. The effort may also lead to guidance that will aid States during project construction, operations, and decision-making.



Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for D-08**

Submitted By:  
Jenn Billo  
AASHTO Staff  
Committee on Environment and Sustainability

Priority #: 5

Comments: The submitters agree with the comments and the suggestion to increase the budget to \$300,000.

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-09**

**Problem Title**

“Leveraging experiences in state DOT migration from manual to automated pavement condition assessment methods to realize the positive impacts of rapidly evolving pavement data collection technology on pavement decision-making.”

**Background**

In recent years many state Departments of Transportation (DOTs) have transitioned from manual pavement distress survey methods to semi-automated and automated pavement data collection, in large part driven by a need to meet FHWA performance-management requirements. While these agencies gain more data, knowledge, and experience with automated/semi-automated pavement data collection methods, this migration also brings new challenges, including changes in data quality control, data analysis requirements, decision making, and MAP-21 target setting processes.

At the same time as they have adopted new data-collection technology, DOTs have largely inherited legacy data quality management processes used in the manual surveys and have continued use of existing data storage and reporting processes, in order to retain this historical information. However, the automated data requires new certification, verification and audit methods; changes how performance trends are observed and measured; and, impacts existing decision-making processes.

Throughout, pavement-management practitioners are expected to conduct consistent, dependable analyses in the face of changing technologies, budgetary restrictions, and increasing demands for accountability. State DOTs need not only to be able to use historical data but also the ability to embrace the positive impact of new technology so that more effective pavement management decisions can be made.

The challenge is compounded by the continued and accelerating evolution of sensing technology, the ability to store vast quantities of data in real-time, and the possibility of integrating data from many connected sources for use in condition assessment. With each transition a similar tradeoff problem between continuity of historical data and the power of the new additional data recurs.

State DOTs and other transportation agencies have a need for a guide that builds on the experience, challenges, and solutions from the manual-to-automated pavement data collection transition and provides a framework for the adoption of next-generation technology in order to maximize its positive impact on pavement-management decision-making.

This research will help state DOTs navigate a world of rapidly evolving technology in the field of pavement condition assessment, retaining crucial historical performance information as well as embracing new information that can provide new insights into performance and consequently result in improved performance targets and pavement management decisions.

### **Literature Search Summary**

A number of studies exist that discuss the transition from manual to automated data collection methods. Some highlight specific agency experiences, while others focus on developing transitional protocols to align manual to automated methods. An ongoing NCHRP synthesis study is gathering the current status of the impact of switching data collection technology. This research study will expand and focus more deeply on adaptability of technology and provide guidelines to equip state agencies with tools to handle the impact of data collection changes on pavement management decisions while maintaining the quality and integrity of the data outputs.

### **Research Objective**

The objective of this research is to leverage state DOTs' experiences migrating from manual to automated and semi-automated pavement condition assessments to develop a guide that can be used to prepare for, and embrace, the potential positive impact of pavement data collection technologies that continue to evolve rapidly. The final deliverable should be a Guide that: is developed using the knowledge gained from transitions from manual to automated data collection at state DOTs; that assesses the impacts of measurement technology on the various components of pavement management systems (condition indices, deterioration models, investment strategies, and performance target setting); that identifies best practices and gaps; and, that recommends actions and processes to reflect these changes in the various components of pavement management systems.

### **Urgency and Potential Benefits**

With pavement evaluation technology evolving rapidly, this study will be instrumental in: continually improving agency business processes to obtain higher-quality, repeatable, high-value pavement data; allowing agencies to plan for, and navigate, the adoption of data collection technology changes; allowing greater interoperability in data and flexibility in acquiring and managing it; and, providing guidance for adjusting pavement management systems – investment strategies, condition and performance targets - to reflect these changes in measurement technology.

### **Implementation Considerations and Supporters**

This project is expected to result in a Guide that can be used directly by pavement asset managers to assist in their data collection processes – whether contracting or collecting pavement data in house; pavement managers would also use the Guide to make the necessary changes to existing processes and systems to prepare for changes in data collection technology, particularly in pavement management systems. The resulting guide could be adopted by the relevant AASHTO committees in this area to assist in the

dissemination of best practices among all state DOTs. The resulting Guide would lend itself to a peer exchange or workshop format to help DOTs implement these findings.

The results of this project will be communicated to the AASHTO Committee on Materials and Pavements (COMP) as well as the Committee on Performance Based Management (CPBM).

A Guide produced through this project will also be communicated to the Federal Highway Administration (FHWA), Office of Preconstruction, Construction, and Pavements.

### **Recommended Research Funding and Research Period**

Research Funding: \$300,000.

Research Period: 24 months.

### **Problem Statement Author(s)**

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Travis B. Walbeck, P.E., National Center for Asphalt Technology at Auburn  
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twb0030@auburn.edu

### **Others Supporting the Problem Statement**

This Problem Statement is supported by the Connecticut Department of Transportation. Contact: Edgardo D. Block, Research and Performance Management, Bureau of Policy and Planning, (860) 594-2495,  
Edgardo.block@ct.gov

### **Potential Panel Members**

- Jenny Li, Texas Department of Transportation, Jenny.Li@txdot.gov
- John Henault, Connecticut Department of Transportation,  
John.Henault@ct.gov

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Edgardo D. Block, PE
- (860) 594-2495
- Edgardo.Block@ct.gov
- Affiliation (limited to): Connecticut DOT

## **NCHRP Review of D-09**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

### Comments:

A. The problem is solvable through the proposed research. B. The topic of research should be of interest to the majority, if not all, state DOTs. C. The objective is not clearly stated but it appears to identify the effects of measurement technology on the various components of pavement management systems (condition indices, deterioration models, investment strategies, and performance target setting) and produce a guide to help transportation agencies incorporate these effects in daily operations and decision making. D. The scope is not clearly defined but it should build on the work currently underway in NCHRP Synthesis Topic 52-07, Use of Pavement Data Collection Technology for Pavement Data Quality Management and MAP-21 Reporting. E. The estimated duration of 24 months seems adequate. F. The estimated budget of \$300,000 seems adequate. G. Only NCHRP Synthesis Topic 52-07 is noted but further literature review, surveys, and other information gathering should be performed as part of this research.

Review Date: 12/14/2020

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## **FHWA Evaluation of D-09**

Reviewed By: HRDI20/Nadarajah Sivaneswaran

### Comments:

Many highway agencies have transitioned from manual (walking or windshield) to automated and semi-automated pavement data collection over the last several years while few are in the process. In addition, even within the (semi-)automated data collection, the sensor technologies are constantly evolving. All these changes, invariably introduce the need to assess, and account for any lack of, consistency and comparability of newly collected and historical data since pavement management is founded on reliable time history of pavement condition data. While some agencies have documented the transition process, they are limited in scope and detail. While some of the challenges and opportunities of the transitions are unique to each agency, many are applicable across. A research effort that builds upon lessons learned (including from ongoing NCHRP synthesis effort) and provides guidance on transition to not just current state of practice but also forward looking and applicable to emerging technologies will ease many agencies transition process. This effort should follow NCHRP 20-05/52-07 synthesis effort findings and research recommendations.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for D-09**

Submitted By:

King Gee

AASHTO Staff

Knowledge Management

Priority #: N/A

Comments: Well intentioned. Not unique to pavement management. The literature is fairly narrow and should include industry practices that exist to help with data governance, digital transformation and data democratization.

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-10**

**Problem Title**

**Roughness Index and Thresholds for Urban and Low-Speed Pavement  
Management**

**Background**

State highway agencies monitor pavement roughness to assess road network condition and construction quality assurance. States are also required to report the International Roughness Index (IRI) on the National Highway System (NHS) under the National Highway Performance Program. The IRI often overstates roughness experienced by vehicles and occupants of vehicles traveling on low-speed and urban roadways. This is because the IRI simulates vehicle response for a travel speed of 50 mph. Vehicles travel much slower on urban and low-speed networks, often between 0 and 35 mph. At lower speeds, the same roughness is experienced over a longer period of time and feels less intense. This is important because more than two thirds of the vehicle miles travelled on the U.S. road system occur on urban and low-speed roadways.

Additional research is required to establish an improved metric and threshold values for roughness on urban and low-speed roadways. This is necessary for effective use in the applications of road roughness measurement, such as construction acceptance and triggers for intervention based on functional performance.

The research would improve the relevance of data already being collected and submitted to the Federal Highway Administration (FHWA) via the Highway Performance Monitoring System (HPMS) and improve transportation asset management and performance management of our nation's highways.

**Literature Search Summary**

The existing literature includes some research that addresses changes in the relationship between ride quality and road roughness as a function of travel speed. However, most of the research ignores other vehicle dynamic responses and unique features that exist on urban and low-speed roadways. National Cooperative Highway Research Program (NCHRP) Report 914 addressed issues with using IRI and recommended alternative options such as adjustments to the IRI algorithm to better align its output to vehicle responses expected at low travel speed. Such proposed changes create a new scale, and only limited information exists to link roughness levels to critical levels of functional quality. NCHRP 914 also showed that localized roughness heavily influences ride quality on many urban roadway sections, and concluded that localized roughness criteria are needed for effective management of urban pavements.

This work would further develop the products of NCHRP 914 for implementation using an urban and low-speed roughness index in pavement management.

Karamihas, S. M., Gilbert, M. E., Barnes, M.A., and Perera, R. W. Measuring, Characterizing, and Reporting Pavement Roughness of Low-Speed and Urban Roads. National Cooperative Highway Research Program, Report 914, Journal of the Transportation Research Board, 2019

### **Research Objective**

The objective of this research is to identify an urban and low-speed roughness index and threshold values for management of urban and low-speed pavements. This includes construction acceptance criteria, intervention thresholds, and fairly categorizing the quality of pavement segments (e.g., good, fair, poor).

### **Urgency and Potential Benefits**

The research would improve the relevance of data already being collected and submitted to the Federal Highway Administration (FHWA) via the Highway Performance Monitoring System (HPMS) and improve transportation asset management and performance management of our nation's highways.

Without this improvement to existing practice, the functional quality of high-speed and low-speed pavements cannot be judged on an equitable scale. The mischaracterization of roughness on urban or low-speed highway segments can skew the timing of maintenance and rehabilitation treatments, thus reducing life-cycle optimization. It is anticipated that the refined index and thresholds will facilitate better management of the functional quality of urban and low-speed road networks, and better characterization of road network status.

### **Implementation Considerations and Supporters**

This research is of interest to pavement management, construction, and maintenance staff. Asset management philosophy has moved to the forefront and state agencies need quality methods to track performance of pavements for development of maintenance and rehabilitation programs. In addition to long-term performance monitoring, ride quality indices are used for construction acceptance. The previous NCHRP study developed the scale for the index; however, threshold values must be established for use in project acceptance. Finally, the threshold values would also be used by maintenance staff to determine when preservation activities, such as grinding, should be performed to minimize roughness that can accelerate deterioration of pavements.

To facilitate immediate implementation of the results, sample source code for the revised roughness index is required. The research will also produce a draft (or revised) AASHTO specification for using the index and thresholds in construction quality assurance and in pavement management.

### **Recommended Research Funding and Research Period**



24 months, \$400K

**Problem Statement Author(s)**

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**Others Supporting the Problems Statement**

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- Louisiana Department of Transportation and Development, Doc Zhang, (225) 767-9162, Doc.Zhang@la.gov
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- Texas Department of Transportation; Feng Hong, PE, PhD; (512) 832-7307, Feng.Hong@txdot.gov

**Potential Panel Members**

- Illinois Department of Transportation, John Senger, (217) 782-8582, John.Senger@illinois.gov
- Mississippi Department of Transportation, Alex Middleton, (601) 359-7648, amiddleton@mdot.ms.gov
- New York Department of Transportation, Thomas Kane, (518) 457-4287, Thomas.kane@dot.ny.gov
- Texas Department of Transportation; Feng Hong, PE, PhD; (512) 832-7307, Feng.Hong@txdot.gov

**Person Submitting the Problem Statement**

LaDonna Rowden  
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## **NCHRP Review of D-10**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

### Comments:

A. The problem is solvable through the proposed research. B. The topic of research should be of interest to the majority, if not all, state DOTs. C. The objective, as stated in the problem statement, provides a clear intent of the research. D. The scope is clearly defined, it will build on the work presented in NCHRP Research Report 914, Measuring, Characterizing, and Reporting Pavement Roughness of Low-Speed and Urban Road., and should yield the intended product. E. The estimated duration of 24 months seems adequate. F. The estimated budget of \$400,000 seems adequate. G. Only NCHRP Research Report 914 is noted but further literature review, surveys, and other information gathering should be performed as part of this research.

Review Date: 12/14/2020

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## **FHWA Evaluation of D-10**

Reviewed By: HRDI/Larry Wiser/Amir Golalipour

### Comments:

Overall it is a very timely problem statement. The research would improve the relevance of data already being collected and submitted to the FHWA via the Highway Performance Monitoring System (HPMS). This is important because more than two thirds of the vehicle miles travelled on the U.S. road system occur on urban and low-speed roadways. This work would further develop the products of NCHRP Research Report 914 for implementation using an urban and low-speed roughness index in pavement management. Asset management philosophy has moved to the forefront and state agencies need quality methods to track performance of pavements for development of maintenance and rehabilitation programs. It would be very helpful to discuss on how and what is required to be done to develop new thresholds. Because other factors may impact the results, such as wet/dry condition, temperature, etc.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for D-10**

Submitted By:  
Casey Soneira

AASHTO Staff  
Committee on Materials and Pavements

Priority #: N/A

Comments: This project will have benefits for designers and materials engineers.

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS**

**SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-11**

**Problem Title**

Design Review and 3D Model Quality Management for Model-based Design and Construction

**Background**

The 3D model-based design approach is close to market saturation for roads and continues to gain market penetration for bridges. 3D model-based design is reframing how we design, review, communicate, and coordinate project details in our organizations, with the public and to contractors. The model-based approach could produce optimal designs, improve information transfer, manage project data better, and improve overall efficiency of the road and bridge project delivery process.

DOTs have also begun a process to change the medium of construction contract documents from paper or 2D PDF plans to include 3D model-based, digital information that is contractually-binding. The drivers of this major change are the ability for contractors and inspectors to consume 3D design data directly to support their activities; and the opportunity to more comprehensively define, evaluate, and communicate the design intent. However, changing the medium of construction contract information also creates a procedural challenge.

More state Departments of Transportation (DOTs) are interested in expanding the benefits of the model-based approach to project delivery. Two distinct, but related barriers are: 1) a lack of a robust approach to 3D model-based design reviews (including review documentation) and 2) a lack of holistic quality control (QC) and quality assurance (QA) processes for 3D model-based contractual information.

The procedures are well established for executing design checks using 2D plans (either paper or PDF-based), but do not translate easily to digital 3D models. Designers need a framework to check designs and estimated quantities using a new, digital medium. The framework should include opportunities to automate checks with software tools and procedures for documenting design comments and their disposition. Project Managers also need a framework for performing data validation, QC and QA on a 3D model that forms part of a letting package.

**Literature Search Summary**

Previous research has identified the wider issues related to the creation and use of 3D models. However, these prior studies have not examined how to perform detailed QC

and QA checks of 3D digital design data. There is a need to find model-based approaches to executing and documenting design checks and QC and QA checks of model-based deliverables.

It is clear from the literature that both inspectors and contractors receive 3D design models to use in construction without rigorous, documented processes to control the quality of the models. Practices for design reviews within the model largely occur by visual peer review and are not typically executed systematically or documented in an accessible, durable, digital format.

### **Research Objective**

The objective of this research is to provide guidance to agencies on how to develop design review QC and review documentation QA procedures for a 3D model environment, as well as to provide guidance for quality control of the digital, 3D model-based construction contract documents.

The outcomes of this research should include:

- A guidebook describing methods for performing QC design checks within a 3D model environment and QA processes for 3D model-based construction contract documents. The methodology should also include standard operating procedures for documenting the design reviews.
- A data dictionary for 3D model-based design checks and 3D model QC and QA checks that software developers can use to create software tools to automate design checks and/or to document design check and 3D model QC and QA procedures.
- A webinar presentation to market the guidebook produced by the research
- A short (up to 4 page) technical brief introducing the guidebook and the business reasons for implementing it.

The major tasks of this research are:

1. Explore available literature to identify 2-4 State Transportation Agencies to conduct a detailed examination of statutes, policies, and practices for QC design checks and construction contract document QA.
2. Create a list of elements that are checked and their respective standards. Identify which of these elements are contractual representations of the design intent or supplemental engineering information. Elements may include existing and proposed features.
3. Develop process maps for QC design checks and construction contract document QA practices. Identify responsible parties for each process and the medium of record (e.g. paper, PDF, CADD, etc.), as well as the retention period.
4. Identify which parts of the processes (including documentation) are requirements or are general practice without express requirements.
5. Evaluate QC design check and contract document QA processes to make recommendations to optimize and digitize the approach to establishing and documenting design and model QC and QA.

6. Create a data dictionary for the required elements of the optimized digital process in #5.
7. Create a guidebook outlining the standard operating procedures for (1) performing QC design checks within a 3D model environment and (2) QA processes for 3D model-based construction contract documents.
8. Prepare a ballot item for the sponsoring AASHTO committee to adopt the guidebook.
9. Create a technical brief and conduct a webinar.

It is envisioned that the Research Team will solicit input from key stakeholders such as AASHTO COBS T-19, JTCEES, and AASHTOWare; and engage software vendors/developers through presentations and surveys.

### **Urgency and Potential Benefits**

While there is progress towards resolving technological challenges to replacing the medium of roadway and bridge design contract documents, a lack of rigorous processes for 3D model-based design reviews and 3D model QC and QA is a serious concern for many agencies and engineering consultants. Owners are unable to scale the practice of contractual 3D models until these two issues are resolved.

### **Implementation Considerations and Supporters**

State Design Engineers and State Bridge Engineers would use the research to provide tools that Design Managers and Project Managers can use in project delivery. The research should provide tools like checklists and process maps that can aid an agency to create their own tools to use with 3D model-based design and construction contract documents. Software developers could use the data dictionary to incorporate software tools to automate parts of the process.

The research could be deployed through conference presentations (e.g. TRB Annual Meeting, IHEEP, AASHTO, ACEC), webinars (e.g. TRB, NHI, ACEC), Transportation Pooled Fund Project TPF-5(372) collaboration forum, AASHTO TC3 course materials, or a future FHWA Every Day Counts activity to deploy the practice of 3D model-based construction contract documents.

Research products could include: a guidebook, a spreadsheet, a data dictionary, stand-alone checklists, short instructional videos, conference presentations, a webinar and a technical brief.

This research is of interest to the following committee and committee members:

- AASHTO COD, Joint Technical Committee on Electronic Engineering Standards (JTCEES)
  - Iowa DOT, Mike Kennerly, PE michael.kennerly@iowadot.us
  - Tennessee DOT, Jennifer Lloyd, PE Jennifer.Lloyd@tn.gov, 615.741.2221
  - Michigan DOT, John Wilkerson, PE WilkersonJ1@michigan.gov, 517-610-6737

- Utah DOT, Cheryl Hersh Simmons, PE cherylhersh@utah.gov, 801-557-7846
- AASHTO COBS, T-19 Software and Technology Committee
  - Iowa DOT, Ahmad Abu-Hawash, PE Ahmad.Abu-Hawash@iowadot.us
  - Illinois DOT, Tim Armbrrecht, PE Tim.Armbrrecht@illinois.gov
  - New York State DOT, Brenda Crudele, PE brenda.crudele@dot.ny.gov
  - Utah DOT, Cheryl Hersh Simmons, PE cherylhersh@utah.gov, 801-557-7846

### **Recommended Research Funding and Research Period**

Recommended funding: \$450,000

Recommended period: 24 months

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

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- AASHTO COBS, T-19 Software and Technology Committee
  - Ahmad Abu-Hawash, T-19 Chair, Iowa DOT, ahmad.abu-hawash@iowadot.us

### **Potential Panel Members**

- Mike Kennerly, Iowa DOT, COD JTCEES, michael.kennerly@iowadot.us
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- Arielle Ehrlich, Minnesota DOT, arielle.ehrlich@state.mn.us
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### **Person Submitting the Problem Statement**

- Ahmad Abu-Hawash, 515-239-1393, Ahmad.Abu-Hawash@iowadot.us, Iowa DOT
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### **NCHRP Review of D-11**

#### Reviewed By:

Christopher T. McKenney  
CMcKenney@nas.edu

#### Comments:

As more state DOTs gravitate towards 3D modeling Quality Management (meaning both QA and QC), it is important any issues are addressed during the predesign and preconstruction phases. Too many times have documents been taken for face value within the design portion of construction plans. This oversight can lead to change orders either after a bid has been awarded or during the construction process. This problem statement is much in common with 2022-D-01 (Evaluation and Selection of 3D Model Viewers for Construction Inspection). Quality Construction Inspection tends to rely on Quality Design. Recommend that 2022-D-11 and 2022-D-01 be combined into one problem statement, because quality construction inspection tends to rely on the quality of the design plans that construction uses. The recommendation is to increase the project period to 36 months from 24 months and with a combined budget of \$600,000.

#### Review Date:

12/21/2020

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### **FHWA Evaluation of D-11**

Reviewed By: HRDI-20/Matt Corrigan

#### Comments:

A guidebook for state agencies on QC design checks within a 3D environment would be valuable. The challenge is the breadth of information and design requirements to cover all aspects of highway construction. Although bridge structure 3D design and models are commonplace, the remainder of highway project details and elements are



not as commonplace and do not have standards or guidance for these elements or projects. It doesn't appear that the budget is large enough to capture this breadth; therefore, funding will need increased or the specific goals and objectives will need to be more narrowly defined.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-D-11**

**From:** [email: ahmad.abu-hawash@iowadot.us]

**Comments:**

Thank you for your comments and suggestions for D-11, Design Review and 3D Model Quality Management for Model-based Design and Construction. We concur with the suggestion to increase the budget, based on the challenge of the breadth of information and design requirements to cover all aspects of highway construction.

It was suggested to increase the project duration to 36 months from 24 months, however due to the dynamic nature of advancements in the industry we believe the 24 month duration is doable and would be preferable for state DOTs. The problem statement as written includes both highways and structures. It is preferable to include both in the scope of the problem statement, since both are rapidly advancing collaboratively within state DOTs . We also believe D-11 stands better as a pre-construction focused effort, rather than combining it with D-01 which is software focused for construction inspection.

Contact Info: Ahmad Abu-Hawash, Office 515-239-1393 Cell 515-357-1876, E-mail ahmad.abu-hawash@iowadot.us

Review Date: December 29, 2020

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Comments:** This Problem Statement was developed by the AASHTO TSP2 Emulsion Task Force Task Group for Rejuvenators, and is considered a pressing need for practitioners of Pavement Preservation

**PROBLEM NUMBER**     2022-D-12

**PROBLEM TITLE**

Developing Performance and Safety Specifications for Rejuvenating Seals

**RESEARCH PROBLEM STATEMENT**

Pavement preservation is an important tool DOTs use to maintain and enhance the conditions of their highways. Pavement preservation treatments do not improve the structural capacity of a pavement; rather they delay pavement deterioration by sealing cracks, preventing pavement oxidation, and, in the case of surface fog seals, rejuvenating the existing pavement surface layers.

Rejuvenating fog seals consist of a rejuvenator which is delivered as an emulsion, however recently non-emulsion based seals have also been introduced to the industry. Traditionally petroleum-based rejuvenators have been used in such applications, however in recent years bio-based rejuvenators have also been increasingly utilized.

Preservation treatments utilizing asphalt emulsions as the binder have generally been considered secondary to hot mix asphalt (HMA) technologies. As such, these treatments have not been upgraded or researched to the same extent as HMA technologies. Over the last 5 years, however, the AASHTO TSP2 Emulsion Task Force (ETF) has made a concerted effort to improve the state of the science in emulsion technology and to create consistent, performance-based standards (specifications, test methods, design practices, etc.) that are sponsored by AASHTO and are not vendor specific. To date, twelve standards have been approved.

The ETF is comprised of members from DOTs, FHWA, academia, and representatives of the Asphalt Emulsion Manufacturer's Association (AEMA), International Slurry Surfacing Association (ISSA), and Asphalt Reclaiming and Recycling Association (ARRA). The ETF has focused on creating and delivering materials standards to the AASHTO COMP.

Rejuvenating fog seals are believed to have the ability to modify the surface binder of aged, cracked pavement surfaces. If they can rejuvenate the surface, they may be able to restore functionality to old pavements and allow them to function for longer without total reconstruction. This is an area that has not received adequate investigation. There are

new materials on the market that warrant a review of those materials and the efficacy of rejuvenating seals.

## **LITERATURE SEARCH SUMMARY**

Since the 1970s, state and local agencies have employed rejuvenators as a low-cost pavement preservation alternative (Rostler and White, 1970; Navy Facilities Engineering Command, 1970; Air Force Civil Engineering Center, 1976). Traditionally, the rejuvenator is applied onto the pavement surface using an asphalt distributor. These treatments, often called fog seals or scrub seals, are meant to prevent raveling and cracking and reduce permeability. The following synthesis of literature demonstrates how the potential effectiveness of such rejuvenating seals has been established through different studies, however, an outstanding need exists for a performance-based specification.

Based on a collection of experiences and case studies, Boyer (2000) determined that for successfully refurbishing an aged pavement, the rejuvenator had to penetrate the pavement to a certain depth and restore the maltene to asphaltene ratio. He prescribed measuring penetration at 25°C and viscosity at 60°C of asphalt binder extracted from untreated and treated cores, and the percent aggregate loss after an abrasion test.

King and King (2007) evaluated experimental sections in terms of permeability, friction, surface texture, spectral wave analysis, chemical and physical properties of cores, as well as roughness, rut depth and noise characteristics of the pavements to assess differences in performance. For different types of products, the authors provided recommendations on the condition of the existing surface and traffic, timing between treatments and application rates. (King, 2007; King and King, 2008).

As part of a Caltrans funded study (CP2-2008-102) a number of different types of rejuvenating fog seal test sections were constructed and the performance was monitored over the course of multiple years. The reports found the fog seals and rejuvenating fog seal to be effective at softening the aged asphalt, noting rejuvenator oil content had an impact on the level of effectiveness. The friction or skid number were affected by the fog/rejuvenating seal but were found to return to that of the original pavement over time. The fog/rejuvenating seal did reduce the permeability of the pavement. It was noted that due to the difference in performance that multiple specifications may need to be listed, but further work is necessary to define appropriate specification (Stroup-Gardiner, et al., 2008).

In 2010, Brownridge studied a specific product available in the market since the 1960s meant to extend the pavement service life at low cost (Brownridge, 2010). He detailed the difference between the rejuvenator and emulsions in fog seal applications in field projects. Based on these observations, he concluded that the non-asphalt base rejuvenator manufactured as an emulsion that he studied was able to restore the light fractions (i.e., maltenes) of the existing asphalt binder in the top  $\frac{1}{4}$  -  $\frac{3}{8}$  inch of the pavement surface when used as a fog seal (Brownridge, 2016). Kebede (2016) studied the performance of

three types of rejuvenators used in fog seal applications: polymer-modified, coal tar, and soybean. These products were applied on various roads in the state of Indiana. The author concluded that the soybean rejuvenator resulted in the least pavement surface friction reduction after application, and the polymer-modified and soybean products yielded the best asphalt binder properties after application. Another study completed in 2016 focused on evaluating the performance of asphalt binders and mixtures treated with various rejuvenators labeled bio-sealants (Ghosh et al. 2016). The laboratory prepared asphalt mixtures exhibited similar results based on bending creep and strength results at low temperature. However, the field cores did not show differences.

As part of the current research cycle at the National Center for Asphalt Technology (NCAT) Test Track, two state departments of transportation (DOTs) sponsored rejuvenating seal experiments (i.e., Mississippi and Tennessee). Based on the surface friction and asphalt binder rheological results, NCAT provided a ranked list of products to the DOTs. The DOTs selected two rejuvenators each that will be evaluated during the current two-year research cycle (Moraes, 2019).

## **RESEARCH OBJECTIVE**

The objective of this project is to study rejuvenating fog seals to determine the extent that they penetrate and rejuvenate the asphalt pavement. Key questions to answer are:

- How are the different rejuvenating compounds penetrating and rejuvenating the underlying pavement?
- How is the desired performance for rejuvenating seal measured and quantified in the laboratory and field?
- How can the impact of a rejuvenating seal design be measured and quantified in the laboratory and field?
- How can one determine the optimum dose of rejuvenator required to provide the desired performance and friction properties?

To this end it is anticipated that the research will at minimum include the following steps:

- Review of previous work in the area (both national and international), and current types of rejuvenating technology used for rejuvenating fog seals, and where available, the history of application and performance.
- Collect a representative selection of samples of current technologies. It is anticipated that this will include both petroleum-based and bio-based rejuvenators.
- Determine best method, including innovative analytical means, for determining the efficacy of rejuvenating additives in rejuvenating seals in terms of penetration into the underlying pavement. It is anticipated that analysis of the surface tension of the rejuvenating compositions, permeability of pavements, and the interrelationship of these parameters will play a role in this analysis.
- Determine best practical means of determining the correct dosage for different types of rejuvenators in the rejuvenating seals application.

Deliverables will include a final report, and a recommended specification for performance-based evaluation of rejuvenating seals prepared in conformance with AASHTO standard practice format.

## **URGENCY AND POTENTIAL BENEFITS**

The FHWA/FP2 study of fog and rejuvenator seals conducted during the early 2000s noted that more than twenty agencies had placed moratoriums on rejuvenator seals, primarily due to safety concerns related to loss of friction. That study also noted that sources of rejuvenators had expanded to include vegetable and pine-based oils, yet rejuvenator emulsion purchase specifications still require Rostler test parameters indicative of only petroleum-based aromatic oils produced as a by-product from lube oil processing. Caltrans followed up on the FHWA research with its own study funded through the California Regional Pavement Preservation Center in hopes it could rescind its moratorium by creating new performance specifications for rejuvenator seals. Although many AASHTO agencies still see significant value in using inexpensive rejuvenator seals as part of their pavement preservation toolbox, AASHTO has neither updated emulsion purchase specifications nor application performance specifications to accommodate current materials or best practices. The Emulsion Task Force recently prioritized its efforts to reestablish rejuvenator seals as standard preservation practice, and views this research project as critical to both DOT Materials (emulsion purchase specifications) and Maintenance (application performance specifications) Divisions wishing to safely extend pavement life at minimal cost.

## **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

Rejuvenator seals would generally fall under the purview of the DOT's Preservation/Maintenance Division. Performance specifications for rejuvenator seals might include pavement selection criteria (condition, permeability), safety targets (friction, sanding recommendations), emulsion dilution/application criteria, and recommended field test strips to verify performance. DOT Materials Division would manage emulsion purchase specifications considering oil quality with respect to crack mitigation, emulsion surface tension for faster penetration, and other standard asphalt emulsion requirements.

Most agencies already have protocols and specifications for rejuvenator seals, but need updating for safety considerations and most lack performance-based metrics particularly to broaden the materials slate to include new technologies such as bio-materials. It is anticipated that workshops and training will be necessary to distribute information and support implementation. The FHWA/FPP project developed many of the needed checklists, powerpoints, and other training aids that could be easily updated.

AASHTO Committee(s) and/or Council(s) that might be interested in the research results and could help support implementation:

- AASHTO TSP-2 Emulsion Task Force: Colin Franco
- National Center for Pavement Preservations: Larry Galehouse

## **ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

### **Recommended Funding:**

\$450,000

### **Research Period:**

24 months

## PERSON(S) DEVELOPING THE PROBLEM

- AASHTO TSP2 Emulsion Task Force - Task Group for Rejuvenators.  
Members: Hassan Tabatabaee (Chair), Edith Arambula, Gayle King, Russel Milan, Andy Clayton, Amy Epps Martin, Andrew Hanz, Andy Durante
- Colin A Franco, RIDOT Associate Chief Engineer (Materials and Quality Assurance); Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO Committee on Pavements and Materials
- Darren Hazlett, Research Fellow, University of Texas – Center for Transportation Research; Member – AASHTO TSP2 Emulsion Task Force

## DATE AND SUBMITTED BY

Colin Franco, RIDOT

## REFERENCES

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Rostler, F.S., and White, R.M., *Rejuvenation of Asphalt Pavements*, Materials Research and Development, Inc., Oakland, California, under Air Force Systems Command Contract F29601-69-C-0129 - May 1970.

Stroup-Gardiner, M., Cheng, D., Hicks, G.; Fog and Rejuvenator Seal Test Sections State Highway 58, Kern County; Technical Report: CP2-2008-102; 2008 (revised 2011).

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## **NCHRP Review of D-12**

### Reviewed By:

Edward T. Harrigan  
eharriga@nas.edu

### Comments:

The problem is potentially solvable through the proposed research. The objective is clear. The scope of the research is reasonable. The budget is adequate.

### Review Date:

12/2/2020

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## **FHWA Evaluation of D-12**

Reviewed By: HRDI20/Morgan Kessler

### Comments:

I concur that there are many unknowns regarding "rejuvenating seals", and many agencies question whether they really do anything beyond what a traditional fog seal does. Much available information is either anecdotal, or provided by the emulsion industry. There should be new research performed to quantify what is meant by "rejuvenation", the effective depth of any "rejuvenation" action into the pavement, and friction effects resulting from the application of this type of product.

### Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for D-12**

Submitted By:

Casey Soneira

AASHTO Staff

Committee on Materials and Pavements

Priority #: N/A

Comments: The work of the AASHTO TSP2 Emulsion Task Force has provided COMP with good work in the past. The results of this project would benefit COMP.

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**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-13**

**Problem Title**

A Methodology for Converting Condition State of Bridges to Condition Ratings

**Background**

General condition ratings (GCR) are used frequently for the bridge management system. State DOTs are required to meet the established performance measures and report them to FHWA. Currently, FHWA uses GCRs as a performance metric for performance measures for funding projects. Additionally, in the bridge management system, we use the condition state of elements to project the condition of elements in the future using advanced deterioration models. Therefore, it is important to accurately convert condition states to GCRs to ensure that a given maintenance or repair program would meet performance targets over the program time frame.

**Literature Search Summary**

FHWA developed a methodology that uses a matrix that shows allowable boundaries of condition states associated with each condition rating. However, the applied methodology overlooks the effects of all contributing factors and therefore does not provide a good conversion profile to convert condition states to condition ratings.

Moreover, the current condition ratings which are assigned by bridge inspectors are very subjective. A right assigned GCR must show the general condition of a bridge rather than the local and non-structural damages. However, in practice and in most cases the assigned GCR is not based on the NBI coding guide requirements. A previous study by FHWA revealed that there is a  $\pm 1$  standard deviation between the real condition rating and the assigned GCR to a bridge. Therefore, it is important to have GCRs that are objective and calculated based on the condition states of elements.

**Research Objective**

The objective of this research is to develop a new methodology for converting the condition state of bridges to general condition rating. The proposed methodology must be well documented and convincing for bridge managers and practitioners.

The contractor may need to conduct interview with state DOTs in the US to find about the current practice in different states. The proposed methodology should be tested in several state DOTs to ensure it is logically sound and provides accurate results.

The outcome shall be published in form of a technical manual that could be utilized by bridge managers and inspectors for bridge rating.

**Urgency and Potential Benefits**

State DOTs are spending a lot of resources to collect the condition state of bridges. However, in practice, these data are not optimally utilized for planning as they must. Despite the aforementioned items, condition ratings are assigned to bridges without using their condition states. Therefore, there is an urgent need to establish a relationship between these two ratings to enhance the accuracy of assigned condition ratings.

**Implementation Considerations and Supporters**

Research results are mostly of interest to bridge management and maintenance program managers or bridge inspection program managers in structure and bridge division of state agencies.

The following organizations might be interested in the research results and could help support implementation.

TRB Committee on Bridge Management (AHD35)  
Chair: Basak Aldemir Bektas, Ph.D.  
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Phone: 507-389-1467  
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Massoud Nasrollahi, Ph.D., P.E.  
Vice president of bridge management user group for AASHTO Bridge Management  
Virginia Department of transportation  
Address: 1401 E. Broad Street, Richmond, VA 23219  
Phone: 804-786-2633

**Recommended Research Funding and Research Period**

Recommended budget is \$250,000 for 12 months period.

**Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

Bridge management user group for AASHTO Bridge Management

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Bridge Maintenance and Management Program Area  
Central Office, Structure & Bridge Division  
804.786.7537 (O), 804.921.7187 (C)  
Todd.Springer@VDOT.Virginia.gov

### **Potential Panel Members**

All members of TRB Committee on Bridge Management (AHD35) could be a potential candidate as panel member.

TRB Committee on Bridge Management (AHD35)  
Chair: Basak Aldemir Bektas, Ph.D.  
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Phone: 507-389-1467  
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### **Person Submitting the Problem Statement**

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### **NCHRP Review of D-13**

Reviewed By:  
Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The title and objective of the problem statement are not clear. The problem statement did not clearly address the research needs and the current issues with the existing method. In addition, the problem statement has not been reviewed by the AASHTO COBS. Because any NCHRP research related to bridge condition ratings and inspection impacts all state DOTs, AASHTO COBS review is very critical to ensure the research is needed and the research product is implementable. Therefore, it is strongly recommended that the problem statement be reviewed by the AASHTO COBS, T18, before funding it under the NCHRP.

Review Date:  
12/15/2020

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### **FHWA Evaluation of D-13**

Reviewed By: HIBS30/Derek Constable, HRDI30/Jean Nehme

Comments:

There are a number of existing NCHRP projects not yet completed that will likely impact this effort and will require coordination. Projects include NCHRP synthesis: 52-06 "Agency Inspection & Monitoring of QC Plans." that are related to design QC and design reviews, 52-14 3D models as contract documents, 51-01 Practices for Construction-Ready Digital Terrain Models; and NCHRP project 10-110 3D Modeling Guide for Construction Inspection. There may be some potential duplication of the synthesis 52-14 effort that will need resolved. How will existing efforts on models and associated data dictionaries be utilized and incorporated in this effort?

Review Date:  
12/18/2020

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### **Submitter Response for 2022-D-13**

**Response to FHWA Comments:** Thank you for your time and for providing valuable comments. We believe these current research significantly deal with the construction contracts rather than inspections reports or contracts. Many of inspections are conducted by state DOTs and they need to come up with a methodology to accurately convert condition states to condition ratings. VDOT has discussed this with Mr.Derek Contable as part of the AASHTOWare Bridge Management (BRM) application. We have requested a new methodology that could be utilized by state DOTs to enhance the accuracy of converted condition states to condition ratings.

**Response to NCHRP Comments:** Thank you for your time and for providing valuable comments. I am sorry that the problem statement is not clear. This is a familiar problem for many bridge management or inspection programs that are using AASHTO BrM in state DOTs and I should have provided more details. Please let us know what parts are not clear and I would be happy to provide more details.

Currently, more than 40 states are using AASHTOWare Bridge Management (BrM) program for their bridge management system. BrM program uses the California Health Index, and users can assign different weights or factors for calculation of the health index.

Therefore, many state DOTs are somehow using the same methodology. This has been discussed by State DOTs in the annual AASHTO BrM users meeting and monthly technical advisory group. Also, Dr.Basak Bektas agreed to bring this topic up at AKT50 for the bridge management and maintenance committee during TRB meeting 2021.

**Contact Info:**

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**Review Date:** 1/11/2021

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-D-14**

**Problem Title**

A New Methodology for Calculation of Bridge Health Index For Bridge Management System

**Background**

State DOTs are currently using condition ratings of bridge components or elements to monitor the status of bridges in terms of safety and serviceability. These condition ratings tend to address different aspects of a bridge management system. For instance, condition ratings are assigned to show the general condition of a bridge. These ratings are not representative when there is severe local damage on a bridge element. Therefore, bridge managers should combine general condition ratings with condition states of elements for a more informed maintenance and repair plan. Additionally, bridge managers need to take into account the economic value of the bridge elements and components for life cycle analysis. Based on MAP-21 State DOTs are required to consider the life cycle plan (LCP) in their transportation asset management plan (TAMP).

This could be successfully accomplished if appropriate health indices were used as an action trigger and performance target in BMS. Also, the health index can be used as a metric for performance measures in the annual TAMP report. Moreover, there are typically several elements in a bridge and it would be important to weigh and combine the health index of different elements of the bridge to come up with a health index that is tangible for engineers and more importantly is truly representative of the bridge condition.

**Literature Search Summary**

In 2010 FHWA conducted synthesis research entitled: "Synthesis of National and International Methodologies Used for Bridge Health indices". This report provides a list of available health indices along with strength and weakness of each existing methodology for calculating an appropriate health index. In most cases, many of these methods are old and do not meet the needs of today bridge management system. Additionally, these methodology may not be useful for the US bridge inventory considering the available data based on the current inspection regime.

**Research Objective**

The outcome of this research should be a new methodology for the calculation of the health index for bridge elements and components. The proposed health index should be tangible and suitable to be utilized by state DOTs. It also needs to use existing information that is collected based on the AASHTO Element or NBI coding guides and does not need any further efforts in terms of collecting data by inspectors in the field. The proposed methodology should be subjective as much as possible and must provide details for weighing and detailed procedures that are needed for bridge health index

calculation. The final outcome must be well documented and convincing for bridge managers and practitioners.

The contractor may need to conduct an interview with state DOTs in the US to find about the current practice in different states. Upon conducting interview, they may need to identify the needs of bridge owners for the new health index. And ultimately the results of the research can be published as a manual that could be used by state DOTs for bridge management system.

### **Urgency and Potential Benefits**

The average age of bridges in most state DOTs is rapidly approaching the end of their service life. The available budget is limited and only a fraction of bridges receive the required budget for maintenance. Therefore, it is vital to allocate funds to those bridges that are in most need of maintenance and repair. A new health index could help bridge managers to optimally allocate the budget and eventually with a better plan which public will benefit from it.

### **Implementation Considerations and Supporters**

Research results are mostly of interest to bridge management and maintenance program managers or bridge inspection program managers in structure and bridge division of state agencies.

The following organizations might be interested in the research results and could help support implementation.

TRB Committee on Bridge Management (AHD35)

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Vice president of bridge management user group for AASHTO Bridge Management

Virginia Department of transportation

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Phone: 804-786-2633

### **Recommended Research Funding and Research Period**

Recommended budget is \$250,000 for 12 months period.

### **Problem Statement Author(s)**

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Virginia Department of transportation

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### **Others Supporting the Problem Statement**

Bridge management user group for AASHTO Bridge Management  
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### **Potential Panel Members**

All members of TRB Committee on Bridge Management (AHD35) could be a potential candidate as panel member.

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### **Person Submitting the Problem Statement**

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## **NCHRP Review of D-14**

Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The definition and calculation of health index are state specific and used differently by state DOTs. In addition, the problem statement has not been reviewed by the AASHTO COBS. Because any NCHRP research related to bridge management systems impacts all state DOTs, this review is very critical to ensure the research is needed and the research product is implementable. Therefore, it is strongly recommended that the problem statement be reviewed by the AASHTO COBS, T18, before funding it under the NCHRP.

Review Date:

12/15/2020

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## **FHWA Evaluation of D-14**

Reviewed By: HIBS30/Derek Constable, HRDI30/Jean Nehme

Comments:

The formulation of the problem statement needs improvement.

Review Date:

12/18/2020

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## **Submitter Response for 2022-D-14**

**Response to FHWA Comments:** Thank you for your time and for providing valuable comments. As you know, State DOTs do not have access to an appropriate health index for the bridge management system. We believe that the term Health Index is familiar to many state DOTs since they are now utilizing the AASHTOWare Bridge management program. Therefore, we developed the statement so the NCHRP panel could expand the topic if it deems necessary. Nevertheless, if you feel some part of the statement formulation need to be explained or changed please let us know.

**Response to NCHRP Comments:** Thank you for your time and for providing valuable comments. Currently, more than 40 states are using AASHTOWare Bridge Management (BrM) program for their bridge management system. BrM program uses the California Health Index, and users can assign different weights or factors for calculation of the health index.

Therefore, many state DOTs are somehow using the same methodology. This has been discussed by State DOTs in the annual AASHTO BrM users meeting and monthly technical advisory group. Also, Dr. Basak Bektas agreed to bring this topic up at AKT50 for the bridge management and maintenance committee during TRB meeting 2021.

**Contact Info:**

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**Review Date:** 1/11/2021

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# **Research Field E**

SOILS AND GEOLOGY

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-E-01**

**Problem Title:**

**Standardizing Rigid Inclusions for Transportation Projects**

Design Methodology, Evaluation of Installation Effects, Specifications, and Basis of Payment

**Background**

This problem statement addresses objectives and goals defined in the following: (1) Strategic Plan for the Committee on Design (approved by Strategic Management Comm., 22-Sept-2018), (2) AASHTO Standing Committee on Research (SCOR) Strategic Plan: 2015-2020; Council on Active Transportation Strategic Research Plan (10-July-2018); (3) Triennial Strategic Research Plan (TSP) of the TRB Transportation Earthworks Committee (AKG50); and (4) Primary Focus and Research Areas of the TRB Foundations of Bridges and Other Structures Committee (AKG70). The results of this research effort would be utilized by many of the state departments of transportation (DOTs), as many are incorporating column supported embankments (CSEs), various means for slope stabilization, ground modification/improvement, and alternative means for structural support as part of their asset management programs. The research work would address various emerging, critical, and/or cross-cutting issues, including: accelerated earthwork construction, automation in construction, specifications, slope stability, geotechnical earthwork asset management, geohazards and geostructures, instrumentation and modeling, and subgrade stabilization.

The research should address needs and gaps, project delivery, quality assurance, sustainability, performance, instrumentation, and data management and integration. Although the technology discussed below has been utilized in the private sector for decades, it is only recently that this technique is gaining increased utilization on infrastructure projects. The methodology and equipment-driven installation has been closely guarded and much is proprietary (commercial competitive advantage), which has left the DOTs dependent on and obligated to the contractor. The technological advancements of the equipment and monitoring systems lend themselves to improved quality control/assurance processes and long-term performance. The proposed research effort is timely, should be of interest to many DOTs, could be achieved within the constraints of the proposed budget and schedule, and the effort should produce implementable products by the end of the work effort (or shortly thereafter, depending on the needs of the DOTs, FHWA, and/or NHI). As the research is practical in nature and developed with input from multiple DOTs, it is expected that the research would be received and implemented in DOT practice where this technique is currently being used and will be so in the future.

## Related Research

A rigid inclusion is cast-in-situ concrete/grout column installed vertically in the ground to improve the performance of the constructed asset (e.g., reduce settlement, increase bearing capacity, and improve stability). Rigid inclusions is a general descriptor term and these elements are known by many different trade names (e.g., controlled modulus columns (CMC), grouted impact piers (GIP), geoconcrete columns (GCC), and augered pressure grouted (APG) columns), which are based on proprietary installation methods and tooling (e.g., Omega, Bauer FDP, Berkel APG, and Fundex). Since the 1980s, relatively small diameter rigid inclusions have been used on commercial building and infrastructure projects for ground improvement / modification. The contractor typically provided a proprietary design based on its proprietary installation method and tooling, for which there was limited means or guidance to evaluate the proposed design. In recent years, as technological capabilities have expanded, the diameter and depths to which rigid inclusions are being installed have increased, and rigid inclusions are now being used as the piling elements in structural foundation systems. However, the design and installation methods are still proprietary, closely guarded by the various contractors as they protect their respective commercial competitive advantage.

Empirical methods have been developed and published (e.g., Decourt, 1995; Bustamante and Gianeselli, 1998; and NeSmith, 2002) but these methods vary considerably in terms of robustness and input detail. More importantly, the published methods were developed based on limited data sets that considered a particular installation method/tool, a small sampling of results from load testing, and select soil types and ground conditions. It has been documented that multiple factors (e.g., soil type, matrix structure, original stress state, density/consistency, shape of the tool, equipment, and installation method) influence the geometry and shape, nominal axial resistance, and load transfer of rigid inclusions. However, the published design methods do not explicitly account for the various factors that influence design and performance. For instance, for the recommended design method in FHWA Geotechnical Engineering Circular (GEC) 8 (Brown et al, 2007), the nominal axial resistance is a function of an “interpreted failure load” corresponding to a head settlement of about 1 inch (equal to 6% of the diameter, derived from tests performed on 14- to 16-inch diameter elements), on index values from CPT or SPT, and a constant that depends on soil gradation and angularity. However, much of the details have not been made available as to how the equations and design charts were developed, and case histories published thereafter have not provided comparisons between the predicted and measured axial resistances.

Since the mid 2000s, the maximum diameter and embedment length of rigid inclusions have increased (upwards of 30-inch in diameter and to depths in excess of 90 ft), mainly due to technological advancements and equipment capabilities. Basu et al (2010) presented summary details pertaining to select design methods. Simon (2012) provided a brief summary of the different installation techniques, load transfer mechanisms, design considerations, and considerations warranting further research. In 2013, ASIRI published recommendations for the design, construction, and control of rigid inclusions for ground improvement, but these were focused mainly on building applications. Regardless of the proprietary method or tooling used, a rigid cementitious column with a nominal diameter is formed in the ground, where the engineering characteristics of the in-situ soils are

altered during installation. However, due to the proprietary nature of each of the different commercially available techniques, there is not a well-established standardized approach to the design and evaluation of rigid inclusions, for estimating the installation effects to the in-situ soil, and for performing a consistent review and comparison of bid offerings by the engineer and/or agency. These issues affect state DOTs that utilize and/or plan to utilize rigid inclusions as part of the earthworks and/or foundation systems portions of their transportation projects. The proposed research, as discussed hereinafter, will address these issues. The proposed research should analyze the available technical literature to establish the state of the practice with respect to design and installation, and the findings should be used to guide the field experimentation program wherein multiple rigid inclusions should be installed using different methods, tested, and the results analyzed.

### **Objectives and Benefits**

The objectives of this research focus on three main areas (nos. 2 to 4) to be accomplished in five tasks that affect the cost effective and reliable implementation of rigid inclusions on infrastructure projects.

1. Literature Review and Assessment of Current Practices - A comprehensive review of the available published technical literature should be performed and synthesized. A survey of state DOTs, designers, and contractors should be conducted to solicit direct input of current practices.
2. Evaluating Design Methodologies - Based on literature and survey results, perform review of existing design methodologies to quantify the effects of various components (e.g., element geometry/arrangement (single vs. group), installation method, and soil conditions) to resistance, load transfer, and performance (e.g., settlement, bearing capacity, and stability). Evaluate design methods with respect to available load test results. The intent of this task should be to produce an approach that should be independent of the installation method used.
3. Quantifying Installation Effects - The installation effects identified and bounded by the work performed in Task 2 should be used to guide instrumented and monitored full-scale physical studies to evaluate the effects to resistance, load transfer, and performance (e.g., settlement, bearing capacity, and stability) due to different installation methods, ground conditions, geometry/arrangement (single vs. group), load transfer due to vertical and lateral loads, ground movements (vertical and lateral) at different distances and depths, alteration of soil properties (e.g., density, strength, and modulus), etc. Small-scale physical tests and numerical studies should be performed to supplement the full-scale experimental program.
4. Standardizing Design Approach – Based on the results from the full-scale field testing, small-scale physical experiments, and the numerical analyses performed in Task 3, the approach developed in Task 2 should be validated and refined so that it could be standardized for the design and evaluation of rigid inclusions for infrastructure projects.
5. Outcomes / Deliverables – At the conclusion of this effort, three deliverables should be produced:
  - i. A new, standardized design method or new recommended factors and input values that account for soil conditions, installation technique, and installation effects to be

included into existing design computations for nominal axial, lateral, and flexural resistance of single and grouped rigid inclusions. The intent of this method should not be to constrain a contractor but to provide the DOTs an approach to evaluate a proposed design.

- ii. Guidance and recommendations to provide a consistent means of developing bid documents, for comparing bid offerings, and for evaluating contractor-based designs. The intent should be to provide guidance that facilitates evaluation regardless of proprietary nature of a particular method, so that the FHWA/state DOTs can evaluate apples-to-apples without total reliance on a contractor and its proprietary method(s).
- iii. Guidance (performance-based) specifications that provide the DOTs (along with FHWA and NHI) a means to perform quality assurance (e.g., inspection and testing) and to evaluate the findings therefrom. The guidance specifications should be developed such that they would apply, be common, and be applicable to the various construction methods used to install rigid inclusions.
- iv. A comprehensive report should document the different efforts performed throughout the research with sufficient detail to describe the development of the various recommendations, as appropriate. The report should provide recommendations and guidance for incorporation into (a) AASHTO bridge specifications, (b) state DOT project specifications, (c) future updates of FHWA guidance documents (e.g., GEC-8 (Brown et al, 2007) and GEC-13 (Schaefer et al, 2016)), and (d) applicable NHI training courses.

### **Implementation Consideration and Supporters of the Problem Statement**

Within a DOT, the design group and construction group would likely be the main beneficiaries of this research effort. The DOTs would be able to implement the deliverables into their groups' respective practices in a relatively straightforward manner as the intent of the tasks should be to deliver usable and near-ready implementable products: design method and guidance/recommendations, as described above. The research results could be utilized by the DOTs/FHWA as standalone products as well as by NHI by integrating into their training materials. Those who have expressed interest and support for this effort include: FHWA; state DOTs; members of TRB committees - AKG20, AKG50, AKG60, and AKG70. In addition, representatives from the following state DOTs have indicated this RNS is a critical need: Caltrans, Illinois DOT, Louisiana DOTD, Minnesota DOT, New Mexico DOT, NJ DOT, and Ohio DOT.

### **Sponsoring Committee**

AKG50 – Committee on Transportation Earthworks

AKG70 – Committee on Foundations of Bridges and Other Structures

### **Recommended Research Funding and Research Period**

- **Recommended Funding** - The estimated funding necessary to accomplish the objectives is \$600,000.
- **Research Period** - The estimated duration of this research project is 36 months, which includes three months for the preparation of a draft final report.

## **Research Priority - High**

### **Problem Statement Authors**

- Antonio Marinucci, PhD, MBA, PE; V2C Strategists, LLC; (347) 670.2006; amarinucci@v2cstrategists.com
- Jie Han, PhD, PE, F.ASCE, University of Kansas and Chair, AKG50 Transportation Earthworks; (785) 864.3714; E-mail: jiehan@ku.edu
- Jesse Rauser, P.E., Louisiana Dep't of Transportation and Development; (225) 379.1935; jesse.rauser@la.gov

### **Potential Panel Members - TBD**

### **Person Submitting the Problem Statement**

- Sharid K. Amiri, PhD, PE, CALTRANS and Chair, AKG70 Foundation of Bridges and other Structures; (949) 371.3817; sharid.amiri@dot.ca.gov

### **Cosponsoring Committees**

AKG20 – Committee on Soil and Rock Properties and Site Characterization

AKG60 – Committee on Geotechnical Instrumentation and Modeling

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The objective is clear. The scope is reasonable. The research can be accomplished in the proposed 36 months. Recommend an increase in the budget to \$800,000 based on experience with projects requiring full-scale physical studies.

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## **FHWA Evaluation of E-01**

Reviewed By: HRDI40/Jennifer Nicks

### Comments:

This is a good problem statement. The proposed research would address a need for consistent guidance on the design and construction of rigid inclusions for different highway transportation projects.

Review Date:

12/18/2020



**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022-E-02**

**Problem Title**

Soil Structure Interaction Construction Dynamics of Transportation Earthworks and Structures

**Background**

- Today's computational modeling tools and visualizations allow for more comprehensive understanding of soil mechanics problems than simplified analytical solutions of the past- yet many relatively common geotechnical situations have not been re-explored in either step-wise construction sequences or parametric studies. An improved understanding of the behavior of embankments, slopes, and foundations when modeled through various construction and life-cycle events can be gained if typical foundation elements and geotechnical features are more robustly explored using current powerful computational modeling tools. Exploring the influence of geometry, material properties, reinforcing elements, construction events, and life cycle changes and subsequent impact on geotechnical and geo-structural performance, will provide insight on risk and reliability and reveal areas for research and practice improvement.
- "Real world" geotechnical situations and deformable-body behavior where changes in geometry, material properties, structural components, extent of excavations and fills, and effects of the actual construction loading sequence will be examined. Performance, risk, reliability, and safety can therefore be explored in more comprehensive detail and in the current LRFD framework- rather than a single "safety factor" which may not appropriately capture service limit state or other performance considerations. Improved understanding of stress/force and strain/displacement characteristics will help improve design and construction practice by relating performance to LRFD strength and service considerations.
- The problem statement relates to the strategic plan for the Committee on Bridges and Structures Goal 5, Accelerated Bridge Delivery and Construction and Goal 6, Optimize Structural Systems. It is also relevant to the strategic plan for the Committee on Design Goal 3, Continually improve the quality and cost effectiveness of projects.

**Literature Search Summary**

A literature search found limited parametric studies of the geotechnical and geo-structural behavior of transportation structures during the process of construction through service

life. The proposed research will supplement and expand existing work, which is currently available for very specific cases and currently lacks broad applicability.

### **Research Objective**

- a. Apply computational modeling tools to several basic transportation construction features, examining how the soils and structures interact and react to construction and life-cycle events with time, with an emphasis on stress and deformation characteristics relating to LRFD strength and service considerations. Study the impact of construction sequence and methods on geotechnical behavior, comparing results with traditional analytical methods, where they exist. Provide graphical output and descriptions of relevant information such as forces, stress/strain profiles, deflection, and measures of risk/reliability.
- b. Major tasks will be creation of 2D and 3D computational models to investigate bearing capacity, soil-structure interaction, and slope stability. Cases with real-world parameters will be adjusted to modeling construction or life-cycle sequencing to reveal the impact of changes in geometry, material properties, time, deformation, reinforcing and structural elements, and sensitivity to site changes over time (such as from erosion, scour, earthquake/liquefaction, dewatering, man-made excavations, soil stockpiles and surcharges, and similar external effects). Examples include:
  - i. Assessment of soil stresses/deflections on a 'typical' dimension of a bridge spread footing as seen from a construction sequence standpoint (e.g. foundation, stem, backfill, beams, deck, rail, service etc.) [6+ construction stages and both soft and stiffer foundation soils]. Continue the model to simulate at least 2 possible modes of failure (e.g. due to soil loss or erosion of the foundation or overstressing).
  - ii. Assessment of soil stresses/deflections on a foundation on piles or shafts of a bridge as seen from a construction sequence standpoint (e.g. foundation, stem, backfill, beams, deck, rail, etc.). Investigate positive and negative side friction distribution and end-bearing under different conditions of soil strength and pile toe stiffness. [several construction stages and several soil types for side resistance and base resistance; potentially also multi-layered systems or external effects, such as liquefaction]. Continue the model to simulate at least 2 possible modes of failure (e.g. due to soil loss or erosion of the foundation or overstressing).
  - iii. Assessment of soil stresses/deflections on a shallow foundation placed over a column supported embankment using auger-cast or controlled modulus columns or similar foundation elements for a bridge as seen from a construction sequence standpoint (e.g. foundation, stem, backfill, beams, deck, rail, etc.) [dragload]
  - iv. Assessment of stress and displacement profiles below cantilever walls, MSE walls, GRS-IBS walls, and soil reinforced structures.
  - v. Assessment of impacts of drainage clogging [failure; hydrostatic pressure increase] on cantilever walls. Simulate at least 2 possible

- modes of failure (e.g. due to soil loss or erosion of the foundation or overstressing).
- vi. Examination of deflection below a new 30ft. embankment over soft ground as it is constructed in stages. Cases: reinforced 1H:1V side slopes; unreinforced 2H:1V side slopes, with internal reinforcing; unreinforced 2H:1V side slopes without internal reinforcing; and unreinforced 3H:1V side slopes without internal reinforcing. Continue the model to simulate at least 2 possible modes of failure (e.g. due to soil loss or erosion of the foundation or overstressing).
  - c. Results should be presented as case-study scenarios/vignettes, providing staged modeling for use in a type of “digital twin” comparison to real world case histories and project observations from State DOT and other experience. Static step-wise models, scenario supporting information and animations should be created to be made available to educators and professional groups to aid in teaching and continuing education. A report should be prepared which can be used for support of DOT guidance and policy and as reference to specifications and manuals of practice, especially where policy may be revised and/or improved based on outcomes of the work.

### **Urgency and Potential Benefits**

- Most state DOTs have not fully implemented local LRFD resistance factors or made improvements to geotechnical guidance or procedures based on the newest methods of analysis and modeling. Providing practical analysis of how construction means, methods, materials properties, and construction sequencing impacts geotechnical works will provide a much-needed basis for improved understanding, greater confidence, and accompanying risk reduction and related reductions in conservatism and cost.
- Changes in geometry, construction staging, and construction practice- will be examined to show the significance interrelationships of force, deflection, settlement, creep, pore-water-pressure dissipation and structural interaction. Negative impacts from not conducting the research include missed opportunities to reduce risk and lower project geotechnical and foundation costs through improvements which could be made to the AASHTO code, especially with respect to performance at the service limit state.
- Often there are superpositions of effects such that unexpected measurements are observed. Improved understanding, through examination of transportation soil mechanics elements, will provide a valuable basis for improvements to the AASHTO code, DOT guidance, and policy for design and construction as well as a useful reference for geotechnical education. Geotechnical and geo-structural engineering communities will immediately benefit from this research, in addition to teachers and educational institutions.

### **Implementation Considerations and Supporters**

- Research results will be used by materials, construction, structural, and geotechnical engineers.
- The research could provide immediate support for policy and guidance or serve as a basis for additional studies for improvements in design or construction procedures and resistance factors in support of consistent levels of risk and reliability among various components of soils and foundation works within the LRFD framework (local calibration and practice, etc).
- Implementation can be supported through organizations: AASHTO, ASCE, TRB, FHWA, others.
- Additional products, such as presentations, video animations, and web-based tools, s and activities (training workshops, peer exchanges) can help create awareness and facilitate use of the research results and adoption as a basis for education, further research, or policy.

Research results and implementation support could be provided by:

- AASHTO COMP Technical Sub-Committee 1b [various members]
- ASCE Geo-Institute, TRB, and other organizations [various members]

### **Recommended Research Funding and Research Period**

Research Funding: The estimates of the total funds needed to accomplish (a) the modeling research objective(s) is \$275,000. The cost estimate (b) for initial activities for communication and implementation of key research products (models, visualizations, report) is \$25,000.

Research Period: The estimate of time to perform the tasks (a) computational modeling with review and preparation of deliverables is 12 months. The time to (b) for communication and implementation is estimated at an additional 6 months.

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

- COMP Technical Sub-Committee 1b; Neoma Cole, Georgia DOT, Pavement Management Branch Supervisor, (404) 608-4817, ncole@dot.ga.gov
- TRB Committee on Instrumentation and Modeling, Soheil Nazarian, PhD, PE, D.GE, 915-747-6911, nazarian@utep.edu

### **Potential Panel Members**

- NDDOT; Matt Kurle, Geotechnical Team Lead, (701) 328-6908 mkurle@nd.gov
- MnDOT Office of Materials & Road Research, Raul Velasquez, P.E., Ph.D., Geomechanics Research Engineer, 651-366-5533, Raul.Velasquez@state.mn.us

### **Person Submitting the Problem Statement**

Matt Linneman, PE, NDDOT State Materials & Research Engineer

## **NCHRP Review of E-02**

Reviewed By:

Waseem Dekelbab  
wdekelbab@nas.edu

Comments: The research objective and the final product are not well defined. The written objective is given as a list of tasks and is underdeveloped. In addition, the research topic is a basic research, while NCHRP is a practical, applied research to address problems faced by transportation practitioners and managers and produce implementable products. Therefore, the problem statement is not suitable for funding under the FY 2022 NCHRP.

Review Date:

12/15/2020

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## **FHWA Evaluation of E-02**

Reviewed By: HRDI40/Jennifer Nicks

Comments:

While numerical modeling can provide valuable insights into the behavior of geotechnical assets under construction loading sequences, practical application of results would require validation of all the models, which is not feasible for the broad scope of work. In addition, the recommended funding and period of performance is insufficient for this proposed study.

Review Date:

12/18/2020

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## **Submitter Response for 2022-E-02**

**Comments:**

Thank you for providing review comments on the RPS and also providing the opportunity to respond to the comments. The reviewer comments are included in bold italics below for reference; responses are included addressing each.

***"While numerical modeling can provide valuable insights into the behavior of geotechnical assets under construction loading sequences, practical application of results would require validation of all the models, which is not feasible for the broad scope of work. In addition, the recommended funding and period of performance is insufficient for this proposed study." -Reviewer 1***

An explicit goal would not include calibration of computational models or validation of their precision or accuracy by new or existing field testing, although the models using existing FEM/FDM or similar methods could be tuned with existing full-scale tests and research work. Rather the proposal intends to apply existing predictive geotechnical computational design tools [FLAC, PLAXIS, and similar] and perform stepwise evaluation of geotechnical projects to provide information on loads and deflections associated with progressive steps of transportation construction processes and longer-term service life processes which have not been fully considered previously. The expectation is that the time-domain aspects of the proposed study will reveal underappreciated dynamics of load and deformation with time and construction sequencing. Practical application follows from creating these generalized models in the public domain for immediate application and use by transportation agencies as a basis to either explore (as a 1<sup>st</sup> step) or implement (as a goal) improved design guidance, policy, or procedures. This is further addressed in the response to reviewer #2.

The author concurs that the scope of work as presented was ambitious, and a revised scope with a focus into 3 of the 6 areas would be more appropriate for the suggested funding and timeline (items i., ii, and v. are timely and relevant to other work). Please modify the problem statement research objectives in section 4b to include only items 1, 2, and 5 from the proposed task list.

***"The research objective and the final product are not well defined. The written objective is given as a list of tasks and is underdeveloped. In addition, the research topic is a basic research, while NCHRP is a practical, applied research to address problems faced by transportation practitioners and managers and produce implementable products. Therefore, the problem statement is not suitable for funding under the FY 2022 NCHRP" - Reviewer 2***

This proposal is consistent with the intents expressed by Reviewer #2, examining DOT geo-construction situations as they progress in in time and geometry to serve as a foundational basis for strategic and immediate implementable improvements in in DOT construction practice. "Basic" research is often crucial as a basis for introducing new concepts or supporting new policy; further, important and varied use cases easily follow from foundational work. As an example, while the long-used general bearing capacity equation, stress field, and elastic settlement equations could easily be considered

“basic research” they clearly have a practical applied benefit to a host of specific use cases faced by transportation professionals. The broad applicability, and non-specific nature, was the author’s original intent, to allow for a wide range of potential practical use cases for DOT’s. The reviewer comments are noted and the importance of specifying a target problem, meeting NCHRP program interest of applied research, is appreciated. Considering the project definition and development, a use case is perhaps an appropriate means to address the gap in proposal content and the reviewer’s comments.

In Case i. (Section 4b), assessment of soil stresses and deflections based on construction sequence of various components is intended to demonstrate a majority of deflection for simple span bridges on shallow foundations [as an example] comes from applied self-weight load of the footing, stem walls, and backfilled soil embankments- while <25% comes from the, more deflection intolerant, structural beams and decking. Recognizing that allowable settlement of foundations, which accumulate more deformation than elements constructed later in the sequence, could be significantly larger than most current prescriptive tolerances is important. Changes in DOT practice, allowing more predicted foundation settlement, but limiting later construction sequence structural settlement, could significantly reduce expenditures on deep foundations and reduce long-term maintenance costs- as spread footings are more likely to settle at similar magnitudes to the approach embankments- reducing the “bump at the end of the bridge” (which results from the discontinuity in stiffness and vertical movement of the structural foundation and the adjacent embankment). This research work would provide the background, definitions, modeling, graphs, and visualizations needed as a basis to support changes in the way geotechnical and structural engineers establish tolerances, apportion risk, and communicate with respect to geotechnical design performance and serviceability. Agencies could cite the work as a basis to reconsider how they establish acceptable performance for foundation in a manner which reflects actual construction practice and dynamic soil response to progressive loading- where specific structural components might require appropriate serviceability tolerances rather than foundations. Alternately, settlement estimates could be provided for total loading and [lighter] superstructure loading. Similarly, but not as rigorously described, in Section 4b Case v., models of the impact of hydrostatic loading over time could immediately be used to justify more robust, or additional, drains or drainage features, as part of an overall risk reduction strategy for MSE or cantilever walls in a life-cycle cost or asset management environment.

The RPS products, computational models and supporting metadata, will provide an engineering basis to underpin ‘implemental products’ which could take the form of 1) improved design process, accounting for dynamic construction processes and soil response during construction or 2) revised policy [tolerances] which recognize that structures are not wished-into-place and are not immune to external life-cycle events, such as changes in soil and water pressure.

**Contact Info:**

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Review Date: January 20, 2021



# **Research Field F**

MAINTENANCE

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**PROBLEM NUMBER: 2022-F-01**

**TITLE**

Tools and Technology for Roadside Landscape Asset Management

**BACKGROUND**

There are an estimated 1,000,000 acres of unpaved land within the nation's state and federal highway systems. This million acre site of our national highway system can also be referred to as the Natural Infrastructure underpinning our built systems and blending these systems into the surrounding landscape.

The design, construction and ongoing maintenance of these linear roadside landscapes is one of the most complex and least understood aspects of highway system asset management. The study and practice of roadside design and management has advanced in recent years, through the use of applied technology and data collection, and in light of increasing environmental concerns such as stormwater drainage, endangered species and pollinator protection, climate change, and invasive species management. This project would bring together the diverse interests and knowledge base in the roadside landscape, and focus on developing recommendations for a state of the art national asset management toolset. The project would be designed to engage the states in implementing recommendations by establishing an ongoing discussion forum for state and local transportation organizations to best manage roadside landscapes.

One of the most critical and unexplored opportunities is the application of geographic information systems, data recording tools, and data management systems in the management of roadside landscape assets. This would be the underlying theme of this project, and starting point for future research and state DOT program development moving forward. By planning work and tracking accomplishment and results in a geographic inventory system over time, we can better understand and explain the continuously evolving process of roadside vegetation growth and maintenance treatment.

This project would bring together and build on several key pieces of recent national study, and would support the integrated research strategies of the two primary TRB Standing Committees focused on highway roadsides: Roadside Maintenance Operations (AKR20), and Landscape and Environmental Design (AKD50). This effort would leverage technology and digital media to create a national model for roadside asset management, and establish a recommended foundation for sustainable state

DOT program development. It would serve as the basis for an ongoing dialogue and discussion with regard to health and resilience of our nation's roadsides, and facilitate our national quest to create the most integrated, locally adapted, sustainable roadside landscapes.

## **LITERATURE SEARCH SUMMARY**

The literature on this topic is extensive and broad-based. However there are a number of emerging and unprecedented issues with regard to climate change and social equity impact roadside landscape assets which have not been adequately studied and will require organized research consideration in the coming years.

Because the topic of roadside management extends to the subject areas of ecology, social equity, sustainability, and climate change there are many overlapping research efforts and interest from a number of other transportation research committees. It is important to note that many state DOTs have developed and published best management practices on this subject and comparative analysis of recent individual state approaches would be advantageous. One of the outcomes of this project would be an appendix of all relevant research and local case study data for reference.

There are also a number of emerging and unprecedented issues with regard to climate change and social equity impact roadside landscape assets which will require organized research consideration in the coming years.

Existing contributions to this subject area that serve as the foundation for this project:

- NCHRP Project 20 68A, Scan 16-02-2019– Leading Landscape Design Practices for Cost-Effective Roadside Water Management
- NCHRP Project 14-04 (Currently nearing completion) Comparison of Cost, Safety, and Environmental Benefits of Routine Mowing and Managed Succession of Roadside Vegetation
- AASHTO Guidelines for Vegetation Management – 2011 (Recently updated Chapter 12 – Permanent Vegetation Control Barriers)
- NCHRP Synthesis Study – **20-05/Topic 49-06-2018** Design and Maintenance Solutions for Urban Freeway Roadsides
- **NCHRP 20-119** – Evaluating the Suitability of Roadway Corridors for Use by Monarch Butterflies
- **NCHRP 25-25/Task 119** Enhancing the International Stormwater BMP Database to Serve as a Highway Specific BMP Database and Task 120 Use of the State Department of Transportation Portal to the International Stormwater BMP Database; Continuation of 25-25 Task 92
- FHWA Publication 2013: VEGETATION MANAGEMENT: An Ecoregional Approach
- NCHRP Synthesis 341 – 2011 – Integrated Roadside Vegetation Management

This project would also include the development of an online information hub and networking website. Examples of similar applications and potential online templates:

**Clear Roads:** <https://clearroads.org/>

**No Boundaries:** <https://rip.trb.org/view/1650152>

**Roadside Revegetation:** <http://www.nativererevegetation.org/>

## **RESEARCH OBJECTIVES**

The objective underlying this entire proposal is the establishment of an organized and ongoing national dialogue regarding best practices for highway roadside asset management. This objective would be accomplished by working with the roadside asset standing committees AKR20 and AKD40, and dissemination of information through these committee networks to the rest of the country. There would also be a series of webinars highlighting the project and progress throughout.

One of the primary objectives of the project for discovery and analysis of information on roadside asset management tools being used by the various states. This survey and analysis would show the current state of the art with regard to design, construction and maintenance practices for roadsides.

Ultimately the project will result in an ongoing dialogue and communication network on the topic of roadside asset management. This will facilitate the development of tools and techniques that can be customized and applied within the context of the various state and local governments.

## **URGENCY AND POTENTIAL BENEFITS**

The timing for this project is the result of a chain of research going back over 20 years, and urgency has been increased in recent years with emerging concerns over endangered species impacts, pollinator decline, increased roadside fire starts, climate change, and increase invasive species pressures on our native ecosystems. Urgency is also heightened by the rapid developments in mapping and data analysis technology, and the application of previously unavailable tools and innovative data management systems.

## **IMPLEMENTATION CONSIDERATIONS**

Research expectations:

- Work with the TRB Project Manager and project advisory panel to coordinate with AASHTO and state transportation agencies to recruit and appoint the project working group, from any states willing and able to participate.
- Establish a panel of national experts to oversee the process of soliciting proposals and selecting a consultant to design and publish and maintain/update a national website, and assist with moderating the ensuing national discussion on roadside asset management.

- The expert panel would also over the soliciting of proposals and selection of a consultant to conduct and publish a national survey, analysis, and recommendations on what systems and tools the various states are using to collect and analyze roadside asset management data, including: Measurements of roadside condition, GIS inventory of roadside vegetation and treatments, planning documents and crew training on roadside vegetation management, and accounting systems with historic unit accomplishment and cost data.
- Engage the entire list of national roadside stakeholders and interested TRB standing committees in the development and launch of the website through a webinar series highlighting the start of the process, half way through the process and at the completion of the initial website.

Research on this topic will be coordinated through the TRB standing committee on Roadside Maintenance Operations (AKR20), and the standing committee on Landscape and Environmental Design (AKD40). These committees include a combined network of over 250 roadside management professionals and academics from throughout the continent, and this group would be used to disseminate information to all states and industry stakeholders. This issue impacts all phases of highway planning, design, construction, and maintenance, and this project will naturally attract the attention of the concerned AASHTO committees and working groups. The committee research coordinators for these two committees will be responsible for coordinating this effort and its findings with all other relevant TRB and AASHTO committees.

**Recommended Funding:** \$350,000

**Research Period:** 24 Months

**Problem Statement submitted by the Author:**

Raymond Willard, PLA

(360)688-0291

ray.willard@wsdot.wa.gov

Washington State Department of Transportation/Maintenance Operations

AKR20 Committee Research Coordinator

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## **NCHRP Review of F-01**

**Reviewed By:** Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

### **Comments:**

A. The problem does not appear to be research oriented. It calls for communications and exchange of information among different parties. B. The proposed topic, although not a research topic, should be of interest to the majority, if not all, state DOTs. C. The objective, as stated in the problem statement, calls for the establishment of an organized and ongoing national dialogue regarding best practices for highway roadside asset management. This objective can be achieved through a synthesis study under

NCHRP Project 20-05 or a domestic scan activity under NCHRP Project 20-68. D. The scope is clearly defined. It calls for surveys of “current state of the art with regard to design, construction and maintenance practices for roadsides” in addition to a “national dialogue regarding best practices for highway roadside asset management” and “the development of an online information hub and networking website”. E. The estimated duration of 24 months seems more than adequate. F. The estimated budget of \$350,000 seems excessive considering the stated objective and scope; a reduction to \$200,000 is suggested. G. Several references are noted but further literature review, surveys, and other information gathering would be helpful. Note: This problem statement is one of 3 problem statements submitted by the AASHTO Committee on Maintenance; it was ranked second by the committee.

Review Date: 12/14/2020

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### **FHWA Evaluation of F-01**

Reviewed By: HEPE-30/Daniel Buford

Comments:

The Problem State is drafty and difficult to understand--the concept seems not fully formed. There are no apparent collaborators identified in the proposal or a potential host of a website. The proposal may include development of guidance, but it is unclear what entity would sponsor the guidance. Consider other options--some communication objectives could be achieved through an inexpensive list serve.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for F-01**

Submitted By:  
Jameelah Hayes  
AASHTO Staff  
Committee on Maintenance

Priority #: 1

Comments: The Committee on Maintenance highly supports this research. It is the committee's #1 priority.

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## **Submitter Response for 2022-F-01**

**From:** [email: kathy.ahlenius@wyo.gov;ray.willard@wsdot.wa.gov]

Based on the comments received, extensive re-work of the problem statement was performed. *[Submitter provided an updated problem statement but that has not been included since it has not gone through the review process.]*

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: 2022-F-02**

**Problem Title**

Validating and communicating the long-term effects of aging Government Fleet Assets

**Background**

Agencies are often faced with tough decisions on how to prioritize transportation investments, State DOT Fleet managers need to get better at communicating the business case to replace Fleet Assets on time. Fleet managers are facing enormous challenges as government budgets get tighter due to stagnant or decreasing tax revenue. As budgets decrease and decisions are made to extend the life of fleet assets, it is more important than ever to efficiently communicate the long-term effects of that decision. When vehicles age, more maintenance issues arise resulting in higher annual operating costs and lower operational availability. Vehicle and equipment downtime are a monetary and safety issue, especially if vehicles and equipment cannot respond to an emergency.

With capital fleet budgets and maintenance budgets typically separate, the relationship between the two are normally overlooked. In certain circumstances, these budgets may be monitored by different managers. Therefore, it is not always obvious or easily presentable that retaining a vehicle over a long period of time may be a costly decision.

Keeping equipment long-term can drive up maintenance costs and increase downtime. This can result in fleet users retaining additional fleet assets as spares to guarantee they cover operational needs however this grows the fleet and increases costs.

A “plug n play” budget communication presentation is needed to help executives unfamiliar with fleet management understand the long-term effects of aging fleet assets. The presentation would include references to research and data from experts verifying the long-term effects of aging fleet assets. These references would reinforce the credibility of the fleet manager’s request.

Research should be able to provide historical data of fleets with different methodologies on retention. It should be possible to extrapolate a user’s data (from their fleet management system) and surmise possible scenarios within the fleet.

This research supports a key focus area of the Maintenance Committee regarding Asset Management and Safety. Vehicle and equipment downtime is a monetary and safety issue, especially if vehicles and equipment cannot respond to an emergency. This



research will be used to effectively communicate the impacts of investment decisions related to Fleet Assets.

### **Literature Search Summary**

A comprehensive literature review was conducted on aging fleet and transportation asset management and Life Cycle Cost Analysis (LCCA). The search yielded several significant references. These references can be grouped into three general categories: current decision on whether to replace or repair, a guide for long range plans and budgets for replacement, and how to optimize equipment life cycles. For example, Category 1 has a project titled, "Guideline for Decision-Making for Repair vs. Replacement of Highway Maintenance Equipment" which will investigate the present. Category 2 will aim towards the future and Category 3 will investigate optimized equipment life cycles. The existing literature does not contain an easy method of validating and communicating the effects of aging government fleet or transportation assets, nor does it have a budget presentation that includes references to research and data from experts on aging fleet or transportation assets. The existing literature does not have a "plug n play" tool to communicate the long-term effects.

### **Research Objective**

The objective of this research is to develop a presentation "plug n play" template that DOT fleet managers can use to effectively communicate the long-term effects of aging the Fleet Assets. The presentation shall include at least the following components:

- A "plug n play" PowerPoint template which includes auto fill boxes linked to other documents such as:
  - Budget Needs
  - Age of Fleet
  - Cost to Defer
  - Link to Research Literature explaining pros and cons of deferring replacement of Fleet Assets
- Training and written guide on presentation and use of PowerPoint template to support management and budgeting decision making and communication with stakeholders.
- Identification of fleet and equipment performance measures that may be used to communicate impacts of aging Fleet Assets
- Guidance for data collection to show cost impacts of deferring Fleet Assets

### **Urgency and Potential Benefits**

The vast majority of state DOTs are faced with tough decisions on how to prioritize transportation investments. Without an effective communication tool, fleet assets may not get funded. With an effective communication tool, leadership will be provided with the information necessary to maximize available funding.

As budgets decrease and decisions are made to extend the life of fleet assets, it is more important than ever to efficiently communicate the long-term monetary effects of those decisions.

The benefits of an effective communication tool explaining the long-term impacts of aging fleet assets will help all state DOTs when making investment decisions.

Benefits may include:

- Increase in funding for fleet assets
- Lower overall fleet costs
- Increased reliability and safety
- Better communication and understanding of long-term impacts without funding

### **Implementation Considerations and Supporters**

Fleet Managers, Governmental and Administrative leaders, making transportation funding investment decisions, will likely be responsible for using the research results.

With a “plug n play” tool, implementation would be straight forward provided state DOTs track data elements such as costs, lifecycles and budgets.

To support implementation, training workshops and presentations could take place during the Committee on Maintenance and regional and national Equipment Management Technical Services Program meetings.

Any AASHTO Committee dealing with asset management could use this tool to better communicate the condition of their assets and the long-term effects of deferring maintenance or replacement. Instead of inserting Fleet Asset Data, you could use Bridge, Pavement or any other asset data.

### **Recommended Research Funding and Research Period**

Research Funding: Estimated \$250,000

Research Period. 18 months

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

AASHTO Equipment Technical Working Group and supported by the ranking of the members of the Equipment Management Technical Services Program (EMTSP)

Tim Cunningham, P.E., Chair; AASHTO Maintenance Committee; Equipment TWG  
Chair; AASHTO EMTSP Oversight Panel, Equipment Engineer, Kansas DOT  
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### **Potential Panel Members**

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### **Person Submitting the Problem Statement**

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### **NCHRP Review of F-02**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

#### Comments:

A. The problem does not appear to be research oriented. It calls for developing marketing/communications tool based on completed research. B. The proposed topic, although not a research topic, should be of interest to the majority, if not all, state DOTs. C. The objective, as stated in the problem statement, calls for "a presentation 'plug n play' template that DOT fleet managers can use to effectively communicate the long-term effects of aging the Fleet Assets". This objective appears to be suited for an implementation activity under NCHRP Project 20-44. D. The scope is clearly defined. It calls for a communications tool in the form of "a presentation that includes a 'plug n play' PowerPoint template which includes auto fill boxes linked to other documents such as budget needs, age of fleet, cost to defer, and link to research literature explaining pros and cons of deferring replacement of fleet assets". E. The estimated duration of 18 months seems adequate. F. The estimated budget of \$250,000 seems excessive considering the stated objective and scope; a reduction to \$200,000 is suggested. G. Several references are noted but further literature review and other information gathering would be helpful in developing the proposed communication tool. Note: This problem statement is one of 3 problem statements submitted by the AASHTO Committee on Maintenance; it was ranked third (lowest priority) by the committee.

Review Date: 12/14/2020

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## **FHWA Evaluation of F-02**

Reviewed By: HRDI-20/Morgan Kessler

Comments:

Fleet assets for an agency are, aside from personnel assets, among the most cost-intensive components of a DOT, and due to the mechanical nature of equipment, fleets require intensive management. Over the past several years, AHD60 and EMTSP stakeholders have been successful in communicating the need for fleet asset research, as evidenced by the number of NCHRP projects that address this topic. With all that has been done, more is needed to round out the previously unaddressed subjects around fleet management. This present RNS is one such topic and, at first glance, may seem a lot like Project 13-08. However, this project specifically asks for a communication tool for equipment decisionmaking, and this has not been addressed to date by any previous work.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for F-02**

Submitted By:  
Jameelah Hayes  
AASHTO Staff  
Committee on Maintenance

Priority #: 2

Comments: The Committee on Maintenance highly supports this research. It is the committee's #2 priority.

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## **Submitter Response for 2022-F-02**

**From:** [email: kathy.ahlenius@wyo.gov]

**Comments:** Thank you Morgan and Amir for your comments. With regards to the funding, the committee agrees that the funding amount can be reduced from \$250,000 to \$200,000. This statement was rated second out of the six topics submitted to

NCHRP, including a topic submitted to the NCHRP Synthesis. The difference between all topic ratings was .77, which indicates that all the topics submitted to NCHRP this year resonated with all the voting States. With regards to submitting this topic Project 20-44, is that something that the committee needs to resubmit the topic to, or can it be considered for at this time?

**Contact Info:** kathy.ahlenius@wyo.gov cell: 307.421.6168

Review Date: 4jan21

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER**

**2022-F-03**

**PROBLEM TITLE**

Construction Guide Specifications for Pavement Treatments – Sand Seals and Ultra-thin Bonded Surface Treatments

**RESEARCH PROBLEM STATEMENT**

Pavement preservation is an indispensable component of Asset management that DOT's use to maintain and enhance the conditions and performance of their highways. Pavement preservation treatments do not improve the structural capacity of a pavement; rather they extend pavement life through delayed pavement deterioration by sealing cracks, preventing pavement oxidation, and, in the case of surface seals, rejuvenating the existing pavement surface layers.

Preservation treatments utilizing asphalt emulsions as the binder have historically been underutilized and therefore considered secondary to hot mix asphalt (HMA) technologies. As such, these treatments have not been upgraded or researched to the same extent as HMA technologies. Over the last few years, however, the AASHTO Transportation System Preservation Technical Services Program (TSP-2) Emulsion Task Force (ETF) has made a concerted effort to improve the state of the science /engineering in emulsion technology with the goal of creating National performance-based standards (specifications, test methods, design practices, etc.) that are adopted by AASHTO and are not vendor specific.

The ETF membership comes from DOTs, FHWA, academia, representatives of the Asphalt Emulsion Manufacturer's Association (AEMA), International Slurry Surfacing Association (ISSA), and Asphalt Reclaiming and Recycling Association (ARRA). The ETF has focused on creating and delivering materials standards to the AASHTO Committee on Materials and Pavements. (see fig 1).

| Accomplishments – Emulsion Treatment Standards |         |        |         |            |                                                                                                            |                                  |                |
|------------------------------------------------|---------|--------|---------|------------|------------------------------------------------------------------------------------------------------------|----------------------------------|----------------|
| Status: AASHTO Emulsion STDs (2019)            |         |        |         |            |                                                                                                            |                                  |                |
| AASHTO STANDARDS                               |         |        |         |            |                                                                                                            |                                  |                |
| Emulsion Treatments                            | M / MP  | T / TP | R       | W/ COMP    | Comments                                                                                                   | Construction Guide Specs         | Best Practices |
| Chip Seal                                      | MP27-16 |        | PP82-16 |            |                                                                                                            | ✓ NCHRP 14-37                    |                |
| Micro Surfacing                                | MP28-17 |        | PP83-16 |            |                                                                                                            | ✓ NCHRP 14-37                    |                |
| Tack Coat                                      | MP36-18 |        | PP93-18 |            |                                                                                                            | NCHRP 14-44                      |                |
| Fog Seal                                       | MP33-17 |        | PP88-17 |            |                                                                                                            | ✓ NCHRP 14-37                    |                |
| Scrub Seal                                     | ✓       |        | PP91-18 |            |                                                                                                            | NCHRP 14-44                      |                |
| Sand Seal                                      | MP34-18 |        | PP90-18 |            |                                                                                                            | PS 2020                          |                |
| Slurry Seal                                    | MP32-17 |        | PP87-17 |            |                                                                                                            | NCHRP 14-44                      |                |
| Foam Asphalt Stabilization                     |         |        | PP38-18 |            |                                                                                                            |                                  |                |
| Bonded Surface Treatments (Nova Chip)          | ✓       |        | ✓       | 2018       |                                                                                                            | PS 2020                          |                |
| Cold Recycled Mixtures                         | MP31-17 |        | PP86-17 |            |                                                                                                            | NCHRP 9-62 / D-07<br>NCHRP 14-43 |                |
| Legend                                         |         |        |         |            |                                                                                                            |                                  |                |
| Emulsion Binder Standards                      | M / MP  | T / TP | R       | W/TRB      |                                                                                                            |                                  |                |
| Emulsified Asphalt                             | M140-16 |        |         |            | M=Material Specs<br>T=Test Methods<br>R=Design Practices<br>P=Provisional<br>✓=Draft STD Submitted to COMP |                                  |                |
| Cationic Emulsified Asphalt                    | M208-16 |        |         |            |                                                                                                            |                                  |                |
| Polymer-Modified Cationic Emulsified Asphalt   | M316-16 |        |         |            |                                                                                                            |                                  |                |
| Emulsion/Surface Performance Grades (E/SPG)    |         |        |         | NCHRP 9-63 |                                                                                                            |                                  |                |

Figure 1

As can be seen from fig 1, all the emulsion treatments except for these two treatments have or are in the process of having their Construction guide specifications developed through the listed NCHRP projects.

Therefore, to close the "gap" and have a full complement of standards for all Emulsion preservation treatments it is critical that these two treatments have their Construction guide specification developed. Some agencies have developed construction specifications for local jurisdictions, but standardized nation-wide construction guide specifications do not exist.

**Sand Seal** is a sprayed application of asphalt emulsion followed by a covering of clean sand or fine aggregate. A pneumatic-tire roller is often used after applying the sand. Excess sand is removed from the road surface after rolling. A sand seal is used to fill existing pavement cracking and even out surface smoothness defects as either a preparatory treatment for other maintenance treatments or as a wearing course.

AASHTO Materials specifications and Design practices exist for Sand seals (AASHTO MP 34-18 for Materials, and AASHTO PP 90-18 S for Design practices).

**Ultra-Thin Bonded Wearing Course (UTBWC -Nova Chip)** is a preventative maintenance tool used to help extend the life of a road. This ultra-thin bonded wearing course is an open graded hot mix asphalt placed over polymer modified asphalt emulsion through a special, self-priming paver and compacted with a roller. The treatment improves skid resistance and reduces hydroplaning and noise. UTBWC can be used in pavement maintenance activities or in new construction.

The Emulsion Task Force has submitted to AASHTO COMP, material specifications and design guides for Ultra-Thin Bonded Wearing Courses.

## LITERATURE SEARCH SUMMARY

Illinois Bureau of Design and Environment Manual (2010), Chapter 52, Pavement Preservation. Link: <http://www.idot.illinois.gov/assets/uploads/files/doing-business/manuals-split/design-and-environment/bdmanual/Chapter%2052%20Pavement%20Preservation.pdf>

Braun Intertec Corporation; Alternatives to Seal Coats; Minnesota Department of Transportation (Mn/DOT); TRS 1602; February 2016"

All States Materials Group; Specifications for Sand Seal, Feb 2015 <http://asmg.com/images/pdfs/Sand%20Seal.pdf>

Evaluation of Pavement Safety Performance; Chapter 3. Pavement Treatment Types, FHWA-HRT-14-065, February 2015

2019 Missouri Standard Specifications for Highway Construction/General Provisions, Missouri DOT, Section 413.30 Ultrathin Bonded Asphalt Wearing Surface

Texas Department of Transportation – Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges; Item 348 – Thin Bonded Friction Courses, November 2014.

Some research on Sand Seals and Bonded Surface Treatments is available; however, a national Construction Guide Specification is not available.

## **RESEARCH OBJECTIVE**

The object of this project is to produce AASHTO Construction Guide Specifications for the application of Sand Seals and Ultra-thin Bonded Surface Treatments. This will assist highway agencies in adapting these specifications to the local conditions and environments and will aid DOTs in implementing these treatments in their pavement/asset management programs.

The Construction Guide Specification will address the construction operations required, with possible adjustments for local materials and experience. Quality Assurance protocols and incentive/disincentives will have to be addressed

The research will include a review of previous work in the area, including construction standards, construction specifications, and construction practices both national and internationally.

Deliverable documents will be in conformance with AASHTO COMP standards format.

## **ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

Recommended Funding: \$200,000

Research Period: 12 months

## **URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

The creation of nationally accepted AASHTO Construction Guide Specifications will aid and enable DOTs in implementing Sand Seals and Ultra-thin Bonded Surface Treatments.

## **PERSON(S) DEVELOPING THE PROBLEM**



Colin A Franco, RIDOT Associate Chief Engineer (Materials and Quality Assurance); Co-Chair – AASHTO TSP2 Emulsion Task Force; Member – AASHTO RAC; TRB RIDOT representative.

Chris Lubbers, Kraton Performance Polymers, Inc., Technical Sales and Marketing Development Manager – Emulsions; Co-Chair – AASHTO TSP2 Emulsion Task Force

Darren Hazlett, Research Fellow, University of Texas – Center for Transportation Research; Member – AASHTO TSP2 Emulsion Task Force;

#### **PROBLEM MONITOR**

Colin Franco

Darren Hazlett

#### **DATE AND SUBMITTED BY**

Colin Franco

Oct. 31, 2020

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#### **NCHRP Review of F-03**

##### Reviewed By:

Edward T. Harrigan  
eharriga@nas.edu

##### Comments:

The objective is clear. The scope is reasonable. An increase in the period of performance to 18 months is recommended. An increase in the budget to \$250,000 is recommended, based on staff experience with current projects with a similar objective and scope.

##### Review Date:

12/2/2020

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#### **FHWA Evaluation of F-03**

Reviewed By: HRDI-20/Morgan Kessler

##### Comments:

This research is needed, and will be consistent with other efforts by NCHRP to produce AASHTO guide specifications. As the RNS states in the included table, sand seals and UTBWC methods are the last of the major preservation treatments to produce guide specifications for via this approach. Both of these methods are, in practice, very much in need of non-proprietary, non-contractor driven, unbiased specification.

Review Date:

12/18/2020

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### **AASHTO Committee Evaluation for F-03**

Submitted By:

Casey Soneira

AASHTO Staff

Committee on Materials and Pavements

Priority #: N/A

Comments: The work of the AASHTO TSP2 Emulsion Task Force has provided COMP with good work in the past. The results of this project would benefit COMP.

# **Research Field G**

TRAFFIC

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**PROBLEM NUMBER**  
**2022-G-01**

**PROBLEM TITLE**

Criteria for Selecting an Appropriate Target Speed on Multi-Modal Urban and Suburban Roadways

**RESEARCH PROBLEM STATEMENT**

The proposed research is intended for practicing traffic engineers and transportation planners with responsibilities for the conduct of speed surveys and setting posted speed limits. It would also benefit transportation professionals with responsibilities related to traffic safety, particularly those implementing Vision Zero and similar programs.

The ideal outcome of this research would be to define practices for determining Target Speeds. There is other research intended to provide guidance on design practices that achieve Target Speeds, but insufficient research to support establishing Target Speeds.

**LITERATURE SUMMARY**

The Institute of Transportation Engineers' *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* (2010) first piloted the concept of Target Speed, defining it as "the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility for motor vehicles and a safe environment for pedestrians and bicyclists...target speed is designed to become the posted speed limit."

Since the advent of Target Speed, several research projects have been conducted or are ongoing related to setting Target Speeds and setting speed limits, recently including:

- *NCHRP 17-76: Guidance for the Setting of Speed Limits* (draft recommendations presented at the 2020 TRB Annual Meeting but not yet published) with objectives to "(1) identify and describe factors that influence operating speed and (2) provide guidance to make informed decisions related to establishing speed limits on roadways." The research proposed in this RNS is focused on determining an appropriate Target Speed.
- *NCHRP 15-76: Designing for Target Speed* (pending selection of a research team) with the objective to "(1) determine the effects of the roadway, roadside, and non-roadway elements on operating speeds on roadways with a target speed between 30 and 40 mph and (2) develop recommendations on how the findings can be

incorporated into the roadway design process.”

- *NTSB/SS-17/01 PB2017-102341- Reducing Speeding-Related Crashes Involving Passenger Vehicles*, a publication by the National Traffic Safety Board (NTSB), which found that: the Manual on Uniform Traffic Control Devices guidance for setting speed limits in speed zones is based on the 85th percentile speed, but there is not strong evidence that, within a given traffic flow, the 85th percentile speed equates to the speed with the lowest crash involvement rate on all road types; unintended consequences of the reliance on using the 85th percentile speed for changing speed limits in speed zones include higher operating speeds, new, higher 85th percentile speeds in the speed zones, and an increase in operating speeds outside the speed zones; and the safe system approach to setting speed limits in urban areas is an improvement over conventional approaches because it considers the vulnerability of all road users.
- *USLIMITS2* is a web-based tool designed to help practitioners set reasonable, safe, and consistent speed limits. It is rules-based tool, that selects a recommended posted speed limit based on inputs provided on roadway characteristics. It precludes the need for a traditional engineering study and, as such, is distinct from the research proposed in this RNS.
- *ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* and *NCHRP 15-76* describe design attributes intended to bring about Target Speeds, *NCHRP 17-76* recommends greater flexibility in engineering studies needed to support changes to speed limits (the largest of which is using 50th percentile speeds rather than 85th percentile speeds), and *NTSB/SS/17/01* concludes that a Safe Systems approach should be considered in urban areas. However, there is a lack of research identifying the selection of appropriate Target Speed thresholds.
- The National Association of City Transportation Officials (NACTO) developed *Setting Safe Speeds Limits on Urban Streets* (presented at TRB 2020 Annual Meeting and nearly published) using conflict density and pedestrian and bicycle activity density as inputs to determine appropriate speed limits in urban and suburban areas, but the research has a policy objective of reducing prima facie speed limits to 25 or even 20 miles per hour which is not applicable in many urban sprawls and suburban areas in the U.S.

## RESEARCH OBJECTIVE

The primary objective of the proposed study is to establish a set of criteria for determining Target Speeds in urban and suburban areas where engineering studies are typically used to establish posted speed limits. The proposed research should consider, at a minimum, activity levels (auto, pedestrian, and bicycle), severity and type of crashes (KA crashes, conflict types, etc.), and observations about auto speed to clarify the safety effects of various speeds on different user groups. Other important criteria may include land uses, roadway design (including the extent to which separation of users is possible), lighting, traffic signs (e.g., conspicuity), and other concept-specific

factors. This study will then develop guidance for considering the aforementioned criteria in determining future speeds.

### **ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

This research would like to require funding of \$500,000 and require two years to execute the technical research.

### **URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

The proposed research is urgently needed as current guidance strongly encourages continued adherence to use of 85th percentile speed to set speed limits despite known unintended consequences. Considerations related to amending the 85th percentile recommendation to use the 50th percentile speed would continue to rely on driver behavior to set speed limits rather than desired safety outcomes. In accordance with NTSB recommendations and FHWA policies related to Safe Systems, a new approach focused on the safety of road users is urgently needed.

This research effort would be beneficial in prioritizing the safety efforts of the state DOTs and federal agencies. The results of this study can be helpful for outreach programs and initiatives such as the American Automobile Association's (AAA) Guide to Teen Driver Safety programs.

The AASHTO Committee on Safety ranks this project #7 of 7.

### **PERSON(S) DEVELOPING THE PROBLEM**

This research statement was developed by:

- Matthew Ridgway, Fehr & Peers DC, m.ridgway@fehrandpeers.com, 202 854 2730
- Nick Ferenchak, University of New Mexico, ferenchak@unm.edu, 505 277 0698
- Bahar Dadashova, Texas Transportation Institute, B-Dadashova@tti.tamu.edu
- Rebecca Sanders, Arizona State University, rlsanders@asu.edu, 510 316 5940

This research problem statement has been reviewed and is supported by leadership of the following Transportation Research Board (TRB) Standing Committees:

- ACH20: Standing Committee on Bicycle Transportation (Bahar Dadashova)
- ACH10: Standing Committee on Pedestrians (Sirisha Kothuri)
- ANB40: Standing Committee on Traffic Law Enforcement (Grady Carrick)
- ABE30: Standing Committee on Transportation Issues in Major Cities (Stephanie Dock)
- ACS20: Safety Performance and Analysis Committee (Karen Dixon)

## **PROBLEM MONITOR**

To be assigned by AASHTO Safety Committee.

Rachel Carpenter (rachel.carpenter@dot.ca.gov) has indicated the California Department of Transportation (Caltrans) support for this research statement.

## **DATE AND SUBMITTED BY**

November 1, 2020

Steven A. Buckley, P.E.  
State Highway Safety Engineer  
Bureau of Transportation Safety & Technology  
700 SW Harrison Street, 6<sup>th</sup> Floor  
Topeka, KS 66603-3745  
785-296-1148

## **REFERENCED LITERATURE**

Institute of Transportation Engineers, *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, 2010

National Transportation Safety Board, *Safety Study*, NTSB/SS-17-01, PB2017-102341, July 25, 2017

National Association of City Transportation Officials, *City Limits: Setting Safe Speed Limits on Urban Streets*, Spring 2020.

Federal Highway Administration, USLIMITS2: A Tool to Aid Practitioners in Determining Appropriate Speed Limit Recommendations, <https://safety.fhwa.dot.gov/uslimits/>, September 28, 2020

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## **NCHRP Review of G-01**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

### Comments:

This project scope lists ongoing studies related to designing the target speed. NCHRP 15-76 is ongoing and has a scope limited to speed limits between 30 and 40 mph and NCHRP 03-139 which will develop the next generation of USLIMITS II both are ongoing. This project must coordinate to ensure there is no duplication of effort. The scope could include roads with speed limits below 30 mph. The budget is adequate however the allotted time should be increased to 36 months.

Review Date: 12/21/2020

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## **FHWA Evaluation of G-01**

Reviewed By: HSA/Guan Xu

Comments:

The proposed research touches on an important concept and practice for implementing a safe system approach to improve traffic safety and achieve zero deaths. The term/concept of target speed has been relatively new to the transportation field. As such, there is a need to define practices for determining target speeds, but the statement doesn't seem to provide sufficient information/explanation to clearly define the purpose, objectives, and intended tasks; and, it appears to mix the target speed and speed limit some places in the statement.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-01**

Submitted By:  
Jameelah Hayes  
AASHTO Staff  
Committee on Traffic Engineering

Priority #: N/A

Comments: The Committee on Traffic Engineering supports this research. Some states are implementing new Speed Management Policies.



**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS  
SPECIAL COMMITTEE ON RESEARCH AND INNOVATION**

**FY 2022 NCHRP Problem Statement**

**Problem Number: WITHDRAWAL 2022–G-02**

(This problem statement is a revised version of a problem statement submitted last year. That earlier version was selected for funding on December 3, 2020. The submitter has asked for this problem statement to be withdrawn.)

**Problem Title**

Safe System in the U.S.: Developing a Roadmap for Transportation Road Designers, Planners, and Engineers

**Background**

According to Vision Zero proponents, in spite of “increased interest, little guidance exists for local transportation planners, policy makers, public health practitioners, police and others working” to advance the Safe System approach (Fleisher, Wier, and Hunter, 2016). The same may be said for guidance to the state and national engineering, design, and planning communities. Yet the recognition, acceptance and use of the Safe System approach is rapidly growing in the U.S. and elsewhere as the following initiatives demonstrate.

- In 2008 the International Transport Forum (ITF) published a report **Towards Zero: Ambitious Road Safety Targets and the Safe System Approach**, which was the first international effort in defining and promoting the adoption of a Safe System approach as the main framework for road safety policies. The definition acknowledges road users make mistakes. A shared responsibility exists for safety and road user safety should not be reduced to achieve increased mobility. In the model, safe speeds resulting in injury minimization represent the primary pathway towards a safer system, followed by safe vehicles, safe roads, and safe road users. The 2008 effort was followed in 2016 with ITF’s publication of **Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System**. The ITF with the World Bank is currently convening a Safe System Working Group to develop a manual on Safe System implementation expected to publish by the end of 2021. This document will review current evidence for the results of a shift to Safe System approaches and establish indicators of progress in taking the steps required. The work is complemented with pilot projects to examine effective implementation of Safe System in a selection of countries and cities. Internationally, countries using the Safe System model have far outpaced the United States in driving down traffic related deaths and are arguably “safer” than the U.S. (Marshall, 2018.)
- The FHWA, in partnership with the Road to Zero Coalition, is developing a Safe System Strategic Plan intended to serve as a roadmap for advancing the Safe System approach in the United States. The strategic plan lays out strategies to increase awareness among transportation professionals on the effectiveness of the Safe System approach and advance a Safe System mindset. While the

strategies outlined are predominately for roadway owners and operators to consider, the plan also considers the broader context of applying the Safe System approach to prioritize safety by doubling down on programs and policies that work. The plan provides insight into the strategies, focus areas, measures of success, timeline, and specific actions allowing a holistic Safe System approach to be widely adopted and supported by infrastructure owners and operators in the United States.

- The Road to Zero Safe System Working Group, led by Jeff Paniati, ITE Executive Director, has created a framework for thinking about Safe System in the US context and continues to work on identifying and documenting Safe System strategies and actions currently being implemented in the U.S.
- Some of the Safe System strategies, such as multidisciplinary implementation to promote safer roads, vehicles, road users, and safety culture are included in the AASHTO's **Towards Zero Deaths** (TZD).
- The Vision Zero Network has been aggressively applying Safe System principles, specifically speed reduction, with more than 30 local communities committed to Vision Zero since 2014.

While these efforts denote ongoing progress, none of the initiatives address the proposed audience or focus on the specific subject matter of this proposed research. Professionals in the road planning, design and engineering community are faced with legacy design processes and standards, as well as how best to implement Safe System without creating liability concerns that prohibit rapid adoption of an aggressive approach to implementing some of the Safe System hallmarks. This NCHRP project can build upon these efforts and contribute to a specific discussion on the role of State and local transportation agencies to advance the Safe System Approach.

Transportation safety is a complex issue and a true Safe System approach must address many factors (e.g. role of the road user in behaving properly, vehicle design, policy and laws, recognition of the shared safety responsibility and public culture) to be successful and adaptable to future changes (e.g. autonomous and connected vehicles). For Safe System to be fully implemented, all of these will have to change. This research is proposed as a starting point to provide practical and effective information for the engineering, design, and planning communities to consult during project development and countermeasure selection processes. It will provide a model and pathway for State and Local Agencies to begin and to advance Safe System implementation.

### **Literature Search Summary**

The Transportation Research and Information Database (TRID) and Research in Progress contain many documents referencing Safe System addressing various methodologies, countermeasures, and policies. Some of the relevant publications are listed below:

- Signor et al. (June 2018). Safe System Synthesis: An International Scan for Domestic Application. University of North Carolina Highway Safety Research Center (A policy scan of international practices associated with Safe System.)
- Dumbaugh et al. (June 2019). Implementing Safe System in the United States: Guiding Principles and Lessons from International Practice. Florida Atlantic University and University of North Carolina, Chapel Hill. (Concept of Safe System and review of practices in international countries).
- Kumfer et al. (2019). Speed, Kinetic Energy, and the Safe System Approach to Safer Roadways. ITE Journal 89(4): pp 32-36. (An illustration of importance of kinetic energy, primarily speed management, within Safe System framework).
- Turner et al. (2017). Safe System infrastructure on mixed use arterials: 123p. (A synthesis of key safety solutions for urban mixed-use arterials in Australia and New Zealand).
- Arason, N. (2019). Canada and the Safe System Approach to Road Safety. ITE Journal 89(4): pp 26-30. (An example of Safe System approach implementation in Canada).
- ITF (2016), Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System, OECD Publishing, Paris (A summary of emerging best practices to start the journey towards a Safe System).

### **Research Objective**

The proposed research is focused on providing data driven support to the transportation engineering, design, and planning communities to ensure all road user mistakes encounter “error tolerance” on the roadways and do not result in serious injury or death. The research will identify tools, countermeasures, model policies, methods, etc., for beginning and accelerating implementation of a Safe System approach tailored to the U.S. environment for small and large transportation agencies. At the same time, it will be forward thinking when evaluating current approaches in anticipation of technological advances, such as connected and autonomous vehicles, and the use of automated speed enforcement. In addition, it will identify and document implementation challenges inherent in the transportation safety culture and practice. At the same time, it will seek remedies to overcome the challenges and barriers.

To achieve the goal of zero deaths and serious injuries in the United States, agencies will need to modify processes for identifying, developing, and completing roadway projects. This research supports the AASHTO Strategic Plan for the Committee on Safety Goal 1, Strategy 1.1, “Lead in the Implementation of Toward Zero Deaths: A National Strategy on Highway Safety.” In an ideal world, any project concept would include elements related to context, evaluation of operations, safety, human factors, public health, and equity as part of a safe transportation system. Each iteration of the project from planning through final design, and operation would depend on this multiple lens approach. The following Safe System approach questions will be investigated:

1. What is a Safe System approach in the context of developing a transportation project and how does it differ from the current project development process?
2. What do Safe System countries (e.g. Sweden, Netherlands, and Australia) use in terms of plans, planning processes, guidelines, and policy constraints on roadway

designers and operators, approaches to design standards, and how can they be mapped to current U.S. standards?

3. How can the U.S. planning process more effectively implement a Safe System approach, and how adaptable will it be to future technologies (e.g. autonomous/connected vehicles, transportation-as-a-service, or micromobility)?
4. What are the differences in various contexts (e.g. urban core, general urban, suburban, rural, etc.)?
5. What tools (major design guides, NACTO, guidelines, context sensitive solutions, human factors, PIARC Road Safety Manual) exist today for a Safe System approach in the U.S.; what are the gaps; and what tools are needed in the various processes including concept, planning, data, analysis, design, and construction?
6. How do the Human Factors, Safety Culture, and Public Health sectors fit in the Safe System approach?
7. What public agency policies may need to be changed and what legal challenges exist?
8. What are the research needs associated with a transition?
9. What is the effect of a Safe System approach on freight transit and economic development?
10. What role does mass public transit play in a Safe System approach?

### **Urgency and Potential Benefits**

The tension to operationalize Safe System approaches for use in the project delivery and operational processes for all projects, as well as safety countermeasure application specifically is heightened by the undisputed and alarming increase in traffic related fatalities over the past several years. Indeed, after years of decreases the number of deaths has risen from 32,744 in 2014 to 36,096 fatalities in motor vehicle traffic crashes in 2019. Although this represents a decrease of 739 (down 2%) from the reported 36,835 fatalities in 2018, 36,09632 deaths and many times more serious injuries, is a national tragedy. It's largely predictable and preventable; hence, transportation policies and practices should be aggressively updated to adopt proven effective strategies. Accomplishing the objectives of this research will benefit not only the state DOTs but also the entire population.

This research problem statement is ranked by the Committee on Safety as its top priority for the FY2022 NCHRP program.

### **Implementation Considerations and Supporters**

The Federal and State DOTs will benefit broadly from the research results, e.g., planners, design and traffic engineers, maintenance and construction departments, and especially management and leadership. Implementation leadership will be critical, but the day-to-day implementation tasks are likely to be assigned to planners and design and traffic engineers.

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<sup>32</sup> <https://www.nhtsa.gov/press-releases/2019-fatality-data-traffic-deaths-2020-q2-projections>, accessed on 10/29/20.

At a minimum, implementation of this study will produce broad recommendations on next steps including future research and data needs, outreach materials for widespread publication and presentation of results for transportation professionals, alternative pathway projections based on potential investment, and reasonable time-based goals and performance measures for successful implementation (i.e., percent fatality reduction, percent infrastructure updated, etc.) All of these results would be immediately implementable in terms of taking the initial steps toward full implementation. It might be useful to produce a “how to” manual with explicit instructions for implementation. Often, this type of document can be developed into a workshop which could be pilot tested and used by the DOTs to train current and future employees. In addition, once implementation is underway, “early adopters” could be teamed with other states through peer exchanges.

AASHTO Committees that might be interested in the research results and could support implementation:

- Committee on Safety
- Committee on Design
- Committee on Planning
- Committee on Traffic Engineering

Additionally, the Governors Highway Safety Association should be interested in the research results and could support implementation particularly for states where the DOT and State Highway Safety Office are combined.

### **Recommended Research Funding and Research Period**

The estimated cost of the project is \$550,000.

The estimated research duration is 24 months.

### **Problem Statement Authors**

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### **Others Supporting the Problem Statement**

TRB Committee ACS 10, Stephanie Malinoff, Chair, [malinoff@umn.edu](mailto:malinoff@umn.edu)

TRB Committee AEP 10, Jerri Bohard, Co-Chair, (503) 986-3421,

[Jerri.L.Bohard@odot.state.or.us](mailto:Jerri.L.Bohard@odot.state.or.us); William Frawley Co-Chair, [w-frawley@tamu.edu](mailto:w-frawley@tamu.edu)

TRB Committee AKD 20, Roger Bligh, Chair, (979) 317-2703 x42703, [R-Bligh@tti.tamu.edu](mailto:R-Bligh@tti.tamu.edu)

TRB Committee ACS 20, Kimberly A. Eccles Co-Chair, (919) 334-5601, [keccles@vhb.com](mailto:keccles@vhb.com), [Karen Dixon k-dixon@tamu.edu](mailto:k-dixon@tamu.edu)

TRB Committee AKD 10, Jeffrey Shaw, Co-Chair, jeffrey.shaw@dot.gov, Hermanus Steyn, Co-Chair, hsteyn@kittelton.com

### **Potential Panel Members**

The following AASHTO Committee on Safety members are recommended as potential panel members:

- John Milton, Washington State Department of Transportation, AASHTO Committee on Safety, (360) 704-6363, MiltonJ@wsdot.wa.gov
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- Lora Hollingsworth, Florida Department of Transportation, AASHTO Committee on Safety, (850) 414-4177, lora.Hollingsworth@dot.state.fl.us
- Susan Herbel, (202) 494-5539, susan.b.herbel@gmail.com

### **Person Submitting the Problem Statement**

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### **References**

- Fleisher, A., M. L. Wier and M. Hunter (2016). "A Vision for Transportation Safety: Framework for Identifying Best Practice Strategies to Advance Vision Zero." Transportation Research Record 2582(1): 72-86.
- International Transport Forum. (2008). Towards Zero. Ambitious Road Safety Targets and the Safe System Approach: 241p.
- Marshall, W. E. (2018). "Understanding international road safety disparities: Why is Australia so much safer than the United States?" Accident Analysis & Prevention 111: 251-265.
- NHTSA 2019, 2017 Quick Facts, DOTD HS#812747

For a concise description of the Safe System Approach, please see the following references:

- The ITE Journal Article on Safe System - <https://www.ite.org/pub/?id=8B6264A1-D5A7-1560-D583-D90F54D8DDB9>
- The FHWA Safety Compass Article on Safe System <https://safety.fhwa.dot.gov/newsletter/safetycompass/2020/fall/#s2>

Reviewed By:  
David M. Jared  
djared@nas.edu

Comments

Timely research topic with impressive breadth of support and potential utility. Also has a good schedule to disseminate results within a reasonable timeframe. I'm glad to see Question #8 under the Research Objective, since agencies should have research data on which to base SS implementation decisions. This research, hopefully, should lay a foundation for that to follow.

Review Date:  
1/5/2021

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**FHWA Evaluation of G-02**

Reviewed By: HSA/Chimai Ngo

Comments:

This project would help build more momentum for the Safe System Approach among State DOTs and compliment the work FHWA and ITE have underway. It would also provide practical and tactical directions on Safe System implementation to practitioners nationwide. In particular, some of the questions noted in the RNS are areas where “gaps” remain (Questions 1, 2, 3, and 7). Overall, this would be an excellent project for FHWA to endorse. Suggestions: (1) coordinate with the FHWA/ITE Safe System Strategic Plan that is being developed; (2) add a question regarding a connection to CAV.

Review Date:  
12/18/2020

**American Association of State Highway and Transportation Officials****Special Committee on Research and Innovation****FY2022 NCHRP PROBLEM STATEMENT****Problem Number: 2022–G-03****Problem Title**

Safety Performance for Active Transportation Modes using Exposure Models

**Background**

The need to develop a modally integrated and well-functioning transportation systems is clear. It is in the interest of agencies to provide safe, accessible, and reliable systems for all, including users who walk; bike; and use mobility assistive devices. At the same time, the financial resources for local and state agencies operating these systems are dwindling, and many agencies are having difficulty maintaining their current assets at a state of good repair, let alone funding for new infrastructure. This often leads to projects being built that prioritize motorized vehicle mobility over facilities that move people and advance the use of active transportation modes (walking and biking) as part of accessible, healthy, and connected communities. In addition to funding challenges, facilities that support active transportation modes often receive less priority because the data and decision-making tools are not available to assess the potential safety performance tradeoffs when evaluating alternatives that includes facilities for walking and biking.

This research will investigate a means to assess the safety performance of projects for multiple modes of transportation in the suburban and urban environments. To fully support all modes and to improve the safety and equity of the system, it is critical to develop a method to determine potential use of the system by those who bike, walk and use mobility assisted devices. Counts of people walking and biking are often unavailable in these environments or have not been collected in a manner that is usable for crash prediction or for a comparisons of the needs of all users to support equitable decisions. Because of this lack of information, the benefits and opportunities for active transportation are often overlooked. This research will look at key factors simultaneously to evaluate the safety performance of urban and suburban facilities using characteristics such as speed, roadway width, (lanes/shoulders/medians), sidewalks, bicycle lanes/tracks, land use, network connectivity, and access management. These factors will be used to determine current and future system usage by the active transportation modes if compatible land use, or walkable and bikeable facilities were to be provided. In addition, various design treatments for active users in different contexts will be evaluated using proven exposure prediction methods for active transportation modes to examine how these designs effect the likelihood of crashes.

Exposure models allow organizations to incorporate predictive information into decisions when volume data for those who walk or bike are not available and



organizations do not have the funds to collect data at every location where a project might be developed. Even if data are collected in some locations for individual projects, state and local transportation agencies are unlikely to have sustainable funding available for regularly collecting active transportation volume data, therefore these critical modes lack the necessary data to justify their consideration during project planning and development. This lowers the potential for inclusion of transportation facilities for active transportation modes, particularly in lower income areas where significant gaps for active transportation modes exists. It is intended that this research advance a decision-making framework that considers how best to achieve an integrated multimodal approach on the public roadway system. The proposed research would develop methods for using for exposure volumes that could be used in other tools, such as the models currently under development in NCHRP 17-84, Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual and other systemic safety tools. In addition, this research would develop additional safety performance functions to supplement the NCHRP 17-84 models with additional functional classes and contexts. This proposal is developed with the intent to supplement other ongoing predictive modeling and systemic tools for active transportation.

### **Literature Search Summary**

The proposed research would build on earlier work in related research topics, such as:

Traffic conflicts and exposure

E Hauer - Accident Analysis & Prevention, 1982 - Elsevier

A review of pedestrian safety research in the United States and abroad

BJ Campbell, CV Zegeer, HH Huang, MJ Cynecki - 2003 - [rosap.ntl.bts.gov](http://rosap.ntl.bts.gov)

Pedestrian volume modeling for traffic safety and exposure analysis: The case of Boston, Massachusetts, N Raford, D Ragland - 2006 - [escholarship.org](http://escholarship.org)

The uses of exposure and risk in road safety studies

AS Hakkert, L Braimaister, I Van Schagen - 2002 - [swov.nl](http://swov.nl)

Exposure measurement in bicycle safety analysis: A review of the literature

J Vanparijs, LI Panis, R Meeusen, B de Geus - Accident Analysis & Prevention, 2015 – Elsevier

Systemic Pedestrian Safety Analysis: NCHRP Research Report 893

Thomas L, et al – 2018, Transportation Research Board, Washington DC

### **Research Objective**

The objective of this research is to advance the predictive methodologies for pedestrians and bicyclist by using exposure (e.g., pedestrian any bicyclist volume) prediction. These exposure models can then be used to develop multivariate safety performance functions and systemic analysis tools for use in planning, design and operational decision making. The safety performance functions will address additional

functional classes and contexts to supplement those developed being develop under NCHRP 17-84. This proposed research will develop models and predictive methods that can be used by state and local agency of all sizes to determine potential exposure, which will allow this information to be used determine the likely safety performance at a given location. The multivariate nature of this approach allows for the necessary planning, design, and operational considerations in different combinations and contexts upfront, so the needed information related to potential safety performance can be used in decision making throughout planning and the project development process for the active transportation modes. This research will also develop guidance for determining appropriate considerations and modifications to the public right of way to provide for an equitable system for people biking and walking in a manner that reduces the likelihood of crashes involving these users and the likelihood of death or serious injury of these users in the event of a crash.

The successful completion of this project, at the minimum, will consist of the following tasks:

***Phase I:***

- Task 1 – *Review of the safety literature* to identify the pedestrian exposure factors associated with highway safety.
- Task 2 – *Identify data needs and potential data sources* for developing exposure models and safety prediction models for the identification of appropriate multimodal roadway locations; and development of a data collection plan.
- Task 3 – *Prepare a Phase II work plan* indicating a methodological framework for developing exposure and safety prediction models.
- Task 4 – *Prepare an interim report* documenting the literature review, datasets, and proposed work plan.

***Phase II:***

- Task 5 – *Execute Work Plan* developed in Task 4 and approved by the NCHRP panel.
- Task 6 – *Conduct the statistical analysis (i.e., exposure and safety prediction)* using the proposed methodologies that have been approved by the NCHRP panel.
- Task 7 – *Develop a user-friendly guideline* to facilitate the implementation of research outcomes and how these models can be used to inform multimodal decision making in different design contexts and for different modal priorities. This guide should include discussion of how changes in the road environment may change safety outcomes for all users and how roadway (mitigation) strategies can be applied to address the respective changes.
- Task 8 – *Prepare final deliverables and guidelines* documenting the research

development process (including assumptions), research results, and the guidelines on incorporating exposure factors in safety research. The final set of deliverables should include the research datasets with a data dictionary, and the program code used for the development of any statistical models to support future research and reproducibility of research results.

### **Urgency and Potential Benefits**

The AASHTO Committee on Safety and the TRB Highway Safety Performance Committee have identified this research as a high priority. This research will have a significant influence on how the state DOTs analyze pedestrian and bicyclist accommodations and will provide the ability to make use of additional analytical tools.

This research is ranked priority #3 of 7 by the AASHTO Committee on Safety.

### **Implementation Considerations and Supporters**

Traffic safety and active transportation professionals will use the results of this research. It would be beneficial to provide presentations on the research results at various AASHTO, TRB, and other committee meetings and webinars to raise awareness of the research. A pilot of the research would provide additional potential users with examples of how to use the research.

Organizations with interest in this research include:

AASHTO Committee on Safety

AASHTO Committee on Design

AASHTO Committee on Traffic Engineering

AASHTO Council on Active Transportation

TRB Standing Committee on Highway Safety Performance – ANB25

TRB Standing Committees on Safety Data, Analysis, and Evaluation – ANB20

### **Recommended Research Funding and Research Period**

Recommended Funding: \$700,000

Research Period: 36 months

### **Problem Statement Author(s)**

John Milton, *Washington State DOT*

Ida van Schalkwyk, *Washington State DOT*

### **Others Supporting the Problem Statement**

AASHTO Committee on Safety

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**Potential Panel Members**

Members of the AASHTO Committee on Safety and Highway Safety Manual  
Steering Committee

**Person Submitting the Problem Statement**

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**NCHRP Review of G-03**

Reviewed By:  
David M. Jared  
djared@nas.edu

Comments:

Builds on a broad set of earlier and recent work (e.g., NCHRP 17-84), but I agree that the budget seems too high and that a 2-year duration is preferable.

Review Date:

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**FHWA Evaluation of G-03**

Reviewed By: HSA/Tamara Redmon

Comments:

This problem statement has a lot of promise and should be a priority. There is a great need for safety performance measures for active transportation modes using exposure models. The cost (\$700,000) and the timeframe (3 years) seem a bit much. No more than \$500,000 and 2 years would be adequate for the work proposed.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-03**

Submitted By:

Phillip Burgoyne-Allen

AASHTO Staff

Council on Active Transportation

Priority #: 2

Comments: This research is an important first step towards better integrating transportation and health data into the decision-making process. As the researchers note, this research would help inform guidelines for increasingly important health performance measures, with a particular focus on equity. Agree with feedback from FHWA and NCHRP on the value of focusing on project scoring methodologies and the importance of privacy considerations.

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT**

**Problem Number: 2022–G-04**

**Problem Title**

**Using Big Data and Artificial Intelligence to Streamline Safety Data Analyses**

**Background**

The need to improve road safety performance for all road users is clear, and particularly so as the drive towards a more equitable multimodal system for pedestrians, cyclists and users of newer devices for travel such as electric scooters increases. State and local agencies are beginning to adopt the Safe System approach to design and operation of the roads and highways. This comes at a time where asset decision-making is becoming increasingly difficult in light of limited resources. To maximize the lives saved and injuries reduced takes new approaches to how we evaluate, analyze and diagnose safety problems and this will require advancement of our data analysis tools. Unlocking the broader sustainable safety, health and social benefits that come from active transportation modes also requires an understanding of the safety performance of infrastructure for these active modes. The absence of low-cost data, safety performance metrics and prioritized investment options makes it difficult for local and state agencies to understand the business case for safer roads and to measure progress.

This research will investigate the use of artificial intelligence (AI) and big data to provide the necessary information required to drive key data-driven safety tools including the United States Road Assessment Program (usRAP), AASHTOware Safety Analyst, Interactive Highway Safety Design Model (IHSDM) and other systemic safety tools. Big data analytics is also becoming increasingly used to perform real time crash analytics for high risk roads and intersections. The availability of large-scale and consistently collected data across the entire the road network will improve the visibility of existing network conditions with a focus on road and exposure features influencing the safety of all road users. This low-cost and consistent data can then inform and accelerate the supporting investments needed to provide for Safe System outcomes with a particular focus on modal priority and the needs of pedestrians, cyclists and new-mobility users. With an increasingly automated vehicle fleet the needs of these vulnerable road users to safely operate in the road environment will continue to highlight prioritization for investment that evolves overtime to ensure an efficient and optimal interaction between all road users and connected vehicles. This will require, and benefit from, big data and AI approaches.

The research will build on the artificial intelligence innovations under development globally for Road Assessment Programs in other countries. Ai-RAP captures the advances in artificial intelligence, machine learning, vision systems (street and sky),

LIDAR, telematics and other data sources to deliver critical information on road safety, crash performance, investment prioritization and RAPS's Star Rating of roads for pedestrians, cyclists, motorcyclists and vehicle occupants. The accelerated and intelligent coding of these attributes can provide significant savings and also deliver the scale and frequency of data collection to support comprehensive performance tracking over time.

### **Literature Search Summary**

Limited research exists on applications of big data to roadway safety. Existing research has been primarily related to real time data for mobility purposes. A masters thesis looked at using big data to analyze the link between digital billboards and highway safety. Another study used artificial intelligence to develop safety models for renewal projects and for truck crashes on ramps.

Shi, Q; Abdel-Aty, M., Big Data applications in real-time traffic operation and safety monitoring and improvement on urban expressways, Transportation Research Part C: Emerging Technologies: Volume 58, Part B, Pages 380-394, 2015.

Bodea, T., A big data approach to examining the link between digital billboards and highway safety, <http://hdl.handle.net/10211.3/197867>, California State University, Sacramento, 2017.

Choi, K., Using big data driven machine learning experimentation to modeling mobility and safety disruption of critical renewal project, Construction Engineering and Management, 2018, koreascience.or.kr.

Awad, WH, Janson BN, Prediction Models for Truck Accidents at Freeway Ramps in Washington State Using Regression and Artificial Intelligence Techniques, TRR: Journal of the Transportation Research Board, Volume: 1635 issue: 1, page(s): 30-36, 1998.

### **Research Objective**

The objective of this research is to advance the use of artificial intelligence (e.g. machine learning) and big data in supporting safe system and modal priority decision making and performance tracking. This research will develop the tools and necessary machine learning mechanisms to accelerate the intelligent coding of road attributes that are used in existing data-driven tools such as usRAP, IHSDM, AASHTO Safety Analyst and the Highway Safety Manual. The research will also identify potential data sources that can be used for intelligent data collection including crash data, road user data, video data, telematics, LiDAR, satellite and aerial imagery, in vehicle as well as document each source's coverage and frequency of collection. This combined data will then allow for lower-cost and more frequent generation of key fatality and injury prediction risk maps; road feature mapping; star ratings, safety models and other safety prediction tools for pedestrians, cyclists, motorcyclists and vehicle occupants; source

data for IHSDM, AASHTO Safety Analyst, HSM analyses and the development of safety plans that can be used for funding submissions and in prioritizing investments across the local and state road networks.

The successful completion of this project, at a minimum, will consist of the following tasks:

***Phase I:***

- Task 1 – *Review artificial intelligence and big data literature and state-of-the-art practice* to identify the current progress on accelerated and intelligent coding of road safety features.
- Task 2 – *Identify source data needs and associated coverage and frequency of collection* to define the extent of the US road network that can be serviced by accelerated and intelligent coding of IHSDM, usRAP, AASHTO Safety Analyst and HSM attributes of interest.
- Task 3 – *Prepare a Phase II work plan* indicating a methodological framework for developing the algorithms, machine learning outcomes and compliance of machine coding to relevant standards.
- Task 4 – *Prepare an interim report* documenting the literature review, datasets, and proposed work plan.

***Phase II:***

- Task 5 – *Execute Work Plan* developed in Task 4 and approved by the NCHRP panel.
- Task 6 – *Complete a detailed application and pilot application of the AI and Big Data* approach to generate attribute data required by the usRAP and IHSDM models using the proposed methodologies approved by the NCHRP panel.
- Task 7 – *Complete quality assurance and statistical analysis of compliance* with the established standards for coding the relevant attributes and develop recommendations for wider application.
- Task 8 – *Develop a user-friendly guideline* to facilitate the use of AI and big data by local and state agencies to undertake data-driven analysis and inform usRAP, IHSDM, Safety Analyst, and HSM applications. This guide will also include details on how the data and results can be used by agencies to deliver safe system and modal priority outcomes.
- Task 9 – *Prepare final deliverables and recommendations* documenting the results of pilot assessments and analysis, the availability and frequency of source data, the AI and big data attributes that can be provided within required confidence levels. The deliverable would also include steps for local and state agencies looking to implement accelerated and intelligent data



collection to inform usRAP, IHSDM, Safety Analyst and associated safe system and modal priority outcomes.

### **Implementation Planning**

Transportation agencies continue to struggle with limited and missing data and this research intends to fill gaps currently seen by these agencies. This research will develop standards for structuring data using a format that can be accessed by multiple tools. Further, these structures will be tested through pilot projects to allow for appropriate adjustment and greater understanding. The development of guidelines will increase agency implementation and provide necessary information on the use of this data in safe systems and in determining modal priority needs. Results of this research could be included in national-level resources such as the Highway Safety Manual, AASHTO Safety Analyst, IHSDM, usRAP, and other tools that support data driven safety analysis.

### **Estimate of Problem Funding and Research Period**

Recommended Funding: \$650,000

Research Period: 24 months

### **Urgency and Potential Benefits**

The AASHTO Committee on Safety and the TRB Highway Safety Performance Committee have identified this research as a high priority. Data availability continues to be a challenge for many agencies, and within different modes of transportation. This data challenge is creating a lack of implementation of many data-driven approaches. This research will accelerate application of the Every Day Counts initiatives and other data-driven safety analysis efforts, and will help local and state agencies optimize existing resources to reduce roadway fatalities and support safe system outcomes and the broader sustainable benefits of modal priority. This research would also benefit international initiatives, such as the World Health Organization's Global Road Safety Performance Targets that support the United Nations General Assembly focus on traffic fatalities worldwide. In addition, this research would benefit Vision Zero and Road to Zero Efforts in the US.

The AASHTO Committee on Safety considers this research to be a high priority and ranks it #5 of 7.

### **Person(s) Developing the Problem Statement**

John Milton, *Washington State DOT*  
Rob McInerney, *iRAP*  
Greg Cohen, *Roadway Safety Foundation*

### **Nomination for AASHTO Monitor**

John C. Milton, PhD, PE

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### **Potentially Interested AASHTO Councils and/or Committees**

Committee on Safety  
Committee on Data and Analytics

### **Submitted By**

Steven A. Buckley, P.E.  
State Highway Safety Engineer  
Bureau of Transportation Safety & Technology  
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### **NCHRP Review of G-04**

Reviewed By:  
David M. Jared  
djared@nas.edu

#### Comments:

Timely and worthwhile to explore and possibly confirm the utilization of big data and AI for safety data analyses. Per the AASHTO Committee on Safety's prioritization, this seems like a medium priority topic.

Review Date:  
1/5/2021

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### **FHWA Evaluation of G-04**

Reviewed By: HRDS/Mohamadreza Banihashemi

#### Comments:

Timely overall, as FHWA and USDOT (through the Safety Data Initiative) are considering approaches to overcome some of our data limitations.

1. Need to clarify if the IHSDM means only the Crash Prediction Module (CPM) or all modules of the IHSDM. If CPM only, it should be clarified. Sometimes IHSDM and HSM are used interchangeably when the intent is the CPM of the IHSDM.
2. Consider clarifying the HSM second edition. Will this project start before or after the HSM Edition 2 is available? If HSM2 is available, the work of this project should be based on the HSM2.
3. Big Data discussed here include, but are not limited to, Census Data and other Socioeconomic and Demographic data that are currently available but are not currently used in the HSM, IHSDM, Safety Analyst, and usRAP models. One example of using these data to upgrade/update the existing models used in the HSM, IHSDM, Safety Analyst, and usRAP models is to develop additional Crash Modification Factors (CMFs) that could improve the existing models. This could be mentioned as an example.
4. A more comprehensive approach would be to use these Big Data, plus the existing data being used in the development of the HSM, IHSDM, Safety Analyst, and usRAP models, and design and develop completely new sets of models using AI and Machine Learning in System-level. If this is part of the goal, it should be clarified.

Review Date:  
12/18/2020

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#### **AASHTO Committee Evaluation for G-04**

Submitted By:  
King Gee  
AASHTO Staff  
Knowledge Management

Priority #: 3

Comments: Recommend including Natural Language Processing in Task 1 and a review of data standards, data dictionaries, taxonomies, and metadata in use to support integration in task 2. It would be beneficial for the project to model how business knowledge is represented in rules for AI applications and models.

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022 –G-05**

**Developing multidisciplinary safety strategies from understanding roadway fatality trends during the new millennium.**

**Background**

Traffic fatality trends in the United States in recent years have raised questions concerning how to continue the decline in fatalities experience from 2005 to 2011. NCHRP Project 17-67 (Report 928) successfully identified major contributors to the decline in fatalities during this period. The research indicated that the most significant contributors to the drop in traffic fatalities were the substantial increase in teen and young adult unemployment, decreased alcohol consumption, and reductions in GDP/capita income. Vehicle design improvements also contributed to the decline significantly, as did the decline in rural vehicle-miles traveled (VMT) and increased strictness of DUI laws.

There is a need to more fully explore the relationships identified in Project 17-67 to reveal information that can be used by states to target safety programs and projects. As fatalities have risen since 2011, there is additional information to examine related to factors contributing fatality trends. This information should be examined and strategies to recreate and expand decreasing trends should be developed. Exploration of this data and relationships could create other data sets for consideration such as socioeconomic or regional behavioral opportunities. Achieving safety targets will necessitate the use of multiple types of strategies and programs that aim to reduce traffic fatalities, since there is not a single discipline that is expected to be able to produce the desired reductions in fatalities and serious injuries. The effectiveness of many individual strategies has been studied, but it is not clear the effect a combination of multiple strategies using engineering, enforcement, education, and emergency medical service approaches will have on crashes. This project would allow for the potential creation of strategies and countermeasures that would more intertwine the work of the 4 E's.

**Literature Search Summary**

Research has been performed on the factors affecting traffic fatalities; the effectiveness of specific safety strategies; and on methods to evaluate infrastructure and behavioral countermeasures.

- NCHRP Report 928 (NCHRP 17-67), *Identification of Factors Contributing to the Decline of Traffic Fatalities in the United States from 2008 to 2012*
- State-specific studies of fatality trends and changes in travel, such as the UC Davis Road Ecology Center Special Report on COVID19 Impacts on California Traffic Accidents

([https://roadecology.ucdavis.edu/files/content/projects/COVID\\_CHIPs\\_Impacts.pdf](https://roadecology.ucdavis.edu/files/content/projects/COVID_CHIPs_Impacts.pdf))

- NCHRP project 17-63, *Guidance for the Development and Application of Crash Modification Factors*

## **Research Objective**

The objective of this project is to develop multidisciplinary strategies for making significant reductions in traffic fatalities through the investigation of the quantitative impact of combined behavioral, infrastructure, and or other mitigation strategies. The first phase of the project would build on earlier research and use experiences and knowledge gained from recent trends to determine the effectiveness of external factors as well as combined countermeasures in previous mitigations. The research will consider specific geographic, temporal and/or functional areas of the highway system. The second phase will be to develop guidance for identifying and customizing specific combined mitigations for individual jurisdictions, regions, or states.

## **Research Tasks**

1. Update the change and count models to reflect data available since the 17-67 project ended (2012 to the latest data year available) and complete a validity test of the previous 17-67 model.
2. Identify new parameters for which comprehensive data is available on a state-by-state basis to see if the 17-67 model performance can be improved.
3. Determine if the factors that account for differences between states can be identified, and whether certain characteristics are associated with states with better-than and worse-than average results can identified.
4. Develop separate models for rural and urban, single-vehicle, vehicle-vehicle, pedestrian, and motorcycle crashes and stratify by age groups and gender. Consider other stratifications that might improve the understanding of fatalities
5. Further explore the relationship of infrastructure improvements, behavioral countermeasures, and safety project/program funding on fatalities using GIS linkage to fatality locations and any other available data.
6. Explore if the mechanisms by which economic factors such as unemployment and income affect traffic fatality risk. Explore socio-economic factors in fatal crashes.
7. Review the relationship of all crashes, Non-injury, injury, and fatal crashes in a sample of states where comprehensive crash data is available. Explore crash severity and crash occurrence trends.
8. Develop methods to model future safety scenarios for each state, including what-if scenarios for safety programs and funding.
9. Develop safety strategies for making significant reductions in traffic fatalities based on the identified relationship of factors to fatalities and a revised model.
10. Produce guidance to assist State and local agencies with implementation of the safety strategies developed through this research.

### **Urgency and Potential Benefits**

A more detailed understanding of data from individual states and data related to individual crash types and contributing factors will allow safety professionals to more aggressively use the strategies that have worked, and to identify new strategies to fill gaps in the tool box. A better understanding of economic and social factors will contribute to the development of programs to change traffic safety culture. In addition, the changes in travel due to the 2020 pandemic and related economic changes may have an effect on fatalities, and an analysis of related data can add to the knowledge regarding potential “4E” and traffic safety culture strategies that would help maintain and continue fatality reductions.

This research would help safety professionals more fully understand the relationships between economic, regulatory, vehicle, and infrastructure factors and traffic fatalities and the mechanisms by which they operate to provide states with insights that can be used to target fatality reduction programs and projects. Moreover, strategies that combine domains will be important for using state resources efficiently to maximize fatality reductions.

This research is ranked priority #4 of 7 by the AASHTO Committee on Safety.

### **Implementation Considerations and Supporters**

There are several potential users of this research, namely state DOT traffic and safety engineers as well as State Governor’s offices of Highway Safety. Michigan, Texas, and Virginia have already used the 17-67 research to enhance their respective safety performance initiatives. The research could have direct application to state implementation of the Federal Highway Safety Improvement Program (HSIP), enhanced safety performance target development, and future safety funding requests. The results of the research could be disseminated through several different methods such as:

- Technical pamphlets that could be distributed to State DOT’s but more importantly local government/tribal lands officials that may be less familiar with multidisciplinary tactics to lower crashes in their community. This information would also be distributed the 4 E’s during a training at a Governor’s Highway Safety Alliance (GHSA) session or thru Traffic Incident Management training.
- State workshops (virtual or in person upon request) where state DOT staff are introduced to the material along with the state LTAP staff. Later, LTAP staff could use the workshop training to introduce the material to local government officials also, sessions at the state highway safety conference could reach police and fire staff.
- Presentations at GHSA, National Association of Counties Conferences (NACE), and state highway safety conferences.

- A website resource, such as the AASHTO towardzerodeaths.org site, that could be available to all parties for reference and consume.
- The pilot testing of the updated 17-67 model could benefit the pilot states and continue to strengthen the research.
- Research results should be presented in a final report that gives clear and actionable strategies to state DOTs and other agencies to strategically combine countermeasures.

The AASHTO Committee on Safety is interested in this research and will assist the member states with implementation. The Governors Highway Safety Association is also a potential avenue for distribution of the research findings.

### **Recommended Research Funding and Research Period**

Research Funding: A proposed budget of \$500,000 would be necessary to complete the research tasks with an additional \$100,000 to complete communication activities, such as technical presentations and training development

Research Period: The expected time-period to complete the research is 18 months with an additional 12 months for communication and implementation activities.

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Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

Comments:

The proposed project would build on a previous project which conducted an analysis of the decline in roadway fatality and subsequent causes between 2005 and 2011, and consider a multifaceted approach for individual states to consider in replicating the downward trend in fatalities in future years. DOTs are certainly interested in achieving



reduced fatalities in their states and the research conducted under this proposed project would help tailor plans for doing so to individual states, versus a nationwide one-size-fits-all approach. However, this is a very complicated problem to solve, and while updated data and models, as well as resulting guidance regarding state-level multi-faceted approaches, could be useful in informing decision-makers, there are a significant number of hurdles to programmatic implementation. The events of this year (pandemic, etc.) should also be considered in this research, however, the data may not exist yet and/or may not be available. There are a considerable number of unknowns for this project including data availability and exploration of relationships that may or may not exist, and an incrementally funded, phased approach should be considered. If significant data and relationships exist, however, then the scope is reasonable and the \$500,000 budget and timeline seem appropriate for the scope, not including the additional \$100,000 suggested for implementation activities.

1/5/2021

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## **FHWA Evaluation of G-05**

Reviewed By: HRDS/James Pol

Comments:

It would be useful to consider the counterintuitive effects that COVID has had on fatalities in the US. Understanding the impacts of the co-factors and the efficacy of the various 4E driven countermeasure can help states to establish performance measures that better reflect reality. Understanding how the 17-67 model breaks down after 2012 will help with developing realistic strategies.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-05**

Submitted By:  
Jameelah Hayes  
AASHTO Staff  
Committee on Traffic Engineering

Priority #: N/A

Comments: The Committee on Traffic Engineering supports this research. Since it is an update to NCHRP 17-67, it would help states establish their annual targets.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER**

**2022–G-06**

**PROBLEM TITLE**

Improving Bicyclist and Pedestrian Safety Using Perceived Risk and Surrogate Safety Measures

**RESEARCH PROBLEM STATEMENT**

Recent upward trends in pedestrian and bicyclist fatalities (6,283 and 857 in 2018, respectively) indicate an urgent need to better understand how to identify and address high-risk situations and locations for people walking and bicycling (GHSA, 2019; NHTSA, 2019). The existing literature suggests that in recent years the number of people bicycling and walking has been increasing. Early in 2020, these numbers have significantly increased due to the COVID-19 pandemic and subsequent social distancing orders, indicating that the safety concerns of vulnerable roadway users will continue to increase in the coming years.

Traditional methods used to identify and improve the locations prone to bicyclist and pedestrian crashes rely on historical crash data. Relying on crash data to identify problems is reactive and inherently problematic, given that crash data involving vulnerable users are known to be underreported, particularly for less serious injuries. Even serious injuries have been found to be misclassified to a high degree (SFDPH, 2017). Hence the Highway Safety Manual (HSM) suggests using a systemic safety approach to select the sites for improving bicyclist and pedestrian safety. The systemic approach aims to be proactive but depends on historical crash data, in that the roadway design characteristics subject to safety improvement under the systemic safety approach are determined using historical crash data. One way to enhance the systemic approach is to begin to incorporate surrogate safety measures (SMoS) into safety analysis. Surrogate safety measures such as Time to Collision (TTC) or Post Encroachment Time (PET) reflect conflicts – near-crashes – that occur between users and can be categorized by type and severity. The NCHRP project 17-86 aims to provide guidance regarding using these surrogate measures to provide insights into the potential for various countermeasures to address crashes and crash types, alleviating the need to wait for crashes –and injuries or deaths – to occur before improvements can be made.

However, a key aspect of pedestrian and bicyclist safety – perceived safety – goes uninvestigated in NCHRP 17-86. Perceptions of safety are far more influential for route and mode choice for pedestrians and bicyclists than for motorists, affecting pedestrian and bicyclist exposure (i.e., traffic volume) through both the presence and absence (i.e.,

latent demand) of people walking and bicycling. Exposure is one of the most important factors affecting the safety and planning decisions of transportation and planning agencies, yet the perceptions of vulnerable roadway users have routinely been ignored in transportation planning and safety modeling efforts because they are not systematically captured in data. Research has found that near conflicts are significantly associated with perceived safety for vulnerable users (Sanders, 2015), suggesting the potential to use surrogate measures to estimate perceived safety without conducting a resource- and time-intensive survey of roadway users. Once surrogate measures are mapped to safety perceptions, safety performance functions (SPFs) estimated based on surrogate data can be used to map network-wide (i.e., macro-level) perceived safety for pedestrians and bicyclists in a much more parsimonious manner. These network-wide values will then substantially increase the likelihood that such perceptions will be used in planning and engineering efforts in cities, suburban areas, and rural areas, and lead to more representative results in the process.

## **LITERATURE SUMMARY**

Various methods have been developed to obtain SMOs, the best known being traffic conflict techniques dating back to the late 1960s. They broadly rely on the collection of traffic conflicts and their characterization in terms of severity or closeness to a potential crash. Various indicators, subjective and objective, related to speed, spatial and temporal proximity such as TTC have been proposed and are used in SMOs studies. While the bulk of road safety research, including using SMOs, focuses in motorized traffic, SMOs have also been applied to study the safety of vulnerable road users, in particular to the safety of countermeasures and dedicated facilities like cycling facilities and crosswalks.

Recent advances in the automated computation of video data provide an opportunity to examine and map the relationship between conflicts, SMOs, and perceptions of safety at a broad scale, which can help supplement and improve traditional crash-based safety analysis. Theoretically, the propensity of conflicts can be mapped by type and severity to the propensity of different crash types and injury severities. For example, an intersection with many right-turning conflicts would be expected to have more right-turning crashes than an intersection with fewer right-turning conflicts, *ceteris paribus*, and these proportions of crashes and conflicts may map to one another in a reliable way depending on other measurable factors. Similarly, an intersection with higher numbers of conflicts would be expected to be perceived as less safe than an intersection with lower numbers of conflicts, *ceteris paribus*. The ability to reliably use surrogates to supplement crash data could be particularly important for analyses that would otherwise rely on smaller numbers of crashes.

A review of SMOs found that “various indicators and their combinations can reflect different aspects of any traffic event”, but that “no existing indicator seems to capture all aspects” (Johnsson et al, 2018). Using macro models, NCHRP project 17-81 found that conceptual factors such as VMT (block group level), median income, demographics, transit stop density and commuting were among such indicators. At the same time, even this conclusion is fraught, given the difficulty of comparing studies that use different

methods to observe and validate the data, as well as different sample sizes for gathering data. This research will build on and supplement findings from NCHRP projects 17-84, 17-86, 15-73, 15-74, and 15-81.

## **RESEARCH OBJECTIVE**

The objective of the proposed research is to build on various research efforts such as NCHRP 17-86, NCHRP 07-25, as well as FHWA technical reports such as Safe Systems Approach to Intersection Planning and Design, and Pedestrian and Bicyclist Intersection Safety Indices to quantify the relationship between surrogate safety measures and perceived safety for pedestrians and bicyclists at intersections. The results of this research could inform safety analyses and modeling, planning, and design for non-motorized roadway user safety. To accomplish these aims, this research must:

1. Conduct a broad, multi-city study that quantifies the relationships between data on perceptions of walking and bicycling safety (specifically, crossing the street) and surrogate safety measures.
2. Develop a methodology (e.g., models, adjustment factors) that practitioners can use to estimate perceived risk based on surrogate measures.
3. Clarify how the adjustment factors can be used to supplement the USRAP/IRAP methodologies.
4. Provide guidance on using surrogate measures and perceptions of safety in safety performance functions, before-and-after studies, and cross-sectional analysis.
5. Build a foundation for incorporating surrogate-based adjustment factors into the Highway Safety Manual.

## **ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

This research would likely require funding of \$500,000 and require 24 months to execute the technical research.

## **URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

In recent months city and state transportation and planning agencies have been trying to re-purposes the streets to make them usable for various types of roadway users. Furthermore, improved safety analysis techniques are critically important in the face of increasing numbers of pedestrian and bicyclist fatalities over the last six years. The proposed research is a high priority for improving the safety and mobility of an increasing number of bicyclists and pedestrians. This research would be applicable to state and local departments of transportation and all consultants working with safety data on site-specific and network projects. The results of the research project will be incorporated into various AASHTO publications such as the HSM, Green Book, Guide for Bicycle Facilities, etc.

The AASHTO Committee on Safety ranks this project #6 of 7.

## **PERSON(S) DEVELOPING THE PROBLEM**

This research statement was developed by:

- ACH20: Standing Committee on Bicycle Transportation
  - Rebecca Sanders, Arizona State University/Safe Streets Research & Consulting
  - Bahar Dadashova, Texas A&M Transportation Institute
- ACH10: Standing Committee on Pedestrians
  - Nick Ferencheck, University of New Mexico
  - Sirisha Kothuri, Portland State University (PSU)
- ACS20: Safety Performance and Analysis Committee
  - Nicolas Saunier, Polytechnique Montréal
  - R.J. Porter, VHB
- Nick Foster, Kittleson Assoc.
- Matthew Ridgeway, Fehr and Peers
- Darren Torbic, Texas A&M Transportation Institute

## **PROBLEM MONITOR**

To be assigned by AASHTO Safety Committee.

## **DATE AND SUBMITTED BY**

Date: November 13, 2020

Submitted by:

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## **REFERENCED LITERATURE**

1. Governors Highway Safety Association (GHSA). (2020). *Pedestrian Traffic Fatalities by State: 2019 Preliminary Data*, Spotlight on Highway Safety. Accessed July 1, 2020: <https://www.ghsa.org/resources/Pedestrians20>.
2. National Highway Traffic Safety Administration (NHTSA). (2019). Traffic Safety Facts, 2018 Fatal Motor Vehicle Crashes: Overview, DOT HS 812 826. Accessed September 1, 2020: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812826>.
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collision experiences. *Accident Analysis and Prevention*, 75, 26-34. DOI: 10.1016/j.aap.2014.11.004

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## **NCHRP Review of G-06**

### Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

### Comments:

This problem statement is very clear and well thought out, however it will be important to gauge the interest of DOTs regarding necessity of this additional information and the ability to include this information in the decision-making process at the state level. The research proposed will add to the body of knowledge of pedestrian and bicyclist safety and the results will be useful in safety planning and roadway design. The objective is clear and the budget and timeline are reasonable for the work.

### Review Date:

1/5/2021

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## **FHWA Evaluation of G-06**

### Reviewed By: HSA/Tamara Redmon

### Comments:

This is an important project. As the problem statement authors state, crashes involving pedestrians and bicyclists are rather rare events and probably highly underreported, and it is difficult to use crash data to narrow down what facilities need improvement. The combination of using Systemic Safety Evals with surrogate data is good. The statement is well thought out and the objective, cost, and timeframe are very reasonable.

### Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for G-06**

Submitted By:

Phillip Burgoyne-Allen

AASHTO Staff

Council on Active Transportation

Priority #: 1

Comments: Pedestrian & bicyclist safety improvement is a critical issue nationwide. Current process of using historic crash data is ineffective to identify need for remediation and not applicable in many cases when crash data is not available or for a new location project. Seems like with this research, we can gain understandings into how surrogate safety measure (SSM) can be utilized for pedestrian and bicyclist safety. This research includes development of models. It will be helpful if this research also can include development of a software tool for deriving surrogate safety measures for pedestrian & bicyclist from data output by these models.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022–G-07**

**Problem Title**

**Enhancement of Roadside Design Features Safety Performance Models for the Highway Safety Manual**

**Background**

The AASHTO Highway Safety Manual (HSM) is a tool that allows safety practitioners to fully and quantitatively consider safety in project decisions. The first edition of the HSM (HSM1) provides a method for considering roadside conditions in analyses of two-lane facilities that is based on a qualitative and visual index. The user selects a factor, called a Roadside Hazard Rating (RHR), using a series of photographs and descriptions to represent the roadside on the existing or proposed facility undergoing analysis. This rating is used in a limited number of safety performance functions (SPF) and/or crash modification factors (CMF) to account for roadside features on two-lane rural roads in crash predictions. Roadside information is limited to only side-slopes on undivided multi-lane roadways and is not incorporated into analyses for other multi-lane divided facility types addressed in the HSM1.

Since publication of the HSM1 in 2010 there has been research to fill in the knowledge gaps in the associated safety performance models and those used in the Roadside Design Guide (RDG) for roadside features. NCHRP Project 17-54, Consideration of Roadside Features in the Highway Safety Manual, developed models to quantitatively consider the roadside in safety analyses. Upon completion of this work, the AASHTO Highway Safety Manual Steering Committee, TRB Committee on Safety Performance, and others reviewed the research results and draft chapter proposed for the second edition of the HSM (HSM2) that is currently being developed.

Because the NCHRP 17-54 models were of a different form than the existing HSM1 models, using exposure versus predictive models, the AASHTO HSM Steering Committee undertook a demonstration project to determine the ability to use the models in the HSM context. In a separate effort, the NCHRP 17-54 results were reviewed by the NCHRP Project 17-82, Proposed Guidance for Fixed Objects in the Roadside Design Guide. This analysis was also considered by the AASHTO committee. The TRB Committee on Highway Safety Performance also provided input to AASHTO on these analyses, and all of the analyses were discussed with the panel for NCHRP Project 17-71, Proposed AASHTO Highway Safety Manual, Second Edition. In summary:

- The NCHRP 17-54 findings for SPF and CMFs could not be validated by small sample testing by several states in the AASHTO HSM Steering Committee. Of particular concern was the shape (reduced road departure crash rates) of the SPF at higher volumes, and the associated effects of roadside fixed objects and their offsets to the travelway. A memo on the findings was prepared on behalf of the Steering Committee that proposed some possible improvements. Review of the fixed object CMFs by the NCHRP 17-82 team working on the RDG made similar conclusions.
- To try to overcome the 17-54 findings, the HSM steering committee recommended to NCHRP to allow the team for NCHRP Project 17-72, Update of Crash Modification Factors for the Highway Safety Manual, to perform an additional task to review the NCHRP 17-54 results and the results of the AASHTO analysis to determine if data from NCHRP 17-54 and other sources could be used to develop an alternative roadside CMF (this was funded through an off-cycle request for continuation funds). Rather than use the data and findings, an optional method was proposed using other data sources that correlated well with the RHR. Several states again tested the models and some states had results that over predicted crashes and some states had results that under predicted crashes, which also happens with models published in the existing HSM. However, in comparison to HSM1 existing methods, it was found that the increased level of effort to use the NCHRP 17-72 roadside method led to results that were approximately as accurate as the more qualitative but less data-intensive method already in the HSM1, since the CMF was calibrated to correlate with the RHR. The result would indicate a continued need for additional method improvement.
- The results of these demonstration tests, while limited in number and scope, along with the analysis of the NCHRP 17-54 research results, have highlighted the need to collect additional data and validate proposed models, and to determine whether improvements are needed for the roadside-related crash prediction tools proposed for future editions of the HSM. If new data are available or readily collectable, then the model improvements could be performed. The same validation and model development would also benefit the existing and future efforts to develop a performance-based Roadside Design Guide.

### **Literature Search Summary**

The proposed research will build upon the recent research referenced in the background section as well as related research conducted by NCHRP and FHWA on collecting roadside design element data and determining safety performance. Related efforts include:

- NCHRP 17-54 Draft Final Report – Consideration of Roadside Features in the Highway Safety Manual
- NCHRP 17-72 Task 8E – Development of CMF for Roadside Characteristics

- FHWA Report (to be published) on Developing Crash Modification Factors for Guardrails, Poles, and Side Slopes Improvements
- AASHTO Steering Committee memoranda on the NCHRP 17-54 and NCHRP 17-72 demonstration and analyses.
- Several roadside element-related CMFs research published in the FHWA Clearinghouse.

Ongoing research in subject area that may provide additional data and methods to validate:

- NCHRP 17-82 Proposed Guidance for Fixed Objects in the Roadside Design Guide
- NCHRP 16-05 Guidelines for Cost-Effective Safety Treatments of Roadside Ditches
- NCHRP 15-65 Development of Safety Performance Based Guidelines for the Roadside Design Guide
- NCHRP 17-55 Guidelines for Slope Traversability

### **Research Objective**

This research will validate and/or develop enhanced roadside safety performance functions (SPF) including associated design element variables that are appropriate for inclusion in the Highway Safety Manual. Appropriate draft text for AASHTO to consider including in appropriate HSM chapters will be prepared. The work will include a review of available roadway and roadside design element inventory and associated crash data. Both the roadway departure safety performance functions and related crash modification factors or functions (CMF) for design elements will be provided for the roadway facility types prioritized by AASHTO members based on available or collected data.

This project will be conducted in two phases.

#### **Phase I Tasks:**

- 1) Conduct a review of recent roadside-related safety research, including data used, analyses performed, and reports or guidance developed, to determine if data exist to validate the recent safety performance research findings and/or develop refined SPFs and CMFs. If additional roadway data are needed, then data collection methods will be proposed for Phase 2.
- 2) Design and conduct a practitioner's survey to determine the critical roadway facility types that require more detailed models for roadside elements (e.g., rural two-lane versus urban multi-lane) and validate those types based on the findings and proposals from step 1.
- 3) Develop draft work plan to include scope of:
  - a. Validation and/or development of new SPFs and CMFs
  - b. Validation of relationship between the HSM and RDG methods and the data collection required.
  - c. Develop design for: data collection, statistical methodology selections, analysis work, and reporting.

Approval of this step 3 is required for data collection effort and for determination of potential success for approving Phase 2.

- 4) Collect data, select methodologies, and analysis approach. Produce a technical memo on potential risks, recommended solutions, possible modification to technical work plan and scope, and cost of recommended work plan.
- 5) Develop final work plan using the step 4 technical memo feedback. Approval of Phase 1 work plan is required to advance to and for productive completion of Phase 2.

#### Phase II Tasks:

- 1) Prioritize the selected the selected facility types (Phase 1, Step 2) and conduct feasibility analysis per final work plan outcome. Further data collections may be warranted per the feasibility analysis.
- 2) Conduct data analysis to develop and validate SPF and CMFs for inclusion in the HSM
- 3) Produce a technical memo for SPFs and CMFs development outcomes including identifying risks/needs/opportunities.
- 4) Use Step 3 memo to produce:
  - a. Final report with recommended SPFs and CMF and associated updated language (text) for inclusion in the HSM.
  - b. Application spreadsheet to conduct the safety analysis and a reference guide for training materials for users understanding in selecting roadside models in conjunction with other HSM models.
  - c. Recommendations/ research problem statements for continuing and complementing the findings.
  - d. Document data for future use.

### **Urgency and Potential Benefits**

Roadway departure crashes are a significant portion of fatal and serious injury crashes. States, their partners and stakeholders are making design tradeoff decisions with limited and outdated methods addressing roadside safety in the HSM. Further, there is the need to quantify the safety performance of design details that presently cannot be provided, especially for waivers and exceptions to the “Green Book” or state standards. Although there has been research intended to improve our quantitative methods and was intended for inclusion in the HSM2, the proposed methods need to be further validated or enhanced/refined to provide satisfactory and defensible results. Since improved information will not be available in the HSM2, it is critical that this research is performed and accessible as soon as possible.

Given potential liability, asset management and cost implications of making roadside design decisions, more detailed considerations, confirmation of the safety performance outcomes, and consistency of methods is critically needed for alternatives analysis using the HSM.

Benefits of improved roadside safety performance will include: prioritizing and programming projects with the best return on the investment (based on SPFs and/or CMFs); project alternative analysis and final design safety performance based decisions; cost effective design waiver and exception decision-making. With many states experiencing 50 percent or more of their traffic fatalities and serious injuries from roadway departure, using our limited resources using data and context sensitive driven decisions will promote a safety system approach to reducing those severe crash outcomes. Further, placing unnecessary safety hardware assets can have implications to the environment and active transportation modes.

This research is ranked the second highest priority (of 7) by the AASHTO Committee on Safety.

### **Implementation Considerations and Supporters**

The AASHTO HSM2 Steering Committee, TRB Committee on Safety Performance Analysis, and the AASHTO Technical Committee on Roadside Safety (TCRS) have held discussions on the implementation of the NCHRP 17-54 results, as well as the work done by the NCHRP 17-72 research team on an alternative method for considering roadside. This topic was extensively discussed by the earlier NCHRP 17-71 panel. A key issue is the need to provide guidance to HSM users not only on the use of the roadside models but also on interpretation of results in conjunction with results from other models in the HSM. It is critical that, as the TCRS leads the updates to the RDG and associated tools, there is involvement in this research for coordination and collaboration to bring the best consistency feasible to the results of the HSM and RDG methods results.

NCHRP Project 17-83, Briefings and Training Materials for Implementation of the Highway Safety Manual Second Edition, will be the key resource for implementing the HSM2. Materials developed under NCHRP 17-83 will likely be the source for training materials to update to include results of the proposed research.

AASHTO committees, TRB committees, and the Federal Highway Administration will be the primary supports of implementing this research. The results of this research would be intended for publication in a future edition of the Highway Safety Manual, and results may also be applicable to a future edition of the Roadside Design Guide.

### **Recommended Research Funding and Research Period**

Research Funding: \$500,000

Research Period: 30 months

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

This research is supported by the AASHTO Committee on Safety, Technical Committee on Roadside Safety, and Committee on Design. TRB committees, including the Committee on Safety Performance Analysis and Committee on Roadside Safety Design are also supporters of this research.

### **Potential Panel Members**

Members of the AASHTO Committee on Safety and HSM 2 Steering Committee  
Members of AASHTO Technical Committee on Roadside Safety  
FHWA Safety Research and Resource Center Staff

### **Person Submitting the Problem Statement**

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Subcommittee

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### **NCHRP Review of G-07**

Reviewed By:  
B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. Better CMFs for roadside features will enable more cost effective designs for numerous projects.

Review Date:  
12/21/2020

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### **FHWA Evaluation of G-07**

Reviewed By: HRDS/Clayton Chen

Comments:

This is a critical gap with focus on addressing the methodological consistency challenges of Safety Performance Models by roadside features for the Highway Safety Manual. Its proposed outcomes are expected to resolve concerns raised by the AASHTO HSM Steering Committee and can provide needed guidance to the practitioners.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for G-07**

Submitted By:  
Jameelah Hayes  
AASHTO Staff  
Committee on Traffic Engineering

Priority #: N/A

Comments: The Committee on Traffic Engineering supports this research. States can use this information when they try and address lane departure crashes which continue to be a top safety focus areas.

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER**

**2022-G-08**

**PROBLEM TITLE**

Cloud Computing and Software as a Service Solutions for Traffic Management Systems

**RESEARCH PROBLEM STATEMENT**

The growth of cloud computing is changing how business and government think about technology solutions. Cloud computing refers to the delivery of and on-demand access to computing services via the internet. These services include physical and virtual servers, applications, networking, communications, data storage, and analytics. Cloud computing service providers offer reliable, scalable, and secure computing options that eliminate the need for users to purchase, setup, deploy, and maintain physical computing resources.

Cloud computing services may be summarized into three types of services

- Web-Hosted: Applications are hosted on dedicated servers in an agency or vendor data center.
- Cloud-Hosted: Unlike web hosting that uses dedicated machines in a single data center, cloud-hosting uses a shared platform of machines. Applications are distributed across multiple machines and exist in a “virtual environment”. Cloud hosting can be “public” with shared hosting with other accounts and applications or “private” with dedicated infrastructure for the account and its applications.
- Cloud-Based: In contrast to hosting licensed applications in the cloud, cloud-based software refers to a “pay to use” approach to software access. Users pay a monthly enterprise fee or a “per-seat” fee to use the software. These software-as-a-service (SaaS) applications specifically designed for cloud computing environments (e.g., Microsoft Azure or Amazon Web Services). Cloud-based applications are often multi-tenant where several clients share one common platform. Examples of cloud-based solutions include Microsoft 365 and Salesforce.

Traditionally, Traffic Management Systems (TMS) have been hosted on-premise, typically at a Traffic Management Center (TMC). Agencies are granted a license(s), most commonly a perpetual license, to the TMS application which is then installed locally. These licensed systems require dedicated hardware and hands-on operations and maintenance by the agency’s Information Technology (IT) staff and/or by the TMS vendor.



In recent years, many transportation agencies have embraced the use of cloud-hosted applications and vendors have brought to market new cloud-hosted and cloud-based TMS offerings including freeway and arterial advanced traffic management systems (ATMS), automated traffic signal performance measures (ATSPM), traffic incident forecasting and prediction systems, video analytics tools, decision support systems, and performance monitoring/business intelligence tools. As a result, agencies are rethinking the need to acquire and manage licensed software and provide hands on support for application deployment, operations, and maintenance.

The purpose of this project is to conduct a state of the industry assessment and develop a primer and guidebook based on lessons learned and best practices for cloud computing for TMS. This project will explore the changing landscape that is moving TMS deployments to the cloud and evolving capabilities of agencies and the private sector to plan, design, implement, and maintain cloud-hosted TMS. The opportunities and challenges with this transition will be discussed and lessons learned from early adopters will be highlighted including:

- Changing roles, policies, and standards of agency IT departments and their role in deploying and maintaining TMS.
- Security and access issues when integrating devices and systems inside an agency's network to cloud-hosted platforms.
- Nimble deployment of cloud-hosted solutions with agile development processes.
- Identifying future TMS needs and requirements and the proper role of cloud computing and SaaS solutions.
- New procurement models and approaches.
- Agency resourcing, knowledge, and skills.

The project will also examine the readiness of the vendor community to support remote hosting solutions. The majority of current TMS were developed for on-premises deployments and virtualized dedicated servers. The real benefit and efficiency of moving to the cloud is to take advantage of the cloud computing architecture, which will result in lower-cost TMS solutions that offer better reliability and scalability than legacy offerings.

## **LITERATURE SEARCH SUMMARY**

Many of the scholarly articles and guides within the transportation industry are specific to big data, data management, and specific data sources (e.g., connected vehicles) but do not address the specific needs for the use of cloud computing and SaaS for traffic management. Research over the past 10 years has proposed several models for cloud computing for urban traffic management. Additionally, there are many articles and presentations on using cloud computing for connected vehicle data, asset management, and freight logistics.

Recently, several agencies have requested cloud computing and SaaS solutions for various TMS, to include ATSPM, ATMS, Traffic Incident Prediction, and Decision Support Systems. For example, ATSPM projects have begun across the country. Several

vendors have begun to develop cloud computing-based solutions, which agencies have begun to utilize; however, there is no guidance to assist these agencies in determining the key procurement approaches, requirements, and specifications needed for these types of services.

## **RESEARCH OBJECTIVE**

The objectives of this research are to:

- (1) Synthesize the state of the practice and lessons learned from agencies using cloud-hosted TMS.
- (2) Create a primer on cloud computing and remote hosted solutions to support TMS.
- (3) Provide a framework for agencies to evaluate their readiness to use and support hosted solutions including resourcing needs, skills, and training.
- (4) Identify the readiness of industry to provide cost-effective TMS tools that optimize the use of cloud computing.
- (5) Develop guidance to address the challenges that agencies may face when migrating systems to the cloud including policies, security, IT, procurement, systems and data integration, real-time operations, disaster recovery, and maintenance.

This research will require the following tasks.

### **Task 1: Primer on Cloud Computing and SaaS for TMS**

This task will develop a primer on cloud computing and hosted solutions including defining the different hosting options, architectures supported by the different options, and advantages and disadvantages of each option including, but not limited to latency, flexibility, reliability, scalability, and security. In addition, the primer should explain different service offerings and pricing considerations for different hosting approaches.

### **Task 2: Synthesis of the State of the Practice of Industry and Agency Readiness and Capabilities**

This task will survey representatives from transportation agencies and industry stakeholders to assess capabilities and readiness to offer and support cloud-hosted and/or SaaS-based TMS.

- Agency survey will include state DOTs, tolling authorities, and local/regional agencies who operate and maintain TMS. This survey will explore the institutional, operational, and technical challenges and barriers of migrating from on-premises hosted TMS to cloud computing solutions. The survey should identify how agencies perceive and understand cloud computing, their capability maturity to plan, procure, implement, and operate such systems, solutions for overcoming barriers, lessons learned, and opportunities. The survey will also identify changing roles and responsibilities as it relates to agency IT staffing, policies, and standards.
- Industry survey will include freeway and arterial-based TMS providers to determine how cloud-ready the solutions are and the readiness of vendors to deploy and support hosted solutions. Perceived advantages and

disadvantages as technology moves from on-premises hosting to cloud hosting.

**Task 3: Develop Guidebook on Cloud Computing and SaaS for TMS**

This task will develop a guidebook to assist practitioners in adopting cloud-hosted and/or SaaS-based TMS. The document will include best practices and lessons learned including advice on how to overcome institutional, operational, and technical barriers. The document will provide guidance for the planning, design, procurement, deployment, and operations of cloud hosted solutions. The document will also support the business case for switching from on-premises to cloud-based solutions.

**Task 4: Final Report**

The purpose of this task is to prepare the additional final deliverables for the project including (a) the final report; (b) an electronic presentation of the research results; (c) recommendations on needs and priorities for additional research; (d) a stand-alone technical memorandum titled "Implementation of Research Findings and Products".

**Task 5: Knowledge Transfer**

Make best practices, data and methodologies available to the transportation community. Prepare materials for a webinar and presentation on the key takeaways from the project.

**ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

Recommended Funding: \$350,000  
Research Period: 12 Months

**URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

There is increasing awareness and deployments of use of Cloud Computing and Software as a Service for Traffic Management Systems and there is a need for better understanding, methods, and guidelines to avoid the lessons learned and issues from early implementers and to procure services that are cost-efficient and produce benefits.

**PERSON(S) DEVELOPING THE PROBLEM**

- Kevin Miller, Kapsch TrafficCom, National Practice Lead, TSM&O 313-354-2126, kevin.miller@kapsch.net
- Jeffrey Adler, Kapsch TrafficCom, VP Solution Consulting, 571-225-2918, jeff.adler@kapsch.net

**PROBLEM MONITOR**

Selected members from the TRB Freeway Operations (ACP20) and Regional TSMO (ACP10) Committees would be available to serve on the technical review panel for this project.

**DATE AND SUBMITTED BY**

Galen McGill  
Oregon Department of Transportation

AASHTO CTSO Research Coordinator  
Phone number: (503) 986-4486  
Email address: Galen.E.MCGILL@odot.state.or.us

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## **NCHRP Review of G-08**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

Comments: Identification of the state of practice and lessons learned would be of interest to state TSMO professionals. The scope of the research is reasonable and the budget is sufficient however the timeframe should be increased to 18 months to allow ample time for a state DOT survey or interviews, and sufficient review time and feedback from the panel.

Review Date: 12/21/2020

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## **FHWA Evaluation of G-08**

Reviewed By: HRDO/Jon Obenberger, HOP/John Harding

Comments:

1) Suggest that the scope of the project be expanded to cover all types of software subsystems and how they may be hosted, supported, and managed by agencies. This would allow agencies to assess needs to manage, maintain, and support the operation of different types of software programs that may be installed on the software subsystem and options to support these needs. Where agency leased or purchased servers, TMS leased or purchased servers, and other hybrid options could be considered in addition to cloud computing. 2) Similarly, suggest the scope include the identification, assessment, and consideration of the range of services that may be needed to support the suite of different types of software programs (e.g., commercial off-the-shelf, agency owned and developed, agency owned and transferred, open source) the agency may manage on the software subsystem in the future.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-08**

Submitted By:  
Patrick Zelinski

AASHTO Staff  
Committee on Transportation System Operations

Priority #: 3

Comments: N/A

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### **Submitter Response for 2022-G-08**

**From:** [email: [pzelinski@aaashto.org](mailto:pzelinski@aaashto.org); Galen.E.MCGILL@odot.state.or.us; ]

**Comments:**

General Response: The TRB Freeway Operations committee and AASHTO CTSO committee were involved with the development and review of this problem statement which was based on a need identified by them.

Comments by Jon Obenberger / John Harding (FHWA)

1. Suggest that the scope of the project be expanded to cover all types of software subsystems and how they may be hosted, supported, and managed by agencies. This would allow agencies to assess needs to manage, maintain, and support the operation of different types of software programs that may be installed on the software subsystem and options to support these needs. Where agency leased or purchased servers, TMS leased or purchased servers, and other hybrid options could be considered in addition to cloud computing.

RESPONSE: The intent of the project is to specifically educate and advise agencies on cloud hosted and cloud-based approaches for traffic management systems. We believe the proposed primer and materials in the guidebook would provide ample information for agency personnel to apply to any software solution the agency seeks to acquire. We would assume the selected research team would include materials about the pros and cons of each with respect to cloud computing so that the agency has a resource and understanding in order to make an informed decision.

1. Similarly, suggest the scope include the identification, assessment, and consideration of the range of services that may be needed to support the suite of different types of software programs (e.g., commercial off-the-shelf, agency owned and developed, agency owned and transferred, open source) the agency may manage on the software subsystem in the future.

RESPONSE: This project has a single focus to develop a primer on cloud computing/ cloud hosting and provide guidance to agencies interested in considering migrating from locally hosted solutions. Your point is well taken and

may be worthy of a new research needs statement or included within another research needs statement.

Comments by Camille Crichton-Sumners (NCHRP)

2. Identification of the state if practice and lessons learned would be of interest to state TSMO professionals. The scope of the research is reasonable and the budget is sufficient however the timeframe should be increased to 18 months to allow ample time for a state DOT survey or interviews, and sufficient review time and feedback from the panel.

RESPONSE: We concur with extending the timeframe.

**Contact Info:**

[email: Galen.E.MCGILL@odot.state.or.us;pzelinski@ashto.org]

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Jeff Adler  
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(571) 225-2918

Review Date: January 20, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022–G-09**

**Problem Title**

ITS & Traffic Sensor Evaluation Methodology and Testing Program

**Background**

There is rapid growth in new Intelligent Transportation System (ITS) sensor system products that leverage new technology(s) which are lacking in any independent, ground truth evaluation to verify results and quantify error. This creates a tremendous agency burden to test each sensor type and iteration that comes to market, often with disappointing results.

Manufacturers (and their distributors) of ITS sensor products rarely, if ever, can provide independent 3<sup>rd</sup> party field verification, validation testing results to demonstrate the “real-world” effectiveness of their sensor(s). Sensors error(s) can have meaningfully negative safety and mobility impacts; particularly when operating in a critical, highly sensitive context(s). The lack of quantified error rates and types presents meaningful risk in many use cases.

**Literature Search Summary**

A review of the Transportation Research Board TRID system resulted in finding no innately similar evaluations, therefore, outreach was undertaken with industry leaders in ITS sensor use which resulted in most identifying more ad hoc type sensor validation by their organizations or reliance on peer agency experiences. The majority of existing research seems to be focused upon vehicle detection for freeway or signalized intersection applications. Both Indiana DOT and ASTM have some vehicle sensor evaluation frameworks in place. Federal Highway Administration is in the early part of research to establish model documents in system engineering for traffic sensor detection systems (TSDS), which will also be useful to build upon.

What appears to be lacking within the proposed topic, is research on:

- (1) sensors focused upon other modes of travel (e.g. pedestrians, bicycles, scooters, wheelchairs),
- (2) other sensor use cases beyond count, occupancy, call/extend functionality, such as near miss crash analytics and vehicle predictive analytics, and
- (3) perhaps most importantly a methodology to scale & mainstream the evaluation methodology into a repeatable, useful testing process to be implemented by a geographically diverse laboratory network, along with a way to consistently present testing results that allow for easy understanding and comparison (e.g. Consumer Reports™ style matrix).

A more comprehensive literature review is proposed with this research.

### **Research Objective**

This research would establish a consistent ITS sensor evaluation methodology and test procedure or sensor testing guidelines. Test protocols will need to be developed for each mode being detected (e.g. vehicle, pedestrian, bicycle). The test protocols will also need to incorporate different factors such as varying weather conditions, lighting level, background, etc. and determine the boundaries for these parameters as the guidelines are developed. This will allow national research laboratories to evaluate a sensor(s) with confidence that the methods and protocols are replicable, transferable, and useful to transportation public agencies and their partners.

### **Urgency and Potential Benefits**

Agencies lack a cost-effective, resource-effective way to know the ground-truth accuracy of an ITS traffic sensor under a spectrum of environmental conditions prior to investing staff and/or funding into their own (often ad hoc) “demonstration” of the sensor system. Too often the sensors are overpromised and underdeliver for agencies multi-modal, multi-use case applications. This leads to a cycle of new versions to address discovered sensor errors, requiring even more agency resources to continue the evaluation until the sensor is deemed “good enough,” and the agency must move on to other matters.

AASHTO’s National Transportation Product Evaluation Program (NTPEP) has indicated an interest in expanding into this type of ITS sensor evaluation. A desire would be for the research team to develop a test procedure or guidelines for sensor evaluation to be implemented within the NTPEP (or similar) program, along with a concise, useful evaluation reporting template(s) with comparison matrices.

Without this research, public agencies will rely on localized, often informal, resource intensive evaluations to assess the accuracy of sensor systems for their critical traffic control and ITS applications. The industry will continue operate ITS sensors in continually differing applications that may result in unintended operational or safety issues. Transparency will be lacking in the performance of ITS and traffic sensor systems.

### **Implementation Considerations and Supporters**

Traffic operations, safety, and ITS staff will be the biggest benefactors of this research and the established testing program. Staff at Georgia DOT, Utah DOT, Oregon DOT, City of Portland, Indiana DOT, Washington County, Oregon, and others have already indicated their strong support and desire for the proposed research products described herein.

DOTs may be able to use the protocol and results of the testing program, to set guidance for how they select sensors for use and increase confidence in specified applications. AASHTO/TRB/FHWA outreach mechanisms can be used to support implementation.



To create awareness and facilitate implementation of the research results, the research team is expected to lean on established proven practices from the recommended test program implementer. We expect that the research panel will conduct workshops with a cross-section of agencies, vendors, regulators, and manufacturers involved in the production, evaluation, and use of ITS traffic sensor systems across a variety of safety and mobility-related use cases.

As the sponsoring AASHTO Committee for this research proposal, the AASHTO Committee on Transportation System Operations will lead efforts to implement this research. Further, the Institute of Transportation Engineers (ITE), Federal Highway Administration, and numerous state and local transportation agencies have expressed support for this research and its implementation.

### **Recommended Research Funding and Research Period**

#### Research Funding:

Research funding is expected to be \$400,000

Anticipated items to be included with this funding amount include:

- Research staff funding: \$250,000
- Data collection/field verification: \$100,000
- Sensor and/or testing device and/or computer modeling purchase: \$50,000

#### Research Period:

The research time estimates for this problem statement are as follows:

- 18 months to complete the research
- 12 months to engage in communication and implementation efforts.

### **Problem Statement Author(s)**

David Hirsch, Oregon DOT, 541-604-4977, David.HIRSCH@odot.state.or.us  
Shaun Quayle, Washington County, OR, 503-846-7938,  
shaun\_quayle@co.washington.or.us

### **Others Supporting the Problem Statement**

Federal Highway Administration, Eddie Curtis, 404-562-3920,  
Eddie.Curtis@dot.gov  
Institute of Transportation Engineers (ITE), Randy McCourt, 503-753-8996,  
503.randy.mccourt@gmail.com

### **Potential Panel Members**

- Darcy Bullock, Purdue University
- Mark Taylor, Utah DOT

*If this problem statement is submitted by an AASHTO Committee or Council,*  
please recommend Committee or Council members as potential panel members.

- Jim Sturdevant, Indiana DOT, AASHTO Committee on Transportation Systems Operations, 317-899-8603, jsturdevant@indot.in.gov

- Alan Davis, Georgia DOT, AASHTO Committee on Traffic Engineering, 404-635-2832, aladavis@dot.ga.gov

**Person Submitting the Problem Statement**

Galen McGill  
Oregon Department of Transportation  
AASHTO CTSO Research Coordinator  
Phone number: (503) 986-4486  
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**NCHRP Review of G-09**Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

Comments:

This problem statement is very clear and addresses a topic of significant interest to most, if not all, DOTs. The proposed timeline and funding are appropriate for the research project at \$400,000 for 18 months. It is unclear if the additional 12 months to engage in communication and implementation efforts are expected to be included in this project or considered for additional funding (e.g. NCHRP 20-44 implementation support program funding) at a later time.

Review Date:

1/5/2021

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**FHWA Evaluation of G-09**

Reviewed By: HOP/Kingsley Azubike, HRDO/Govind Vadakpat

Comments:

1) Suggest the objectives of the project be revised to clearly express when and how the proposed evaluation methodology may be applicable. Most states have robust methodology in place to ascertain the accuracy and validity of information generated by sensors before they are included in the standard specifications for design and construction contracts. 2) It appears there is not a single COTS sensor available on the market that is capable of fully accomplishing the objectives. Suggest modifying the

objectives to create a framework to measure and assess the performance characteristics mentioned in the project objectives.

Review Date:  
12/18/2020

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**Submitter Response for 2022-G-09**

**From:** [email: Galen.E.MCGILL@odot.state.or.us;pzelinski@ashto.org]

**Comments:**

We agree that some states have a robust testing approach, and that these can be utilized as a starting point for developing a standardized approach. The idea behind this project wasn't to identify a single sensor, but to develop a standard test process that could be utilized to provide performance data for the growing number of traffic related sensors that are coming to market. We agree with the comment about the possibility of leveraging the 20-44 implementation funding during the implementation phase of this project.

**Contact Info:**

Galen McGill  
System Operations & ITS Manager  
Oregon DOT  
Galen.e.mcgill@odot.state.or.us  
503-508-1881

Review Date: 1/29/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-10**

**MASH Crashworthiness of Luminaire Poles**

**Background**

Crashworthiness of poles propose a unique set of obstacles that previous research projects are not likely to address. Some of these challenges are:

- The breakaway base is typically made by one company. The pole and other associated connection hardware are made by others.
  - This can make it difficult to determine if breakaway hardware would be acceptable with other styles of pole or other hardware and who is responsible for testing of the various configurations.
- Previous testing criteria for poles concentrated on acceptable change in velocity and maximum stub height.
  - MASH testing criteria includes new occupant compartment crush criteria, including a maximum of 4 inches of roof crush.
    - Little or no data from previous NCHRP 350 crash testing indicates the extent of roof crush or how existing pole configurations would perform with MASH testing criteria.
- Most prior research on breakaway poles was done in the late 80's and early 90's and there have been significant changes to the vehicle fleet.

Research conducted by FHWA set the maximum weight and height of poles and associated hardware. These values combined with the roof crush criteria need to be reevaluated. Currently computer models appear to be overestimating roof crush for signs. Lack of accuracy in computer modeling makes it difficult to use computer modeling to predict likely success in crash testing.

This research will look to:

- Use physical testing to determine the maximum pole height and weight including all attachments and hardware that would meet MASH criteria.
- Compare testing results to computer modeling, focusing on increasing the accuracy of the computer modeling.
- Investigate if adjustments to the 4-Inch tall object on a 5-foot chord is still applicable to current vehicle fleet.

Results from this research may help guide futures improvements to MASH, the Roadside Design Guide, and other AASHTO documents.

This relates to TCRS's Strategic Plan by develop, implement, and maintain evaluation standards to support roadside safety innovation and decision making.

### **Literature Search Summary**

1. Rowan NJ, Kanak EW. Impact Behavior of Luminaire Supports. TTI; 1967. Report No.: 75-8.
2. Martinez JE. An Analytical Solution of the Impact Behavior of Luminaire Support Assemblies. Highway Research Record. 1968;222.
3. Edward TC, Martinez JE, McFarland W, Ross H. NCHRP Report 77 Development of Design Criteria for Safer Luminaire Supports. NCHRP; 1969. Report No.: 77.
4. AASHTO. 1975 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. 1975.
5. Nordheim E, Prodoehl RF, Dusel J. Dynamic Tests of Breakaway Lighting Standards Using Small Automobiles. Caltrans; 1975. Report No.: FHWA-RD-76-50-527.
6. Owings RP, Adair JW, Rudd TJ. Safer Sign and Luminaire Supports Task F - Laboratory Acceptance Testing for Sign and Luminaire Supports Volume 1. FHWA; 1976. Report No.: FHWA-RD-76-32.
7. Bloom JA, Hinch J. Laboratory Evaluation of Existing Breakaway Structures Volume 3 Test Data. 1979.
8. Mak K, Mason R. Accident Analysis - Breakaway and Non-Breakaway Poles Including Sign and Light Standards Along Highways Volume II Technical Report. FHWA; 1980. Report No.: DOT-HS-805-605.
9. Hinch J, Manhard G, Stout D, Owings RP. Laboratory Procedures to Determine the Breakaway Behavior of Luminaire Supports in Mini-Sized Vehicles Collisions Volume 1 R. FHWA; 1987. Report No.: FHWA/RD-86/105.
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11. Hinch J, Manhard G, Stout D, Owings RP. Procedures to Determine the Breakaway Behavior of Luminaire Supports in Mini-Sized Vehicle Collision Volume 3 Foil Operation and Safety Plan. FHWA; 1987. Report No.: FHWA/RD-86/107.
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15. Pfeifer BG, Holloway J, Faller R, Post ER, Christensen DL. Full-Scale Crash Tests on a Luminaire Support 4-Bolt Slip-Base Design. Transportation Research Record. 1992;1367.
16. AASHTO. 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. 1994.
17. Vallabhan G, Burkette W. Evaluation of Structural Strength Characteristics of Light Pole Transformer Bases. Texas; 1997. Report No.: TX-970-1416-1R.
18. AASHTO. AASHTO Standard Specifications for Structural Supports Pages. 2009.
19. AASHTO. 2009 Manual for Assessing Safety Hardware (MASH)2009.

20. Rosenbaugh S, Faller R, Lechtenberg K, Bielenberg B, Sicking D, Reid JD. Dynamic Evaluation of New York State's Aluminum Pedestrian Signal Pole System MwRSF; 2009. Report No.: TRP-03-223-09
21. AASHTO. 2011 AASHTO Roadside Design Guide 4th Edition. 2011.
22. AASHTO. 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. AASHTO; 2015.
23. AASHTO. LRFD Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals 2015.

### **Research Objective**

This research will provide the following:

1. Determine maximum height and weight of breakaway poles and hardware that will meet MASH requirements.
  - a. Physical test data needed to correlate roof crush with pole and hardware height and weight and aid in determining critical pole configurations.
  - b. This may include dropping poles with associated hardware of varying height and weights onto vehicles as a precursor to full-scale crash testing.
2. Identify improvements to vehicle computer models to better simulate crash testing roof crush.
3. Investigate if adjustments to the 4-inch tall object on a 5-foot chord is still applicable to current vehicle fleet.
  - a. Review procedures used to develop the 4-inch tall on a 5-foot chord criteria.
  - b. Determine if modification or improvements to the procedure can be implemented.
  - c. Conduct analysis of procedures with current vehicle fleet.

The research will be presented in the AASHTO Manual for Assessing Safety Hardware, AASHTO Roadside Design Guide, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

### **Urgency and Potential Benefits**

Currently, there are no MASH compliant breakaway poles. There are many barriers to developing breakaway poles to MASH criteria. There are multiple manufacturers involved in a breakaway base/pole installation as well as hundreds of potential pole and hardware configurations currently in use. Basic research on pole weight and height is needed to develop hardware.

Traffic, safety, standards engineers, manufacturers and eventually the public would benefit from this research. AASHTO MASH crash test criteria would be validated or modified based on the results of this research. Potential improvements in computer modeling can make it less expensive to obtain MASH compliant breakaway poles.

This research is ranked #4 priority by the AASHTO Technical Committee on Roadside Safety and #3 by the Committee on Design.

### **Implementation Considerations and Supporters**

The following AASHTO committees would likely be implemented the results: Technical Committee of Roadside Safety, and Highways Subcommittee on Bridges and Structures.

Results could be implemented into revisions or interpretations of the following AASHTO documents: AASHTO Manual for Assessing Safety Hardware, AASHTO Roadside Design Guide, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Traffic, safety, and standards engineers would be responsible for implementing use of MASH-compliant hardware systems developed as a result the results of this research. Recommendations provided by this research could be implemented in standard drawings and design standards. Also, the following AASHTO documents

### **Recommended Research Funding and Research Period**

\$600,000

36 months

### **Problem Statement Author(s)**

Erik Emerson

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**Others Supporting the Problem Statement**

The AASHTO Technical Committee on Roadside Design supports this research.

**Potential Panel Members**

Members of the AASHTO Technical Committee on Roadside Safety

**Person Submitting the Problem Statement**

Erik Emerson

Vice Chair AASHTO Technical Committee on Roadside Design

Wisconsin Department of Transportation

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**NCHRP Review of G-10**Reviewed By:

David M. Jared

djared@nas.edu

Comments:

This research would be worthwhile and perhaps complementary to C-07, but with an emphasis on luminaire poles. I would consider it medium/high priority, which is consistent with the TCRS and COD prioritizations.

Review Date:

1/5/2021

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**FHWA Evaluation of G-10**

Reviewed By: HRDS/Eduardo Arispe

Comments:

Different attachments can be used with the same luminaire pole and this project will determine the critical maximum weight and height of poles. It will also be helpful to determine what attachments can be used with the same pole. The assumption that simulation wouldn't be accurate might not be correct, and rather than dictate the way the research is conducted, it would be beneficial to allow the researchers to propose their best approach.



Review Date:  
12/18/2020

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### **Submitter Response for 2022-G-10**

From: [email: erik.emerson@dot.wi.gov]

Comments:  
Response to FHWA

There is an agreement that determining what attachments are acceptable with the same pole is a good research proposal. However, the research into the maximum height and weight need to be conducted 1<sup>st</sup>. After this basic research, is conducted a second research proposal looking at the variations on one pole can be conducted.

Discussion during research development indicated that computer modeling was not accurately predicting roof deformation with sign impacts. Because of results of the computer modeling with signs, it is likely that roof crush with poles is likely to have the same issues. Also, it is unlikely that all possible combinations of breakaway base, pole, height, and attachments will be physically crash tested. Computer modeling will need to accurately predict roof crush.

The proposal committee believed that it was important to indicate that improvements to the computer modeling was needed.

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Review Date:01/12/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-11**

**PROBLEM TITLE**

Evaluating the Impacts of Real-Time Warnings and Variable Speed Limits on Safety and Travel Reliability during Weather Events

**BACKGROUND**

Even during normal weather conditions, transportation agencies can find it challenging to harmonize traffic to reduce congestion and keep roadways safe and reliable. Weather events, ranging from fog to blizzards, greatly increase that challenge as roadways become less safe and drivers behave differently. The practice of Road Weather Management (RWM) involves use of solutions and strategies that minimize the impact of weather events on transportation system operations to increase safety and travel reliability.

RWM has advanced significantly with new sources of road weather data and the opportunity for more active management of roadways through various Transportation Systems Management and Operations (TSMO) deployments and capabilities that enable more direct communication with drivers. As a result, during the past decade there has been growth and experimentation with RWM safety applications and strategies that have proven to yield high payoff benefits during weather events.

A survey of TSMO practitioners conducted in 2019 revealed six strategies that would have the most positive impact on system safety and reliability during weather events. Actively managing the system using real-time data on the road conditions to provide variable speed limits (VSL) and real-time motorist warnings (RTW) for road weather hazards were both identified as high priority strategies. At a TSMO focused peer exchange of State DOTs, FHWA, AASHTO, NOCoE, and a consultant held in June 2019, participants agreed that the use of VSL and RTW systems for weather applications is still advancing nationally, but that there is a need for additional research at the national level on the safety and travel reliability benefits as well as systems engineering processes to advance VSL and RTW for road weather. Notably, each of these solutions depend on actions by the driver or driver response, requiring a greater understanding of the human factors and driver behaviors involved in order to optimize the systems and measure the safety and travel reliability payoff of these strategies.

Many states including Ohio DOT (VSL on I-90 east of Cleveland) and Michigan DOT (RTW signage for slippery roadways and bridges) have seen significant safety and reliability benefits (eliminating fatalities and serious injuries and reducing overall incidents) associated with these near real-time alert TSMO strategies.

### **Variable Speed Limits**

VSL are systems that provide flexible speed limits for drivers, as opposed to the traditional fixed speed limit. VSLs allow an infrastructure owner-operator (IOO) to post speed restrictions—regulatory or advisory, depending on local policy—that are based on real-time information that may not be available to the motorists, such as congested conditions ahead, a major incident, or weather events such as fog or ice. Most VSL programs use roadside or overhead signage to notify motorists.

In order for VSL to be effective in changing driver behavior and increasing roadway safety and reliability, the IOO must have a detailed understanding of both the operational environment and the anticipated responses of drivers. The IOO must know traffic conditions, roadway surface conditions, current and forecasted weather in order to determine the appropriate speed limit. The IOO must also understand how drivers react to VSL messages during different weather events, how they receive and interface with the messages, whether they respond differently based on advisory or regulatory messaging, and many other human factors and driver behaviors.

### **Real-Time Warnings**

RTW can refer to any message or technology that improves traveler awareness of an inclement condition when that condition is present. In the RWM context, RTW generally refers to a notification provided to drivers of inclement weather conditions, usually consisting of a brief description of the condition and a recommended adjustment to their driving behavior (for example slow down, use caution, or stop and seek shelter followed by why you should). RTW can be distributed through a variety of mechanisms including roadside or overhead signage and radio transmissions. Some examples of RTW applications include icy curve, high water warnings, low visibility warnings (including snow, fog, and dust applications), high wind warnings, and evacuation guidance systems. To help influence driver behavior/attention/response, a message of action should be followed by a short succinct reason.

In order for RTW to be effective, the IOO must know the current and anticipated environmental conditions and have a mechanism at their disposal to alert drivers. As with VSL, the IOO should have a detailed understanding of how drivers will react to RTW during different weather events, how they receive and interface with the messages, whether they respond differently based on advisory or regulatory messaging, and many other human factors and driver behaviors. The IOO also needs to understand the ideal ways to capture the driver's attention to the message/warning and needs to have approved standards/consistent messaging to deliver.

### **Research Needs Related to Driving Behavior**

The June 2019 peer exchange identified several gaps in existing knowledge connected to effective VSL and RTW operation. On the VSL side, research needs included guidelines for where to deploy VSL and how to change the speed limit as well as opportunities for in-vehicle communications of VSL. For RTW, there were similar gaps tied to effective strategies for system deployment, automation, and keeping up with technology advances.

Both VSL and RTW share significant gaps related to driver behavior/human factor understanding, requiring further research. These include:

- Safety and travel reliability benefits
- Baseline and document driver understanding of VSL and RTW.
- Detailing the current understanding of anticipated driver response and level of compliance to messages during all potential operating conditions.
- Documenting the effectiveness of different visual cues and messaging on driver response.
- Documenting the effectiveness of in-vehicle messages versus messages generated via roadside or overhead signage on driver response.
- Detailing the impact of other operating restrictions (example; commercial vehicle restrictions such as lane restrictions and chain requirements) on driver response to messages.
- Understanding of the impacts of agency and partner regulatory and enforcement authority for violations on driver behavior (including automated enforcement options).
- Investigating potential design modifications needed to account for human factors and driver behavior.

Agencies seeking to make the roads safer and more reliable need more detailed guidelines on what messages and methods are most effective for getting the driver attention and ultimately changing driver behavior. Trying to understand and determine the human factors for which appropriate messages (whether an adjusted speed limit or warning about weather conditions) for a given situation/event are applied and what safety and travel reliability results are achieved from them are the basis of this research topic.

## **LITERATURE SEARCH SUMMARY**

Some specific findings: Research from the SHRP2 Naturalistic Driving Study (NDS) noted in its investigation of the impacts of fog that results from the speed selection model showed that the odds of reducing speed were 1.31 and 1.28 times higher for drivers traveling in near fog and distant fog, respectively, compared with drivers who were driving in clear weather conditions. (Khan et al. 2018). Additionally, a 2019 search of the TRB TRID database for the key words “fog and driver behavior” reveals 125 records, including publications relevant to lane keeping, aggressive driving, and visibility among others. The recent FHWA ATM signage study (Perez et al., 2010) developed and tested alternative signs for variable speed limit (VSL) signs and used the deployments in Minnesota and Washington as inputs to sign development. Laboratory and field studies determined both the comprehension of the ATM signs as well as their respective legibility distances. Another major issue is how to make drivers believe that they would be better off (e.g., save time or reducing crash risks) if they comply with VSL messages and travel at a slower speed than they intuitively desire. (Katz. Et al.)

### ***Literature:***

Sandeep Thapa, Rhonda Young, P.E., Ph.D, August 2019. Speed Selection During Winter Road Conditions.  
<https://www.ugpti.org/resources/reports/downloads/mpc19-394.pdf>

UDOT/FHWA May 2017 FHWA-HOP-17-003: Synthesis of Variable Speed Limit Signs  
<https://ops.fhwa.dot.gov/publications/fhwahop17003/fhwahop17003.pdf>

USDOT/FHWA June 2012, Publication Number: FHWA-JPO-12-046: Guidelines for Disseminating Road Weather Messages: [www.its.dot.gov/index.htm](http://www.its.dot.gov/index.htm)

SHRP2 Report S2-L10-RR-1 2011: Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior That Causes Nonrecurring Congestion  
<http://www.trb.org/Publications/Blurbs/165281.aspx>

Md Nasim Khan, Ali Ghasemzadeh, Mohamed M. Ahmed, June 2018. Investigating the Impact of Fog on Freeway Speed Selection using the SHRP2 Naturalistic Driving Study Data. <https://trid.trb.org/view/1497201>

Guangchuan Yang, Mohamed M Ahmed, Sherif Gaweesh, April 2019. Impact of Variable Speed Limit in a Connected Vehicle Environment on Truck Driver Behavior under Adverse Weather Conditions: Driving Simulator Study.  
<https://trid.trb.org/view/1593429>

Xuguang, Zhang, Jianping, Gao, 2018. Research on the Fixation Transition Behavior of Drivers on Expressway in Foggy Environment.  
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Chang, Xin, Li, Haijian, Qin, Lingqiao, Rong, Jian, Lu, Yao, Chen, Xiaoxuan, 2019. Evaluation of Cooperative Systems on Driver Behavior in Heavy Fog Condition Based on a Driving Simulator.  
<https://doi.org/10.1016/j.aap.2019.04.019>

Hammit, Britton E, Ghasemzadeh, Ali, James, Rachel M, Ahmed, Mohamed M, Young, Rhonda Kae, 2018. Evaluation of weather-related freeway car-following behavior using the SHRP2 Naturalistic driving study database.  
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USDOT/FHWA, 2016. Active Traffic Management: Comprehension, Legibility, Distance, and Motorist Behavior in Response to Selected Variable Speed Limit and Lane Control Signing. FHWA-HRT-16-037

Saerona Choi, Cheol Oh, January 2016. Proactive Strategy for Variable Speed Limit Operations on Freeways Under Foggy Weather Conditions.

<https://journals.sagepub.com/doi/10.3141/2551-04?icid=int.sj-challenge-page.similar-articles.2>

Yao Yao, Oliver Carsten, Daryl Hibberd, Penghui Li, April 2019. Exploring the relationship between risk perception, speed limit credibility and speed limit compliance.

<https://www.sciencedirect.com/science/article/abs/pii/S1369847818306405>

Archak Mittal, Eunhye Kim, Hani S. Mahmassani, Zihan Hong, August 2018. Predictive Dynamic Speed Limit in a Connected Environment for a Weather Affected Traffic Network: A Case Study of Chicago.

<https://journals.sagepub.com/doi/abs/10.1177/0361198118791668>

Bryan Katz, Cara O'Donnell, Kelly Donoughe, Jennifer Atkinson, Melisa Finley, Kevin Balke, Beverly Kuhn, Davey Warren, August 2012. Guidelines for the Use of Variable Speed Limit Systems in Wet Weather (FHWA-SA-12-022).

[https://safety.fhwa.dot.gov/speedmgmt/ref\\_mats/fhwasa12022/tech\\_rpt.cfm](https://safety.fhwa.dot.gov/speedmgmt/ref_mats/fhwasa12022/tech_rpt.cfm)

Ahmed Al-Kaisy, Levi Ewan, David Veneziano, June 2012. Evaluation of a Variable Speed Limit System for Wet and Extreme Weather Conditions: Phase 1 Report (FHWA-OR-RD-12-14).

[https://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR743\\_VSL\\_System.pdf](https://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR743_VSL_System.pdf)

## RESEARCH OBJECTIVE

The objective of this research is to advance the RWM strategies of VSL and RTW that lead to safer and more reliable roadways through a better understanding of driver behavior. Specifically, this research will:

- Provide a detailed understanding of the anticipated driver behavior impacts from VSL and RTW on safety and travel reliability in a variety of applications and operating environments.
- Provide information on best practices in VSL and RTW messaging including message locations, content, platform, and timing.
- Strengthen the ability of agencies to plan for and/or optimize VSL and RTW functions that maximize impacts on driver behavior for improved safety and travel reliability outcomes.

In support of the objectives, the research plan should consider but not be limited to the following tasks:

1. **Literature Review.** Researchers will review and document a synthesis of current and past related research on the topics of VSL, RTW, and associated impacts on driver behavior. Key topics will include:
  - a. Human factors that impact responsiveness;

- b. Observed and modeled driver responses to different message locations, content, platforms, and timing;
  - c. Impacts of the operating environment on driver response; and
  - d. New and innovative strategies/systems/algorithms/methodologies impacting driver behavior for VSL and RTW applications.
- 2. **Best Practices Assessment.** Researchers will identify driver behavior responses from active deployments of VSL and RTW by interviewing IOOs. Key topics of discussion include:
  - a. Operating characteristics of VSL and RTW systems;
  - b. Roadway environments of deployed systems (environmental, regulatory, operational);
  - c. Observations of driver behavior and responses to VSL and RTW messaging;
  - d. Understanding drive needs for appropriate messaging that draws attention and action;
  - e. Observed or modeled safety and/or travel reliability benefit/return on investment; and
  - f. Lessons learned and keys to success in RWM through VSL and RTW.
- 3. **Guideline Development.** Based on the findings of Tasks 1 and 2, researchers will assemble draft guidelines for effective VSL and RTW and their connection to driver behavior that impact safety and travel reliability. Guidelines will cover:
  - a. Ideal message locations, content, platforms, and timing to maximize driver responsiveness;
  - b. System features necessary to maximize driver response;
  - c. Recommended modifications to current system designs and operating procedures;
  - d. Abbreviated system engineering criteria (con-ops, requirements, design) for VSL and RTW road weather applications; and
  - e. Opportunities/building blocks for standardization across IOOs.
- 4. **Workshop.** Researchers will plan and facilitate a workshop of practitioners from the RWM community. The goal of the workshop will be for TSMO practitioners and Project Research Panel members to comment on and revise the draft guidelines developed in Task 3. Researchers will present on the findings of the literature review and best practices assessment (potentially budgeting time for 2-3 presentations of best practices and driver responses from agencies). Researchers will introduce the draft guidelines and lead the group in discussion and exercises intended to build out and strengthen the guidelines, ensuring they are sound, backed with experience, and targeted towards and applicable for the RWM practitioner community. Make guideline modifications/revisions to improve quality and content of final product deliverables based on workshop feedback, etc.
- 5. **Final Report.** Researchers will summarize all findings into a final report for publication.

## **URGENCY AND POTENTIAL BENEFITS**

The anticipated products of this research will offer immediate benefit to IOOs dealing with roadway safety and travel reliability challenges due to weather. VSL and RTW have a wide variety of functions and have been applied to face a variety of weather challenges from dust in the Southwest to snowfall in the North and flooding throughout the United States. IOOs that currently deploy VSL and RTW applications will be able to strengthen and optimize their messaging in the near-term and their system design and deployment in the mid- to long-term. IOOs looking into the development of VSL and RTW applications will have guidelines in place to build an effective system with maximum benefit and impact on driver behavior. Further, this research will promote these highly beneficial and cost-effective RWM strategies among state DOTs and other IOOs to increase network safety and security.

Given the relatively low levels of current deployment of VSL and RTW solutions, there is significant opportunities for safety and travel reliability gains as IOOs target their areas of greatest need (need for abbreviated system engineering process to better understand deployment locations, messaging and IOO/driver needs). As demonstrated by the wide variety of applications for VSL and RTW, road weather challenges across the United States can be addressed by these cost effective and high-performance solutions.

If the research is not completed, IOOs will continue to address road weather safety and travel reliability in a piecemeal approach with minimal understanding of best practices, actual driver behavior responses to their messages and limited research on how best to effectively deploy strategies/solutions while engaging IOO and drivers' needs.

## **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

This research will provide the greatest value to 1) IOOs with existing VSL and RTW applications, and 2) IOOs that are considering VSL or RTW as an RWM strategy/solution. This latter group is growing, particularly as more state DOTs look to TSMO planning and implementation to support safety and travel reliability performance.

The AASHTO Committee on Transportation System Operations (CTSO) Community of Practice (CoP) on Road Weather Management (RWM) will serve as a champion for the research findings and promote it to broader groups of overlapping interest, including the larger CTSO subcommittees and agencies. Several of the state DOT representatives involved in the CoP on RWM will likely serve as early testers/adopters of the research findings as they update and refine their existing VSL and RTW systems.

## **RECOMMENDED RESEARCH FUNDING AND RESEARCH PERIOD**

### **Recommended Funding:**

- a) Research funding is expected to be \$400,000
  - 1. Research Objectives: \$350,000
  - 2. Communication and implementation of key research products: \$50,000

### **Research Period:**



- a) 18 months to complete the research
- b) 6 months communication and implementation of key research products

#### **PROBLEM STATEMENT AUTHOR(S)**

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Other state DOTs that have deployed and have experience with VSL and RTWs

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## **NCHRP Review of G-11**

Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

Comments:

This problem statement is clear and well thought out. The additional detail of driver behavior and response during weather events in deployment of VSL and RTW will assist IOOs. The methods by which the data collection and analysis will be done may need some more detail. The focus seems to be on driver behavior during weather events as indicated in the first sections of the problem statement; however, this is not clearly communicated under the Research Objective section or in the task descriptions. The \$400,000 funding level for 18 months of research seems appropriate. It is unclear if a budget is provided for the 6 months of implementation work and whether this would be included in the project or requested through an additional funding source.

Review Date:

1/5/2021

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## **FHWA Evaluation of G-11**

Reviewed By: HRDO/Gene McHale, HOP, HSA/Guan Xu

Comments:

HRDO/Gene McHale - The problem statement is well written and clear in its intent and is a very important topic. My only comment is related to "in-vehicle" messages for real-time motorist warnings (RTW). Including the effectiveness of in-vehicle vs. roadside/overhead is mentioned in the bulleted list under the "Background" section. However, the topic of "in-vehicle" does not seem to be emphasized under the section on "Research Objective". Try to ensure "in-vehicle" is still part of the scope of the "Research Objective". Most deployments and empirical data may be related to roadside/overhead messages, but this project should include the investigation of "in-vehicle" RTW. For example, examining the role of public/private partnership, such as

incorporating RTW into “commercial” in-vehicle navigation applications.

HOP - Very well written and organized problem statement, but would consider including Public Works and/or City/County Agencies in addition to just the State DOT under Section 6 Potential Benefits, and a better description or understanding of what an “abbreviated system engineering criteria” looks like in section 5.3.e

HSA/Guan Xu - It is a well written statement of the problem. Clearly stated issues/gaps related to driver behavior/human factor understanding of VSL, and objectives and tasks to address them. The research would look into human factor aspects to better understand actions by the driver or driver response, and driver behaviors involved in response to VSL and RTW, and ultimately develop guidelines on what messages and methods are most effective for getting the driver's attention and ultimately changing driver behavior. These aspects are important factors to make the VSL and RTW more effectively deployed to improve safety and travel reliability. But one question is related to ‘how the data on driver behavior in response to the VSL and RTW will be collected.’ Will it be an NDS data collection, or rather roadside observations by researchers, or some other means to collect these data?

Review Date:

12/18/2020

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## **Submitter Response for 2022-G-11**

### **Comments:**

1. Try to ensure “in-vehicle” is still part of the scope of the “Research Objective”. Project should include the investigation of “in-vehicle” RTW.

Agree. Part of the intent of this project is to investigate the impact of in-vehicle applications, driver behavior and response, and the impact that in-vehicle RTWs have on drivers' reactions when compared to roadside RTWs.

2. Consider including Public Works and/or City/County Agencies in addition to just the State DOT under Section 6 Potential Benefits.

Agree. Need to include these recommended stakeholders under Section 6 & 7 “Urgency and Potential Benefits” and “Implementation Considerations and Supports”.

3. What an “abbreviated system engineering criteria” looks like in section 5.3 d

An “abbreviated system engineering” criteria (con-ops, requirements, design) for VSL and RTW road weather applications is recommended for this project as a full-blown Systems Engineering Process would be cost prohibitive, take too long to produce, and not really provide valid return on investment based of project needs. Public agencies need a document that is succinct and to the point for VSL and RTW deployment and

messaging. This "abbreviated system engineering" criteria would be a document of 20 pages or less that provide VSL and RTW needs and deployment based on how this research investigates outcomes of human behavior and perceived displays of messaging. The document would provide only not the concept of operations needs but also the use-case scenarios, requirements when planning, designing the infrastructure architecture layout of where, when, and how VSL and RTWs should be installed, functionality of equipment deployed, and state of the practice for messaging dissemination and display. This may not be all inclusive in the con-op and requirements as other factors that are determined and discovered during the 2-year project may roll to the "abbreviated system engineering" criteria. The "abbreviated system engineering" criteria document will be part of the final report for publication. Also, any proposed ideas as to the how this document will be formatted for public agency integration and use by the researchers providing project proposals should give a higher score.

4. How the data on driver behavior in response to the VSL and RTW will be collected. Methods by which the data collection and analysis will be done may need some more detail.

The intent will be for data and information discovery during the project from several combinations of interviews, surveys, literature search, industry technologies/best practices, public agencies/best practices, current/forecasted technology advancements, workshop (under the RNS 5 Research Objectives no. 4), and any proposed ideas the researchers provide in the project proposals should give a higher score.

5. Driver behavior during weather events as indicated in the first sections of the problem statement; however, this is not clearly communicated under the Research Objective section or in the task descriptions.

The phase "better understanding of driver behavior" is specifically mentioned in the RNS, part 5 Research Objectives several times throughout the description and the four key project tasks. Not sure what is missing here or maybe I am not clear on what is being asked by this comment.

6. Unclear if a budget is provided for the 6 months of implementation work and whether this would be included in the project.

Yes, 6-months of communication and implementation (slide decks for presentations, webinars, white paper, etc.) is considered included in this research project, the \$400,000 is the total funding request for the project. We also anticipate submitting for additional dollars through a separate NCHRP 20-44 Implementation Support project. This could include a series of regional workshops and more aggressive implementation activities.

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Review Date: January 26, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-12**

**Problem Title:**

Driver Distraction in an Era of Rapid Technological Change in Advertising Sign Lighting

**Research Background**

Advertising Sign illumination is a dynamic aspect of the advertising industry. See e.g., “A Successful Lighting Retrofit” in February 27, 2020 Billboard Insider. Independent analysis of this subject area has only been rarely accomplished and importantly, most of the empirical studies undertaken to date feature methodological limitations. Consequently, there is an urgent need for more focused research in this area, given that lighting technology is changing rapidly. See e.g., “The impact of road advertising signs on driver behavior and implications for road safety” (2018) listed below.

**Literature Search Summary**

Digital Billboard Recommendations and Comparisons to Conventional Billboards by Ian Lewin Ph.D., FIES, L.C. (2008)

Digital LED Billboard Luminance Recommendations: How Bright Is Bright Enough? (Draft) by Christian B. Luginbuhl, U.S. Naval Observatory Flagstaff Station, Howard Israel, Phoenix, Arizona, Paul Scowen, Arizona State University, Jennifer and Tom Polakis, Tempe Arizona (2010)

FHWA Driver Visual Behavior in the Presence of Commercial Electronic Variable Message Signs (CEVMSS) by William A. Perez, Mary Anne Bertola, Jason F. Kennedy, and John A. Molino (2012)

Statistical Analysis of the Relationship between On-Premise Digital Signage and Traffic Safety by H. Gene Hawkins, Jr., Ph.D., P.E., sponsored by Signage Foundation, Inc. (2012)

OAAA Digital Billboard Lighting Measurement (2013)

Digital Advertising Billboards and Driver Distraction by Virginia Sisiopiku, Ph.D., et al.

The impact of road advertising signs on driver behavior and implications for road safety: A critical systematic review by Oscar Oviedo-Trespalacios<sup>a,\*</sup>, Verity Truelove<sup>a</sup>, Barry Watson<sup>a</sup>, Jane A. Hinton<sup>b</sup> (2018)

### **Research Problem Statement**

Advertising signs impact millions of travelers around the world every day. Driver inattention and distraction are recognized as two of the most critical factors for road safety worldwide, and advertising signs are designed to distract drivers. Existing research on the subject is limited due to a lack of standardized methods and practices, data reliability, appropriate assumptions, relevant hypotheses, and objective intentions. See e.g., “Digital Advertising Billboards and Driver Distraction.” (2015) Consequently, new research on advertising options and driver safety will prove paramount in the near future, especially because of the dynamic state of the industry and the fact that many related studies are outdated. Research would focus on the degree of driver distraction caused by advertising sign illumination during daytime and nighttime travel and all-weather conditions. It would establish practical criteria for advertising sign luminance limits and color based on advertising sign-to-viewer distances and time of day for standardized advertising sign categories.

### **Urgency and Potential Benefits**

- Every DOT regulating outdoor advertising must deal with rapid technological changes in sign illumination. Ultimately, the gap in knowledge between the current regulation and future technology will affect driver safety.
- This study will measure how each illumination technology impacts driver distraction in an objective way.
- The original data developed by this study should provide DOTs with the research-based information needed to generate guidance and enforceable regulations in this area. With those regulations in place, a reduction in traffic accidents caused by illuminated sign-related driver distraction is expected.

### **Research Objective**

The objective of this research is to provide municipalities and DOTs who regulate advertising signs, with tools and resources to manage outdoor sign illumination. The goal of having these resources available is increased driver safety while maintaining the ability of sign owners to continue to develop better means of communicating with the public. An additional potential benefit may be that this research will impact other sign regulations, such as size, spacing and location if one type of illumination was determined to be more distracting than another.

Specifically, the research for the regulation of advertising sign lighting would at minimum:

1. Research the following topics:
  - a. Compare luminance ( $\text{cd}/\text{m}^2$ ) and illuminance ( $\text{cd} \cdot \text{sr} \cdot \text{m}^{-2}$ ) of conventional and digital advertising signs
  - b. Measure “Sky Glow” lumens entering the night sky from conventional and digital advertising signs
  - c. Investigate factors related to changing images and advertising sign message movement
  - d. Consider general human-factors metric (e.g., the amount of attention required to process the roadside advertising sign using eye movements or driving performance)
  - e. Consider the wide range of road users, including motorcycle riders and pedestrians, and their interactions
2. Develop guidance or recommendations based on the research related to the following topics:
  - a. standards to define, measure or quantify advertising sign light trespass on adjacent properties
  - b. advertising sign luminance and illuminance recommendations
  - c. advertising sign lighting color temperature (Kelvin) recommendations
3. Provide recommendations for sign lighting alternatives or newer technologies.

### **Research Funding and Duration**

The estimated funding for this project is \$600,000. The estimated time to conduct the research including review time is 24 months.

### **Problem Statement Authors**

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### **Others Supporting the Problem Statement**

- AASHTO Committee on Right of Way, Utilities, and Outdoor Advertising Control
  - Contact AASHTO, Casey Soneira, 202-624-5824, csoneira@ashto.org

### **Person Submitting the Problem Statement**

- Casey Soneira, AASHTO (on behalf of Committee on Right of Way, Utilities, and Outdoor Advertising Controls), 202-624-5824, csoneira@ashto.org



## **NCHRP Review of G-12**

Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

Comments:

This would seem to be a useful study as implementation of changing technologies accelerates. Proposed funding would also appear to be appropriate.

Review Date:

12/14/2020

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## **FHWA Evaluation of G-12**

Reviewed By: HRDS/Jesse Eisert

Comments:

Whenever you say see (citation), it is unclear what we are looking at the citation for. Instead, include a sentence or two about what relevant information you are pulling from that citation, then add "see (insert citation)" at the end of the sentence. For the literature search summary, please provide an actual summary of the literature and how that impacts the problem statement. Additionally, the summaries should direct the reader/reviewer to be able to see what the missing part of the literature is, which will help strengthen the problem statement. While the problem and what will be specifically researched is clearly defined, I don't see any mention on what methods/how the research will be conducted. It would also be helpful to see a estimated schedule/steps to completing the project.

Review Date:

12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER: 2022-G-13**

**PROBLEM TITLE**

Assessment of Technologies for Measuring Work Zone Intrusion Frequency and Characteristics

**RESEARCH PROBLEM STATEMENT**

Traffic intrusions into work zones, when they occur, present a significant safety risk to construction, maintenance, and utility workers. “Struck-by” accidents are a major cause of roadway construction worker deaths. Motorists are also at risk when intruding into a work zone, potentially colliding with work equipment and materials.

Unfortunately, the rate at which intrusions occur, and the factors that influence that rate, are not well understood at this time. As a result, it is difficult to quantify possible benefits of intrusion mitigation strategies (use of positive protection, intrusion alarms, etc.) or determine when and where such strategies are cost-effective. Recent advancements in sensor technology (such as 360-degree lidar, thermal cameras, machine vision, and others) now allow vehicle trajectories to be tracked and could be used to monitor work zones and systematically collect intrusion data. Research is needed to first determine which technologies are best suited for this purpose, and then to quantify and characterize intrusions that occur into work zones when using that technology.

**LITERATURE RESEARCH SUMMARY**

A 2019 Association of General Contractors (AGC) survey found that 67 percent of contractors reportedly had a vehicle intrude into one of their work zones during the year. It was also reported that 8 percent of respondents had one of their workers killed in a work zone crash, and 28 percent had a worker injured by a vehicle crashing into their work zones (AGC website, May 23, 2019). Because of a lack of actual data on intrusion frequencies, efforts to quantify the benefits and costs of positive protection have relied on the Roadside Safety Analysis Program (RSAP) (NCHRP 581, TTI Report 6163-1, Idaho Transportation Department Report RP-228). The program performs an encroachment-based hazard analysis. However, the encroachment data upon which it is based is dated, and the data itself only represents vehicles departing the roadway. As a result, it is not known how well the model reflects intrusion potential into work zones that are in travel lanes, that have lane shifts, or that have other work zone features which also influence intrusion risks, for example.

**RESEARCH OBJECTIVE**

The objective of this research is two-fold:

1. Perform an assessment of the technologies available to collect data on work zone intrusions.

2. Use those technologies that are suitable to collect data on work zone intrusion frequency and characteristics at a sampling of work zones nationally.

**ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

\$500,000 over 2 years

**URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

Current regulations require states to consider positive protection needs for work zones. Data on actual intrusions is urgently needed to assist those states in making positive protection decisions.

**PERSON(S) DEVELOPING THE PROBLEM**

National Committee on Uniform Traffic Control Devices; Signals Technical Committee,  
Chair John Fisher  
signals-chair@ncutcd.org

**PROBLEM MONITOR**

**SUBMITTED BY:** John Fisher

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**NCHRP Review of G-13**Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

Comments:

While this is an important topic for DOTs, parts of this submission are identical to 2022-G-19 which seems to be an updated version of 2022-G-13. G-19 provides additional detail regarding the urgency and potential benefits of this project.

Review Date:

1/5/2021

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**FHWA Evaluation of G-13**

Reviewed By: HOTO/Jawad Paracha

Comments:

FHWA prepared this problem statement (G-19) with help and support from other state DOTs and TRB WZ Committee.

Review Date:

12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER: 2022-G-14**

**PROBLEM TITLE: Exit Advisory Speed Warning Sign Standards for Freeways and Major Highways**

**RESEARCH PROBLEM STATEMENT**

Run off the road or speed differential crash are some of the more significant factors in damage, injuries and fatalities on highways. In freeway settings due to higher speeds, the consequences are substantial. Exit conditions on freeway, expressways and highways have this circumstance. While research has been conducted that has resulted in the identification of traffic control devices to address these conditions and the Manual on Uniform Traffic Control Devices (MUTCD) exists with guidance today, there remains significant gaps in the applications of these traffic control devices that leads to wide spread lack of uniformity across the country in this area (unlike other horizontal curve applications). Recent National Cooperative Highway Research Program (NCHRP) research outlined recommendation for the use of traffic control devices in this circumstance bases upon speed differential of 20 mph or greater. However, the actual message, hierarchy of traffic control with increased speed differential, placement and order/sequence with other signs (given the complex decision making and need for multiple traffic control devices in this area) was not addressed. Based upon research conducted by the National Committee on Uniform Traffic Control Devices (NCUTCD) Regulatory and Warning Signs Technical Committee (RWSTC) Exit Advisory Speed Task Force, there are clear inconsistencies in all 50 of the state Departments of Transportation (DOT) related to application of the MUTCD exit speed advisory. This inconsistency can be a contributing factor to exit related crashes (one of the highest locations for conflict and crashes on the freeway system). The inconsistencies fall into five questions that require further research to resolve:

- Use of the terminology of EXIT v. RAMP. Currently guide signs uniformly display the word EXIT and include options for speed advisory. The warning signs provide options (which leads to lack of uniformity) that include both the words EXIT and RAMP. Table 2C-5 actual mandates both which is not a uniform practice. Designers will argue that all exits are ramps but not all ramps are exits. Guide signs commonly refer to exits and exit numbering. If uniformity leads to greater safety, which message should be recommended?
- Placement of the exit speed advisory signs can vary in position prior to the gore, at the gore and beyond the gore. When is the ramp advisory speed utilized on an exit vs. horizontal curve warning?
- Given the consequence of higher speed differential and driver errors, can a hierarchy/progressive tiering/priority of traffic control be established to reduce

potential for driver error? Is their driver recognition and optimal response to different traffic control devices (from warning sign to warning signs imbedded in guide signs (supplementary speed advisory to E13-2 or E5-1a), to use of flashing beacons) that would relate to the progressive application of such devices at different (higher) speed differential conditions?

- What is the basis for advisory speed designation (first curve, slowest curve)? How do driver expectations at an off-ramp affect the need for advisory speeds?
- What is order, sequence and location/placement of horizontal exit speed advisory signs to have the greatest positive influence on reduction in excessive speed exiting a freeway or highway?

This gap in research creates a significant and immediate need to address application to complement the research already completed. Because of the higher speeds at these facilities, addressing the most appropriate traffic control application to avoid run off the road issues/barrier strikes/risky behavior is needed for public safety.

Advance warnings signs have been demonstrated to produce crash reductions when optimally and uniformly applied and the models suggest that the effect increases with increased severity. This NCHRP research indicated that progressive additional traffic control devices (signs) with higher speed differential on horizontal curves can produce reduced driver error and crashes. While the research focused on horizontal curves and primarily two-lane roadways, it did not assess freeway/expressway/highway exits. Research is needed to uncover the answers to these questions and provide recommendations for revisions to the MUTCD in this area.

## **LITERATURE SEARCH SUMMARY**

A literature search on the TRID database identified limited research related to exit advisory speed on freeways, expressways and highways. Most research focuses on horizontal curvature of two-lane, rural highway and freeways and the associated traffic control devices for these type facilities. The following studies partially reviewed the application of exit speed advisory but provided no definitive answers for this select set of highway facilities.

*A Guide for Reducing Collisions on Horizontal Curves, NCHRP Report 500: Volume 7, FHWA*

*Communicating Changes in Horizontal Alignment NCHRP Report 559, FHWA,*

*Manual on Uniform Traffic Control Devices (MUTCD), FHWA, 2009, Section 2C.14*

*Traffic Control Device Guidelines for Curves, NCHRP 03-106, TRB, April 2015, pages 63 and 64.*

## **RESEARCH OBJECTIVE**

The objective of this research is to produce definitive, uniform guidance to designers on the optimal standards for exit advisory speed signs.

To accomplish this research should include findings regarding the key questions outlined above with clear recommendations on:

- Use of terminology (ramp v. exit).
- Placement of exit advisory signs, given constraints of other exit sign needs, in advance of reduced speed design features, particularly in relation to the gore and possible use of standard highway horizontal curve warning signs beyond the gore. This should address criteria for establishing the exit advisory speed (first curve?) and the order and sequence of traffic control devices (coordinated with other horizontal curve requirements).
- Hierarchy or tiering of traffic control applications for excessive speed differential (above 20 mph from posted mainline speeds).

The outcome shall include revisions to MUTCD text, tables and figures in Section 2C-14 consistent with the research findings. The modification of MUTCD text shall be done collaboratively with the NCUTCD technical committees.

Accomplishment of the project objectives will be accomplished by undertaking the following tasks.

## **TASKS**

### **Phase I – Refine Work Plan**

Task 1 – Develop research plan and refine budgets for each task (40 hours).

Task 2 – Conduct outreach to AASHTO Committee on Traffic Engineering (CTE) and NCUTCD Regulatory and Warning Signs Task Force on Exit Speed Advisory on scope of services. Meet with Research Panel to review the Interim Report and obtain approval of the research plan (80 hours).

### **Phase II - Synthesis**

Task 3 – Conduct a literature search for any documents pertaining to the above issues (50 hours).

Task 4 – Conduct outreach/survey (SurveyMonkey) with state traffic engineering offices, working collaboratively with the AASHTO CTE, NCUTCD and ITE to reach out to the expert sign designers who work with the DOTs on this topic at the section, district, division level (100 hours)

Task 5 – Create photo log as a synthesis of the diversity of exit advisory speed applications in the United States and examples from other countries of sample applications, using Task 4 outreach as a means of obtaining samples (40 hours)

Task 6 – Submit a Phase II Report for Tasks 3 through 5 (50 hours).

Task 7 – Meet with Research Panel to review the draft Phase II Report and confirm Phase III research plan. Include collaboration with NCUTCD Task Force on findings (40 hours).

**Phase III – Research** (note that these tests should be defined in Task 1)

Task 8 – Create and conduct human factors testing of sign messages. This would focus on comprehension testing of exit v. ramp and hierarchy of exit advisory speed types from the synthesis and MUTCD for various speed differential conditions, focusing understanding, comprehension and legibility (140 hours).

Task 9 – Develop a simulation of exit conditions with various sign types as explored and refined in Tasks 3-7. Not less than three simulation facilities shall be used (ie. Universities or organizations with simulation research capabilities to provide diversity of responses). In this task all questions shall be queried and studied to determine the best applications that respond to the project objectives (600 hours).

Task 10 – Provide revisions to the MUTCD text related to exit advisory speed (specifically Section 2C.14) including specific text edits, creation/revision of tables and graphics (80 hours).

Task 11 – Prepare summary of findings report for Tasks 6 and 7 (120 hours),

Task 12 - Meet with Research Panel to review the draft Phase II Report. Include collaboration with NCUTCD Task Force on findings (40 hours).

Task 13 – Submit final report (80 hours)

Initial Estimate of Total Hours: 1,460

**ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD**

**Recommended Funding: \$200,000**

**Research Period: 18 Months**

**URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION**

The application of uniform traffic control devices across the United States for exit advisory speed has the potential to reduce crashes and severity of crashes. Using crash modification factors as a surrogate for benefits, this research when applied should produce a crash reduction factor of X.XX. Given ramp run off the road, rear end and sideswipe crash reduction potential, these countermeasures install systematically would contribute to each states Vision Zero objectives for highway crashes.

This research will provide the necessary findings to create uniform guidance in the MUTCD to address one of the elements associated with ramp crashes and heavy vehicle overturning. U7n

With the update to the MUTCD potentially in the next two years, this research is needed immediately to provide the potential basis for an interim approval that would provide clear direction for the optimal and safe traffic control applications for exit advisory speed.

This research shall be provided to the NCUTCD who will develop recommended MUTCD recommendations for consideration by the Federal Highway Administration.

**PERSON(S) DEVELOPING THE PROBLEM**



National Committee on Uniform Traffic Control Devices; Regulatory and Warning Signs Technical Committee, Chair Tom Heydel, WISDOT; Research Chair Jason Kennedy, Pierce County Transit; Exit Advisory Speed Task Force Chair Robert Weber, VADOT; Task Force: Mike Kimlinger, ODOT, Lee Roadifers, WYDOT,

Problem Statement Author Ransford S. McCourt, P.E.,PTOE; Principal, DKS Associates  
720 SW Washington Street, Suite 500, Portland, OR 97205; rsm@dksassociates.com

**SUBMITTED BY: Randy McCourt**

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## **NCHRP Review of G-14**

Reviewed By:

B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is good. Human factors testing will be needed as described in the problem statement but I think the budget is too low. Since implementation will take several years once the research is complete (signs are likely to be updated on a replacement basis), advanced driver assistance system (ADAS) technologies should be considered. I recommend increasing the budget to \$500,000.

Review Date:

12/18/2020

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## **FHWA Evaluation of G-14**

Reviewed By: HSA/Guan Xu

Comments:

Based on information provided in the proposed statement of problem, it appears the outcomes of the proposed project would provide information to be considered for future possible revisions to the MUTCD text related to exit advisory speed (specifically Section 2C.14).

Review Date:

12/18/2020

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER: 2022-G-15**

**PROBLEM TITLE:**

**Warrants for a Pedestrian Traffic Control Signal and for Other Pedestrian Traffic Control Devices**

**RESEARCH PROBLEM STATEMENT:**

Greater uniformity throughout the country with respect to pedestrian crossing treatments can be achieved when criteria are available regarding when to use a class of pedestrian treatments. The different classes of pedestrian treatments can range from no treatment, to pavement crosswalk markings and a sign (side or in-roadway mounted), up to yellow flashing devices (e.g., rectangular rapid flashing beacons, border LED warning signs, in-pavement warning lights, etc.) or devices that display red indications (e.g., pedestrian hybrid beacons or traffic control signal).

In particular, the current Manual on Uniform Traffic Control Devices (MUTCD) warrants for a pedestrian traffic control signal currently do not permit consideration of additional pedestrians that would likely begin using the crossing if a signal was present. For example, pedestrians may avoid a crossing because they do not feel safe in attempting to cross a road at that location (resulting in using a less direct route or mode, such as car). A warrant that is based primarily on the existing number of crossing pedestrians limits the ability to adequately account for demand that would be expected if a safer crosswalk treatment were present. Given the physical limitations of some pedestrians, such as the very young, very old, or persons with disabilities, should the warrants better address the needs of these groups? Should the pedestrian signal warrant not be based on number of pedestrians but rather on the characteristics of the land uses, such as type and size, represented on either side of the street? Should it incorporate equity considerations of long spaces without safe crossings of large, high volume, high speed roadways?

There is a growing interest from agencies in having information that guides them in choosing from the increasing variety of pedestrian crossing treatments, to have a better understanding of the characteristics of each treatment and how they might be beneficial for a given location. In addition, as more agencies and programs promote walking and walkable communities, the interest (and need) for such guidance is growing. Issues of the standard of care in the logical and prudent progression of pedestrian crossing treatments (rather than a cumulative assembly of all treatments anywhere) is a growing local agency need. Guidance on treatment selection will provide practitioners with the ability to more confidently provide an improvement to a crossing with reduced concern

about over-treating or under-treating those crossing or introducing unintended effects from a treatment/multiple overlapping treatments. If the project is not performed, agencies will continue to approach the selection of treatments with the same information currently available, which can vary widely from one jurisdiction to another or commonly be nonexistent, leading to inconsistent application of treatments and less expectancy by drivers and pedestrians, and a less safe outcome.

**OBJECTIVE:**

To develop MUTCD warrants for pedestrian traffic control devices, especially for the pedestrian traffic control signal. Characteristics that could be considered include vehicle volume, operating speed, available gaps in the vehicle stream, pedestrian demand (including forecasted demand), crossing distance, posted speed limit (target vehicle speed), pedestrian walking speed, and neighboring land use; although additional characteristics will probably need to be considered based upon the reviews and surveys of practice. As part of this project, guidance will be developed to provide explanations on how to use the procedure to identify the appropriate treatments for the conditions present at the location.

**KEY WORDS:**

Pedestrians, traffic control signal, crosswalk, rectangular rapid-flashing beacon, pedestrian hybrid beacon

**RELATED WORK:**

Selected for funding for 2021 is NCHRP Project 03-141 *Midblock Pedestrian Signal (MPS) Warrants and Operation*. The MPS would operate similarly to a standard vehicular traffic control signal at a midblock crossing, except that it would (1) use the same pedestrian crossing volume guidelines as are used for the HAWK Signal/Pedestrian Hybrid Beacon (PHB) and (2) display a flashing RED indication in place of a solid RED indication during the pedestrian clearance interval. This research should coordinate or use the findings from NCHRP Project 03-141.

A project jointly sponsored by TCRP and NCHRP studied a wide variety of treatments for unsignalized crosswalks and produced (a) recommended pedestrian traffic signal control warrants and (b) guidelines for practitioners to select from treatment categories based on the pedestrian delay. The treatment categories (i.e., signal, red, active/enhanced, crosswalk) could have more than one possible treatment to choose from, but the practitioner could reduce the number of potential choices based on which treatment category showed the best potential for the conditions at that site. The work is documented in TCRP 112/NCHRP 562.

FHWA in 2018 published a *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*. The Guide provides a list of potential countermeasures based upon a site's speed limit, roadway configuration, and vehicle volume. A traffic control signal is not one of the countermeasures included in the document. The Guide is available at: [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/step.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/step.cfm).

TRB's *NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways* (2016) compiles information on the state of existing practices regarding application of pedestrian crossing improvements and does not produce new guidance. The report includes a survey of state departments of transportation (DOTs) and local transportation agencies, a synthesis of current recommended practice and policy guidance, and a literature review of safety evidence for more than 25 pedestrian crossing treatments.

<http://www.trb.org/Publications/Blurbs/175419.aspx>

A gateway installation of the R1-6 signs can be installed at a crosswalk by placing them on the edge of the road and on all lane lines. This requires all drivers to drive between two signs. The perceived narrowing of the road is one factor influencing the treatments efficacy. However, the message also has been shown to influence efficacy even more. A 2016 Michigan Department of Transportation publication, *User Guide for R1-6 Gateway Treatment for Pedestrian Crossings* provides guidance on the use of the treatment.

[https://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_user\\_guide\\_gateway\\_treatment.pdf](https://mdotcf.state.mi.us/public/tands/Details_Web/mdot_user_guide_gateway_treatment.pdf)

**RESEARCH PERIOD:**

24 months

**ESTIMATE:**

\$750,000

**POTENTIAL TASKS:**

To produce guidance on revising the MUTCD pedestrian traffic control signal warrants and selecting appropriate treatments for pedestrian crossings, the following tasks are proposed:

- Identify existing guidance on treatment selection through a review of current practices by state and local agencies. This could largely be completed through an online search.
- Determine the MOEs of greatest interest to practitioners (e.g., crashes, delay, etc.). While this could be obtained to some degree through the review of existing guidance, a more complete exploration of MOEs can be accomplished by contacting practitioners in various agencies, both those with existing guidance and those without. Identify what practitioners would want in either a revised pedestrian traffic control signal warrant or in a guide for selecting appropriate treatments.
- Using the information gained from current practices and practitioners, develop a work plan to collect the data necessary to identify relationships between treatments and MOEs of interest.
- Execute the work plan and analyze the data.
- Develop revised pedestrian traffic control signal warrants and the proposed guidance on selection of pedestrian crossing treatments.

## **URGENCY, PAYOFF POTENTIAL AND IMPLEMENTATION:**

There is a growing interest from agencies in having information to guide them in choosing from the increasing variety of pedestrian crossing treatments, to have a better understanding of the characteristics of each treatment and how they might be beneficial for a given location. In addition, as more agencies and programs promote walking and walkable communities, the interest (and need) for such guidance will grow and be more regularly used if available. Guidance on treatment selection will provide practitioners with the ability to more confidently provide an improvement to a crossing with reduced concern about over-treating or under-treating those crossing or introducing unintended effects from a treatment. If the project is not performed, agencies will continue to approach the selection of treatments with the same information currently available, which can vary widely from one jurisdiction to another or may be largely nonexistent, leading to inconsistent application of treatments and less expectancy by drivers and pedestrians. Without this guidance regarding the prudent progression of safe pedestrian crossing treatment, overlapping devices will continue to be installed with unintended consequences and increased risk and liability to public agencies and private roadway owners.

## **REFERENCES:**

- Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E.S. Park, J. Whitacre, N. Lalani, D. Lord (2006) *Improving Pedestrian Safety at Unsignalized Crossings*. TCRP Report 112/NCHRP Report 562. Transportation Research Board.
- Blackburn, L., C. Zegeer, K. Brookshire (2018) *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* available at: [https://safety.fhwa.dot.gov/ped\\_bike/step/docs/STEP\\_Guide\\_for\\_Improving\\_Ped\\_Safety\\_at\\_Unsig\\_Loc\\_3-2018\\_07\\_17-508compliant.pdf](https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf). Accessed on: January 25, 2020.

## **PERSONS DEVELOPING THE PROBLEM:**

This problem statement was initially developed by the following individuals:

- Kay Fitzpatrick, k-fitzparick@tamu.edu
- Frank Tramontozzi, ftramontozzi@quincyma.gov
- Randy McCourt, 503.randy.mccourt@gmail.com
- Timothy J. Gates, gatestim@egr.msu.edu
- David Hurwitz

Comments and support were provided by:

- TRB Pedestrian Committee (Bob Schneider, former chair / Laura Sandt, current chair / Sirisha Kothuri, research subcommittee)
- TRB Traffic Control Device Committee (Tim Gates, chair)
- TRB Signal Systems Committee (Susan Langdon, chair / Stacie Phillips, subcommittee)

Reviewed By:  
B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. The list of related efforts is excellent and Table 1 in the FHWA's *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* provides a good starting point for selection criteria for the treatments. The proposed research will provide more definitive guidance on selecting the best treatment. As noted, NCHRP Project 03-141, Midblock Pedestrian Signal (MPS) Warrants and Operation, is related but the funding for that project is not sufficient to compare treatments (that project is expected to start around 4/1/21). Pedestrian safety and mobility are important topics for many state and local DOTs and the proposed research will help practitioners improve them.

Review Date:  
12/18/2020

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## **FHWA Evaluation of G-15**

Reviewed By: HRDS-30/Laura Mero

Comments:

1. The focus of the proposal seems to vary between the objectives section and the tasks and urgency, payoff potential and implementation sections. The objective is “to develop MUTCD warrants” with guidance development as a component. However, the focus of the latter sections of the proposal has limited information on warrants and focuses on the guidance.
2. Pedestrian demand is included as an element in this proposal, but this is known to be a challenge to capture. More detail of how they plan to measure pedestrian demand would be helpful.
3. The cost of the proposal seems very high for the timeframe based on the information given. More information to support this cost would be helpful.

Review Date:  
12/18/2020

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-16**

**Problem Title**

Motorist behavior and safety impacts on bicyclists from centerline and shoulder rumble strips on high-speed two-lane highways.

**Background**

**Problem:** Shoulder and centerline rumble strips provide significant safety benefits to motorists. However, contact with rumble strips is very jarring to bicyclists, making safe riding upon them unlikely or impossible. States are increasingly installing rumble strips on roads frequented by bicyclists, particularly rural two-lane roads with speed limits over 50 miles per hour, and often with less than 4 feet of shoulder space. As a result, the bicyclist community is increasingly experiencing challenges when rumble strips are installed in rideable shoulder space and bicyclists are forced to ride in the lane with high-speed mixed traffic.

The Federal Highway Safety Improvement Program is a major funding source for rumble strip projects. Federal law (23 USC 148(a)(4)(B)(iii)) allows HSIP use for such projects *“if the rumble strips or other warning devices do not adversely affect the safety or mobility of bicyclists and pedestrians....”* However, there is a lack of available research quantifying the safety effects for bicyclists with the use of rumble strips in shoulders and center lines.

The second problem with rumble strips affecting bicycle safety is motorist behavior when passing cyclists riding on roadways with centerline rumble strips. A study by Michigan Department of Transportation’s Traffic and Safety Division suggests that motorists are less likely to cross centerline rumble strips when passing cyclists due to vibration and noise. This may induce unsafe behaviors such as motorists passing too closely, increasing risk of a motorist-cyclist crash.

At present, there are few studies that explore motorist and bicyclists interactions with rumble strips and there is no research assessing the safety impacts of motorist-bicyclist interactions caused by rumble strips. In addition to public safety concerns, these impacts have repercussions for compliance with federal law.

**Whom does it affect?:** Installing centerline and shoulder rumble strips on rural, two-lane high-speed roadways without sufficient rumble-free clear zone has an impact on the safety of bicyclists that needs to be studied. Motorists interacting with on-road bicyclists are also affected, to a lesser degree.

**How will the research solve the problem?** Research into the design of rumble strips on high-speed roads and its effects on bicyclist and motorist behaviors and interactions would determine and quantify the safety impacts that may exist. The results of this research could be used to improve design and inform potential policy modifications, ensuring transportation departments are compliant with federal law when using HSIP funding for rumble strip projects.

**How is this problem statement related to the strategic plan or research agenda of an AASHTO Committee(s) and/or Council(s)?**

With the national rise in the number of serious injuries and fatalities for people who walk and bike, the AASHTO Council of Active Transportation has prioritized bicycle and pedestrian safety and have developed a number of goals and strategies to address risk to the most vulnerable road users.

**Literature Search Summary**

While there is extensive research in regard to the safety improvements shoulder and centerline rumble strip applications provide motorists in reducing run-off the road and head-on crashes, a literature review showed no studies that simulate bicyclists and motorists behavior when a rumble strip installation reduces or eliminates rideable shoulder space on rural roads. Studies, guidance, and reports mention “bicyclist concern” and provide examples of how FHWA guidance, AASHTO publications and DOT policies and shoulder rumble strip designs try to address these concerns through placement and design, but no research actually simulates driver behavior or definitely show how cyclists safety and mobility is affected by these shoulder treatments. Bicycle-motorist specific research will complement existing documents, policies and guidance that provide rumble strip design recommendations to accommodate cyclists with placement, gap patterns, depths, and widths.

Only one study by the Michigan Department of Transportation’s Traffic and Safety Division looked at driver behavior when centerline rumble strips were present and was not conclusive in predicting driver behavior. Research on how motorists react to the presence of centerline rumble strips when approaching a bicyclist will build upon this limited research.

**Research Objective**

The objective of this research is to determine and quantify safety impacts on bicyclists, for the use of centerline and shoulder rumble strips on high-speed rural roadways. Primarily using a simulator, the researcher would compare motorist behavior passing bicyclists traveling in the same direction, using consistent rumble strip design dimensions that follow best practices for accommodating bicyclists (see *Adventure Cycling's Solutions for Making Rumble Strips Safer for Bicyclists: Best Practices for Transportation Decision Makers*) on 50+ mph roadways with 12-foot lanes and no centerline rumble strips:



1. Bicyclist riding in the far-right of the travel lane on a roadway without paved shoulders and no rumble strip.
2. Bicyclist riding in the center of a 5-foot paved shoulder with at least four feet of rumble-free clear zone to the right of rumble strips.
3. Bicyclist riding in the far-right of the travel lane on a roadway with paved shoulders that are not usable due to rumble strips and a lack of sufficient rumble-free clear zone.

For roadways *with* centerline rumble strips.

4. Bicyclist riding in the center of the 5-foot paved shoulder.
5. Bicyclist in the far-right travel lane with no paved shoulder.

In addition to simulation results, based on data availability, historical crash data can be used to understand crash rates for cyclists on high-speed two-lane rural roadways with shoulder and centerline rumble strips and discover possible contributing factors. The results should present the five cases' crash rates and/or lateral passing clearance statistics as suggested. If the results warrant, guidance for Crash Modification Factors should be developed. Design recommendations should be provided for shoulder and centerline rumble strips.

### **Urgency and Potential Benefits**

With the growing nationwide use of rumble strips to reduce motorist run-off-road and head-on crashes, knowledge of whether there are unintended bicyclist safety impacts from specific design policies is needed. Depending on the research's outcome, any state DOT using or funding rumble strips could:

- Adjust rumble strip installation and design parameters through Federal Highway Administration guidance and recommendations
- Ensure compliance with Federal Highway Safety Improvement Program law
- Confidently respond to bicycle community concerns on shoulder and centerline rumble strips

### **Implementation Considerations and Supporters**

The safety, planning, design, and engineering offices at State DOTs will benefit from this research as they determine when, where and how to apply rumble strips. State DOTs will implement this research into their design manuals and rumble strip policies.

State DOTs will make revisions to their current design standards or create new design details. State DOTs may need to revise or develop rumble strip guidelines and implementation policies to implement the research. AASHTO committees interested in this research include: The Council on Active Transportation, The Committees on Planning, Design, Construction, Maintenance, and Traffic Engineering.

A report summarizing the findings of this research should be posted on FHWA research pages. A summary brochure could be distributed to state highway safety offices and DOT's planning and engineering departments. A summary of research and link to the

brochure and report provided in FHWA newsletters. Researchers should present their findings to AASHTO committees and through the FHWA Center for Accelerating Innovation, Every Day Counts program.

### **Recommended Research Funding and Research Period**

Total Funds Requested: \$400,000

Research Period: 24 months

### **Problem Statement Author(s)**

- Atifa Ferouz, Caltrans Division of Safety, 916-654-5032, Atifa.Ferouz@dot.ca.gov
- Saara Snow, Adventure Cycling Association, 406-396-7230, ssnow@adventurecycling.org

### **Others Supporting the Problem Statement**

#### **Potential Panel Members**

- Barb Chamberlain, Director, Active Transportation Division, Washington State Department of Transportation, ChambBa@wsdot.wa.gov, Council on Active Transportation
- Josh DeBruyn, AICP, Pedestrian and Bicycle Coordinator/Specialist, Michigan Department of Transportation, 517-335-2918,
- Rachel Carpenter, Chief Safety Officer, Division of Safety Programs California Department of Transportation, rachel.carpenter@dot.ca.gov

### **Person Submitting the Problem Statement**

Joe Horton, California Department of Transportation, Headquarters Division of Research, Innovation, and System Information, (916) 955-7841, Joe.Horton@dot.ca.gov

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### **NCHRP Review of G-16**

#### Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

#### Comments:

The problem statement is detailed and well thought out and the objective is clear. While the suggested use of a simulator is appropriate for this type of study and the authors suggest historical crash data may be used, data mining of an NDRS such as SHRP2 should certainly be considered in addition to the simulation study. The project timeline

and budget seem appropriate if both a simulator study and data mining of a pre-existing database effort are conducted to achieve the project objectives.

Review Date:  
1/5/2021

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## **FHWA Evaluation of G-16**

Reviewed By: RC-SHD-TST/Brooke Struve

### Comments:

The simulator project could provide good information for designers. Using a driving simulator with a bicyclist avatar will only capture driver behavior. If the study's intent is to capture both driver and bicyclist behavior, a connected simulation is needed, which greatly limits who can conduct the study and would likely increase the cost. Regarding the simulation options to include, it might be appropriate to add a 14-foot lane/shoulder combo for center line rumbles, since that is the basis of current guidance. Also suggest using only the most common shoulder widths (2-, 4-, or 6-foot). The project cost is adequate for a basic simulator study, but will probably need to be increased if the intent is a connected simulation or to study crash history. It seems very unlikely the data would be available to develop CMFs on this topic; would suggest removing that from the proposal or clarify if the intent is something different.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-G-16**

**From:** Atifa Ferouz Atifa.Ferouz@dot.ca.gov – Co-author of the Problem Statement

### **Comments:**

Thank you for the opportunity to comment. I concur with the evaluation

### **Contact Info:**

Atifa Ferouz, Caltrans Division of Safety, 916-654-5032

Review Date: 1/13/21

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## **Submitter Response for 2022-G-16**

## **Motorist behavior and safety impacts on bicyclists from centerline and shoulder rumble strips on high-speed two-lane highways**

**From:** [email: joe.horton@dot.ca.gov]

Comments:

**Using a driving simulator with a bicyclist avatar will only capture driver behavior. If the study's intent is to capture both driver and bicyclist behavior, a connected simulation is needed, which greatly limits who can conduct the study and would likely increase the cost.**

The intent is to capture driver behavior only.

**Regarding the simulation options to include, it might be appropriate to add a 14-foot lane/shoulder combo for center line rumbles, since that is the basis of current guidance.**

Within that 14-foot lane/shoulder combo, whether part of it is striped as shoulder – and how wide that shoulder is – would likely affect motorist behavior in this centerline rumble comparison. While rural 14-foot lanes are likely rare, it would be interesting to add the 14-0 case (14-foot lanes, no shoulders) to compare with 12-0. Another centerline-rumble 14-foot combo case to add might be 11-3 or 10-4, as shoulders narrower than that are too narrow for bicycling. To prevent the complication of inadequate clear zone for bicyclists, there should probably be no shoulder rumble strips in this second case – thus allowing the bicyclist to bike in the middle of the shoulder.

**Also suggest using only the most common shoulder widths (2-, 4-, or 6-foot).**

5-foot was chosen due to the FHWA recommendation on 4-foot clear zone to the right of rumbles, plus narrow shoulder rumble strip designs whose width and offset add to 1-foot. To use more common shoulder widths, Case 2, “Bicyclist riding in the center of a 5-foot paved shoulder with at least four feet of rumble-free clear zone to the right of rumble strips”, could be replaced with two shoulder-rumble, no centerline cases:

- “Bicyclist riding in the center of a 6-foot paved shoulder with at least four feet of rumble-free clear zone to the right of rumble strips.”
- “Bicyclist riding in the center of a 4-foot paved shoulder with three feet of rumble-free clear zone to the right of rumble strips.”

Even without shoulder rumble strips, 2-foot shoulder widths are generally too narrow for bicycling. With rumbles, biking would be nearly impossible. So, perhaps that width should not be included.

Similarly, Case 4 with centerline rumbles, “Bicyclist riding in the center of the 5-foot paved shoulder”, could be replaced with the 6- and/or 4-foot shoulder width cases, as well.

**The project cost is adequate for a basic simulator study, but will probably need to be increased if the intent is a connected simulation or to study crash history. It seems very unlikely the data would be available to develop CMFs on this topic; would suggest removing that from the proposal or clarify if the intent is something different.**

Since the intent is to capture driver behavior only, no connected simulation is needed. CMF development can be removed. Simulation of driver behavior is the primary intent; a crash history study would be a bonus if it did not require an increase in project cost.

Contact Info:

email: [joe.horton@dot.ca.gov](mailto:joe.horton@dot.ca.gov)

Saara Snow, [ssnow@adventurecycling.org](mailto:ssnow@adventurecycling.org), co-author

Review Date: 1/27/21

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-17**

**Problem Title**

Improve highway safety by developing guidance and standards for the design of left turn pocket approach tapers on single and multilane highways.

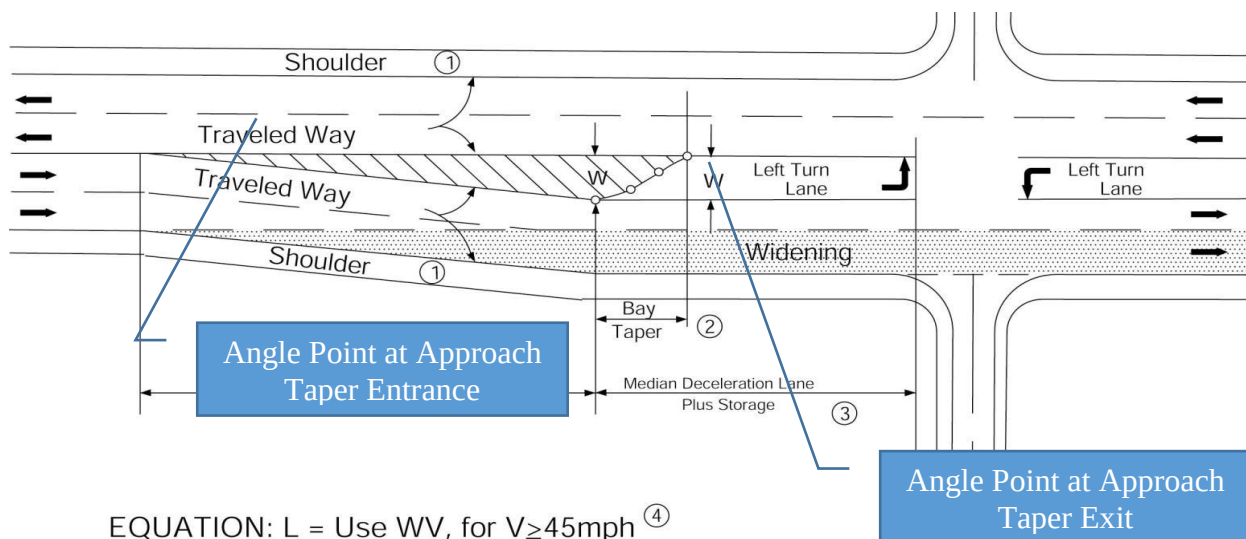
**Background**

Current design guidance and standards do not adequately address the design of turn pocket approach tapers. Existing standards provide turn pocket lengths without addressing the issue of horizontal alignment for the lane shifts necessary to accommodate the added width of left turn pockets. Vehicles passing on through-movements to the right of left turns traverse a horizontal alignment change that is different than the roadway centerline alignment and should therefore be designed as such for traveler safety.

This problem statement seeks three primary goals to address these separate alignments:

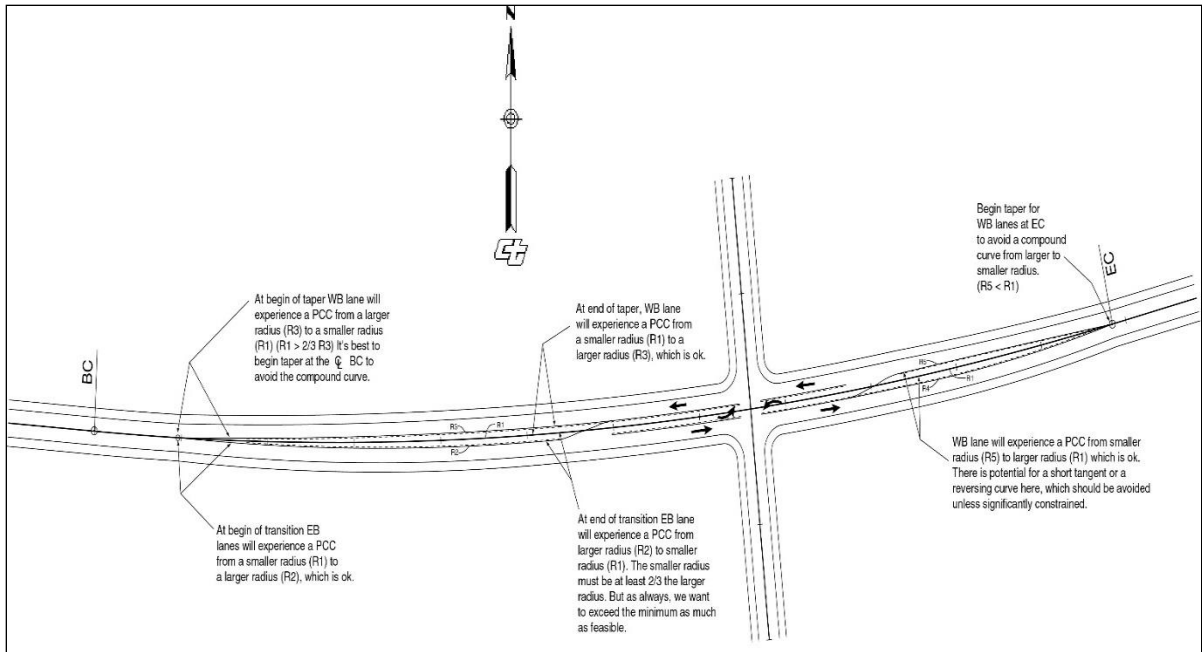
1. Create guidance for treating approach tapers as independent alignments for each of the two directions of travel.
2. Create guidance and standards for highways with tangent centerline alignments – Existing design guidance typically consists of equations providing approach taper lengths dependent upon width of shift and vehicle speed, however, angle of deflection is not discussed. Most importantly, acceptable maximum angle of deflection is not addressed. Large angles of deflection can result in erratic movements other than what is expected where vehicles cross over the right edge line when entering an approach taper and the left edge double yellow striping when exiting the approach taper in order to negotiate their desired direction of travel. (See Exhibit A for an illustration)

Exhibit A: Caltrans Highway Design Manual Fig 405.2A – Standard Left Turn Channelization



3. Create guidance and standards for highways with horizontal curve centerline alignments – There is currently no existing guidance related to approach taper shifts on horizontal curves. Since angles of deflection are inappropriate for horizontal curves, use of compound curves may be a more appropriate solution and should therefore be studied. Furthermore, guidance for superelevation is needed to address changes in curve radii between adjoining curves, which may require different superelevation rates to address different alignments on adjacent directions of travel. (See Exhibit B for an illustration)

Exhibit B → Left Turn Pocket Approach Tapers on Horizontal Curves



The lack of design guidance for the conditions described above affect the ability of our nation's design and traffic engineers to design safe highways.

A thorough and complete literature search is necessary to exhaust all possibility of prior efforts and sources of applicable guidance. Developing guidance and standards requires field research to measure the physical characteristics and constraints of vehicle instabilities while traversing a range of angle points on tangent alignments and curved alignment of varying design speed. Field observations and evaluations of driver behaviors of external vehicle movements using cameras and possibly in-automobile as well, could provide the appropriate design guidance that matches driver expectations and real life behaviors for the range of situations.

Improving the design of the left turn pocket approach taper will improve efficiency and mobility while reducing collisions. Improving transportation safety is part of AASHTO's Mission Statement where Safety Focused is its top Value. Safety is the top priority in the USDOT and FHWA Strategic Plan and Mission Statement. Turn pockets are typically the result of safety improvements for vehicles who await gaps in traffic to make left turn movements the approach tapers to turn pockets pose an even greater risk to overall highway safety because all drivers passing through the approach taper are affected by the horizontal alignment change from the centerline of the roadway. Consequently, properly designed approach tapers increase the safety of all motorists traversing left turn pocket approach tapers.

### Literature Search Summary

A thorough literature search has already been performed and the lack of national and State guidance regarding left turn pocket approach taper lengths and alignment, particularly in restricted situations and on curved alignments, prompted the need for this problem statement. The following literature searches have been performed:



- The Caltrans Division of Research, Innovation, and System Information (**DRISI**) contracted with its primary research consultants, CTC and Associates, who performed a thorough national literature search. The report is available at: <https://dot.ca.gov/programs/research-innovation-system-information/preliminary-investigations>
- The Caltrans senior librarian performed a database literature search of all available Caltrans, TRB, NCHRP, and AASHTO literature.
- Caltrans design experts performed in-depth reviews of AASHTO 7<sup>th</sup> Edition, Caltrans Highway Design Manual, and various TRB/NCHRP publications.
- During winter 2021, the DRISI and FHWA will query all State DOTs for subject guidance and standards for supportive information to assist with this proposed research objective.

### **Research Objective**

The objective of this research is to improve the safety of the traveling public by developing guidance and standards for the nation's engineers who design left turn pocket approach tapers on single and multilane highways. The workplan should include:

- Task 1. Review of Literature and Current Practice.
- Task 2. Field Data Collection:
  - Establish a data set of existing site conditions by locating existing turn pocket approach tapers consisting of a range of approach speeds, angle points and horizontal curvature.
  - Investigate collision data associated with the data set locations for applicability to design.
  - Observational Study: Assemble and analyze video footage of vehicle paths and movements traversing the approach tapers in the data set locations.
  - Behavioral Study: Assemble and analyze in-automobile video footage of driver behaviors while traversing the tapers within the data set locations (This is an Optional Task).
  - Analyze vehicle performance using ball bank indicator testing or similar techniques for the data set locations. Investigate the possibility of replacing field testing with analytical models.
- Task 3. Identify Critical Parameters: The objective of the task is to identify the critical parameters that affect vehicle movement in left turn pockets and in the adjacent through lanes, such as design vehicle, angle of deflection, horizontal curvature, grade, lane width, shoulder width, cross-slope, superelevation, etc.
- Task 4. Develop Framework for Model: The objective of this task is to develop a framework for incorporating the critical parameters identified in Task 3.
- Task 5. Develop Workplan: The objective of the task is to develop a workplan for calibrating the model based on the results from Tasks 2 and 3.
  - Problem assessment using crash analysis
  - Field Data Analysis

- Testing of analytical and simulation models
- Analysis of results
- Task 6. Prepare Interim Report: Using the results of Tasks 1 – 5 to,
- Task 7. Develop Design Guidance: Consideration for standards recommendations for use in AASHTO, State, and local agency manuals and guidance.
- Task 8. Prepare Final Report:

### **Urgency and Potential Benefits**

The research is needed immediately to fill a gap in current left turn pocket approach taper design guidance, standards, and policy. The consequences of not conducting this research will be the continued misinterpretation of left turn pocket approach taper design, mainly the use of angle points and curvilinear alignments that are mismatched to vehicle speeds due to a lack of subject information and guidance. Consequently, all private and government transportation engineers, general civil engineers, and practitioners will benefit from filling this knowledge gap.

### **Implementation Considerations and Supporters**

The results of this research will be implemented by the AASHTO Technical Committee on Geometric Design in a future edition of the AASHTO Green Book. The California Department of Transportation has committed to incorporating the research into our Highway design manual and will make these changes available to other State DOTs.

### **Recommended Research Funding and Research Period**

Total Funds Requested: \$500,000

Research Period: 18 months

### **Problem Statement Author(s)**

John Roccanova, Project Delivery Coordinator, Caltrans, HQ Division of Design, (916) 275-2890, John.Roccanova@dot.ca.gov

### **Others Supporting the Problem Statement**

Antonette Clark, Chief, Office of Standards and Procedures, Caltrans, HQ Division of Design, (916) 761-0587, Antonette.Clark@dot.ca.gov

Josue Pluguez, Design Program Manager, FHWA California Division, (916) 498-5035, Josue.Pluguez@dot.ca.gov

### **Potential Panel Members**

John Roccanova, Project Delivery Coordinator, Caltrans, HQ Division of Design, (916) 275-2890, John.Roccanova@dot.ca.gov

### **Person Submitting the Problem Statement**

Joe Horton, California Department of Transportation, Headquarters Division of Research, Innovation, and System Information, (916) 955-7841, Joe.Horton@dot.ca.gov

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## **NCHRP Review of G-17**

### Reviewed By:

B. Ray Derr  
rderr@nas.edu

### Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. Widening projects to add left turn bays are common and the design will often be drawn towards using minimal design parameters to reduce right-of-way purchases and pavement surface. Information on the safety and operational impacts of various configurations would be in keeping with the Green Book moving towards performance-based design and help the designer consider alternative designs.

### Review Date:

12/21/2020

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## **FHWA Evaluation of G-17**

### Reviewed By: HSA/Jeff Shaw

### Comments:

The RNS seems to imply that the current methods (using MUTCD criteria for lane shift and AASHTO Green Book for turn lane taper rates/length) for developing a left-turn lane are not adequate, but beyond more explicit consideration of coincidence with horizontal curves, it isn't totally clear that this is the case. NCHRP Report 780 (2014) looked closely at turn lane development, including taper rate/length and corresponding deceleration behavior, so perhaps the RNS authors should review its findings and revise the RNS as necessary. It is also possible that this research could take a more human factors centric approach to determine what are the thresholds of comfort and what should be a principles-based approach, which could be useful both in the near term and for future autonomous/automated vehicles. The authors should also consider use of NDS data from SHRP2 and other sources in lieu of additional field data collection. For the current scope, the requested funds are quite high.

### Review Date:

12/18/2020

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## **AASHTO Committee Evaluation for G-17**

### Submitted By:

Kelly Hardy  
AASHTO Staff  
Committee on Safety

### Priority #: N/A

Comments: This RNS could be enhanced by looking at the CMFs for differing turn lane elements by volumes (free flow to congested with spill back issues) , for example, approach transition length, approach total length for storage and decel, and taper lengths by time of day or V/C. While crashes related to left turns are a high safety priority, it is unknown how much of an effect taper design has on these crashes. Rating 2.7

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## **Submitter Response for 2022-G-17**

### **Design of left turn pocket approach tapers on single and multilane highways**

Caltrans would like to thank everyone for there consideration of Problem Number 2022-G-17 titled: Improve highway safety by developing guidance and standards for the design of left turn pocket approach tapers on single and multilane highways. Below are responses and clarifications to comments from FHWA and NCHRP.

#### Response to FHWA comments:

FHWA has offered three primary points of discussion, see Comments # 1, #2 and #3 with corresponding responses to each comment below:

Comment #1: "The RNS seems to imply that the current methods (using MUTCD criteria for lane shift and AASHTO Green Book for turn lane taper rates/length) for developing a left-turn lane are not adequate, but beyond more explicit consideration of coincidence with horizontal curves, it isn't totally clear that this is the case. NCHRP Report 780 (2014) looked closely at turn lane development, including taper rate/length and corresponding deceleration behavior, so perhaps the RNS authors should review its findings and revise the RNS as necessary."

Response to Comment #1: NCHRP 780 was reviewed thoroughly prior to submitting this problem statement and it does not address the problem statement. NCHRP 780 Page 45 provides a good definition of the term approach taper. Figure 4-6 provides taper lengths for turn lanes on tangent sections, and Table 4-2 provides deceleration standards, however, NCHRP 780 does not address maximum alignment deflection angles in constrained situations, nor does it address curve radii and superelevation for curved alignments. It should also be noted that several state DOTs have design

standards similar to Figure 4-6 and Table 4-2, however, none have been found to address the three primary objectives of this problem statement. NCHRP 780 primarily addresses left and right turn radii for the vehicles making turn moves within the intersection from highways to cross streets, however, it does not address alignment curvature of the mainline highway for vehicles passing through intersections.

Comment #2: "It is also possible that this research could take a more human factors centric approach to determine what are the thresholds of comfort and what should be a principles-based approach, which could be useful both in the near term and for future autonomous/automated vehicles."

Response to Comment #2: Caltrans is in agreement and has provided suggestions for addressing this in Section 5, Task 2, Bullets 3 and 4. Our experience suggests that drivers identify and expect left turn pocket lane shifts and are therefore more comfortable with less conservative design criteria for angle points, compound curves, and superelevation at left turn pocket approaches. Unfortunately, there does not appear to be sufficient design guidance or standards addressing these conditions. In particular, most state DOTs use up to  $\frac{1}{2}$  degree angle points on tangent alignments in place of horizontal curves, however, those state DOTs with left turn pocket approach taper standards (similar to NCHRP 780 Figure 4-6) allow for angle points greater than  $\frac{1}{2}$  degree, which implies drivers are comfortable with angle points larger than  $\frac{1}{2}$  degree when traversing lane shifts at left turn pockets. There does not appear to be guidance related to this situation that provides justification for angle points greater than  $\frac{1}{2}$  degree. We do not believe a human factors approach alone would sufficiently address this problem statement as vehicle instability is also an issue, particularly when establishing maximum angle points or curve/emax combinations.

Comment #3: "The authors should also consider use of NDS data from SHRP2 and other sources in lieu of additional field data collection. For the current scope, the requested funds are quite high."

Response to Comment #3: We are certainly agreeable to adjustments in the suggested contract funding. \$500K was simply a preliminary estimate based a few past similar studies, and we would gladly defer to the NCHRP for help in determining the appropriate funding. Also note, the tasks in Section 5 are intended as a guide at this point in the process, and we look forward to working with FHWA and the NCHRP Panel to develop a more refined workplan outline.

Response to NCHRP comments:

Thank you for your support on this problem statement. Please feel free to contact Caltrans any time to discuss any questions or concerns that may arise.

As the response from FHWA appears to have reservations regarding this problem statement, Caltrans is available to discuss and address any concerns at FHWA's convenience. Please do not hesitate to contact me if you have questions, comments, or

concerns. Thanks to everyone for your consideration. Caltrans looks forward to the next step in addressing Problem Number: 2022-G-17.

Thank You,

***John Roccanova***

Acting Project Delivery Coordinator (Districts 7 & 12)

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Sac, CA 95814

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-18**

**Problem Title**

Best Practices for Roundabout and Alternative Intersection/Interchange Lighting

**Background**

Alternative (aka "innovative") intersections and interchanges are junctions of two or more roads that do not use traditional intersection/interchange layouts. Several research projects have demonstrated the numerous safety and operational benefits of Alternative intersections/interchanges over traditional intersection/interchange configurations, as summarized in the FHWA *Alternatives Intersections/Interchanges Informational Report* (AIIR) and the *Roundabouts: An informational Guide* (NCHRP Report 672) publications.

Most alternative intersections/interchanges installed in the US to date have roadway lighting, in part because lighting is strongly recommended by both the AIIR and NCHRP 672 publications. However, lighting adds significantly to both the upfront construction cost and ongoing maintenance costs, which can be a barrier to successful implementation to such projects. Lighting can also be a barrier to implementing projects where local communities are concerned about light pollution/trespass. Some agencies have a formal or informal policy that alternative intersections/interchanges must be lit, but do not necessarily light traditional signalized intersections – a policy that may be backwards given that traditional signalized intersections typically have much greater number of conflict points for both pedestrians and vehicles than alternative intersections/interchanges.

This research would support of the following items in the AASHTO Committee on Design Strategic Plan:

2.1 Promote Flexibility in Design Practices

2.5 Play an active role in the development of guidance on climate change and energy efficiency efforts in the design of projects.

4.1 Develop and promote timely research into highway and transportation facility designs that improve safety for all modes.

This research would also support the following items in the AASHTO Committee on Traffic Engineering Strategic Plan:

Goal 2: Improve access and safety of non-motorized user groups to member department roadways.

Goal 5: Prepare and update traffic engineering technical products (which includes the AASHTO Roadway Lighting Design Guide)

### **Literature Search Summary**

Limited research is available to support the recommendations of the FHWA *Alternatives Intersections/Interchanges Informational Report* (AIIR) and the *Roundabouts: An informational Guide* (NCHRP Report 672) publications.

The proposed research would build onto 2012 NYSDOT research “*Demonstration of Roundabout Lighting using the Ecoluminance Approach*”, which investigated a technique involving landscaping in the central island and then landscaping-style low-to-the-ground lighting that illuminates the landscaping.

<https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-08-03FinalReport-Project18233-C0803.pdf>

### **Research Objective**

The intended research is intended to result in answers to the following questions:

- What are the safety benefits of lighting at various alternative intersection/interchange types?
- Can criteria be established that prioritizes what characteristics of alternative intersections/interchanges most strongly warrant lighting? For example, lighting may be more beneficial at multilane roundabouts than single-lane roundabouts.
- What are best practices for lighting design of alternative intersections/interchanges?
- For some junction types, lighting has long been recommended as a way to reduce risk of wrong-way entry, for example going clockwise in a roundabout or entering wrong-way on a DDI. Does lighting provide measurable benefit in reducing risk of such maneuvers? Note that for alternative interchanges, wrong-way entry risk may be lower than it is at traditional diamond interchanges.

Anticipated major activities:

- Literature review
- Survey of current state practices, and practices in other countries where roundabouts are more common than in the US
- Review crash data for existing alternative intersections/interchanges with and without lighting. Note that this may be challenging given that there are likely few examples nationwide of unlit alternative intersections/interchanges.
- Driver simulation analyses of various alternative intersection/interchange types with and without lighting, and with different lighting strategies.

The primary final product would be recommended revisions to the AASHTO Roadway Lighting Design Guide.



### **Urgency and Potential Benefits**

Most state DOTs are strongly encouraging use of alternative intersections and interchanges due to their significant safety and operational benefits as compared to traditional designs. However, the current recommendations out there generally strongly encourage or require lighting for all such junctions. This adds significantly to both their initial construction cost and future maintenance costs. Additionally, some communities are opposed to lighting in general, out of a mistaken belief that traditional intersection/interchange designs don't need lighting.

Additionally, some intersection/interchange designs have different vehicle paths and different vehicle speeds than traditional intersections, for example a vehicle exiting a roundabout and approaching the crosswalk at a splitter island, or designs like RCUTs that heavily rely on U-turning traffic. Lighting design requirements for traditional junctions may not apply to lighting designs at alternative intersections/interchanges.

This research would benefit all road users by potentially making it easier (more quickly, less expensive) for agencies to implement alternative intersection designs.

### **Implementation Considerations and Supporters**

This research would primarily be used by those within state DOTs responsible for lighting policy and lighting design. The research should be integrated into other existing national-level design publications such as the AASHTO Roadway Lighting Design Guide and Illumination Engineering Society's (IESs) RP-8 Recommended Practice, and be used to update the recommendations of the FHWA AIIR report and the NCHRP Roundabout Design Guide.

Training workshops and outreach to state and local road agencies would be necessary during implementation of this research and ensuring awareness of the findings.

This research would primarily be of interest to the AASHTO Joint Technical Committee on Lighting, which reports to both CTE and COD. This research would also be of interest to the Roadway Lighting Committee of IES.

### **Recommended Research Funding and Research Period**

\$750,000, 18 months

### **Problem Statement Author(s)**

Marc Lipschultz, Virginia DOT, 804-371-6022, Marc.Lipschultz@vdot.virginia.gov

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

- Mark Luszc
- 302-760-2356
- Mark.luszc@delaware.gov
- Affiliation (limited to): Delaware DOT

## **NCHRP Review of G-18**

Reviewed By: Camille Crichton-Sumners [ccrichton-sumners@nas.edu](mailto:ccrichton-sumners@nas.edu)

Comments: This topic will be of interest to practitioners responsible for innovative geometric design configurations including roundabouts. Lighting at roundabouts requires consideration of access for maintenance and impacts safety and right-of-way. The budget is sufficient; however the timeframe should be lengthened to 36 months. Data collection will require resources from within state agencies which may be a challenge.

Review Date: 12/21/2020

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## **FHWA Evaluation of G-18**

Reviewed By: HSA/Jeff Shaw

Comments:

This is needed, but rather than a revision to the AASHTO Lighting Guide, which among other things would involve a time-intensive balloting process, this would be better as a stand-alone resource that could inform an update to the AASHTO Guide at the appropriate time, as well as updates to the various alternative intersection informational guides. Given the amount of requested funding (which is unusually high for an 18-month project, so perhaps this should be a longer timeframe), this should allow for a very comprehensive scope of research, including a thorough vetting of existing state policy, cost and maintenance issues related to intersection lighting. The emphasis should be on maximizing the benefit-cost ratio with respect to intersection lighting across multiple conventional and alternative contexts, and should explicitly address the lost opportunities related to not lighting conventional intersections to the same extent.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-G-18**

**From:** [email: mark.luszcz@delaware.gov]

**Comments:** I agree that the product of this research should be able to be utilized as a standalone guide, with the longer term intent of updated the AASHTO Lighting Guide. I also agree with the comments of both reviewers that a longer schedule should be used than the one originally proposed.

**Contact Info:**

mark.luszcz@delaware.gov  
302-760-2356

Review Date: 12/31/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER: 2022-G-19**

**PROBLEM TITLE**

Work Zone Intrusion Frequency and Characteristics

**RESEARCH PROBLEM STATEMENT**

Traffic intrusions into work zones, when they occur, present a significant safety risk to construction, maintenance, and utility workers. According to the Bureau of Labor Statistics Census of Fatal Occupational Injuries, “struck-by” crashes are a major cause of roadway construction worker deaths. Motorists are also at risk when intruding into a work zone, potentially colliding with work equipment and materials.

Unfortunately, the rate at which intrusions occur, and the factors that influence that rate, are not well understood at this time. As a result, it is difficult to quantify possible benefits of intrusion mitigation strategies (e.g. use of positive protection, intrusion alarms, etc.) or determine when and where such strategies are cost-effective. Recent advancements in sensor technology (such as 360-degree lidar, thermal cameras, machine vision, and others) now allow vehicle trajectories to be tracked and could be used to monitor work zones and systematically collect intrusion data. Research is needed to determine which technologies are best suited for this purpose, and then to quantify and characterize intrusions that occur into work zones when using that technology.

**LITERATURE RESEARCH SUMMARY**

A 2019 Associated General Contractors (AGC) of America survey found that 67 percent of contractors reportedly had a vehicle intrude into one of their work zones during the year. It was also reported that 8 percent of respondents had one of their workers killed in a work zone crash, and 28 percent had a worker injured by a vehicle crashing into their work zones (AGC website, May 23, 2019). The New York State Department of Transportation has tracked work zone crashes on its roadways for many years. Analyses of their data indicates that work zone intrusion crashes comprise 9 to 10 percent of all work zone crashes that are tracked (Bryden and Andrew TRR 1657, NCHRP 627). Approximately 20 percent of intrusion crashes involve a collision with a worker on foot; the remainder involve collisions with construction vehicles, equipment, materials, or debris within the work space. Unfortunately, similar data are not available from other states to compare with these numbers. Furthermore, data are not available on the number of intrusions that occur but do not result in a crash because the driver is able to turn the vehicle back into the travel lane.

Due to the lack of actual data on intrusion frequencies and characteristics, it is difficult to assess work zone safety impacts during project planning and design. For example, recent efforts to quantify the benefits and costs of positive protection have relied on the

Roadside Safety Analysis Program (RSAP) (NCHRP 581, TTI Report 6163-1, Idaho Transportation Department Report RP-228). The program performs an encroachment-based hazard analysis. However, it is not known how well this model reflects intrusion potential into work zones that are in travel lanes, that have lane shifts, or that have other work zone features which may also influence intrusion risks.

## **RESEARCH OBJECTIVE**

The objectives of this research are as follows:

1. Perform an assessment of the technologies and methods available to detect work zone intrusions.
2. Use appropriate technologies and methods to collect data on work zone intrusion frequency and characteristics at a sampling of work zones nationally.
3. Develop predictive models and methods to estimate intrusion likelihood as a function of key roadway, traffic, and work zone variables based on the collected data to improve work zone safety management decision-making.

## **URGENCY AND POTENTIAL BENEFITS**

Current regulation (23 CFR 630 subpart K) requires consideration and management of road user and worker safety in work zones. The processes, procedures, and/or guidance shall address the use of positive protection devices, exposure control measures, other traffic control measures including uniformed law enforcement officers, and the safe entry/exit of work vehicles onto/from the travel lanes. Data on actual intrusions is urgently needed to assist agencies in making work zone safety management decisions.

## **IMPLEMENTATION CONSIDERATIONS AND SUPPORTERS**

State DOTs will utilize the results of the research to update and expand their current processes and procedures for determining when and where to include appropriate work zone safety management strategies to reduce work zone intrusions and improve overall work zone safety.

A decision-support tool in Microsoft Excel or similar software should be developed to aid in implementing the predictive models and methods. Webinars to increase awareness of the research results should also be included.

Members of the AASHTO Committees on Construction and on Traffic Engineering would be interested in this research.

## **RECOMMENDED FUNDING AND RESEARCH PERIOD**

\$600,000 over 2 years (Note: Expected FHWA support of \$75K if this problem statement is selected)

## **PROBLEM STATEMENT AUTHORS**

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TRB Work Zone Traffic Control Subcommittee (Committee on Traffic Control Devices (ACP55))

### **POTENTIAL PANEL MEMBERS**

Members of the AASHTO Committees on Construction and Traffic Engineering  
Work Zone Safety Practitioners including contractor representatives  
Safety data collection and analysis experts

### **PERSON SUBMITTING THE PROBLEM STATEMENT**

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### **NCHRP Review of G-19**

Reviewed By:  
Leslie C. Harwood  
LHarwood@nas.edu

Comments:

This research directly addresses 23 CFR 620 subpart K and thus is an important topic for all DOTs. The proposed project has the potential to ultimately increase the safety of highway workers and decrease fatalities in work zones through the analysis of work zone intrusions and the identification of technologies which are best suited to monitor and collect intrusion data. The timeline for this work is appropriate, however the budget is unclear; I am not sure whether it is a total of \$600,000 meaning that \$525,000 comes from NCHRP and \$75,000 from FHWA support mentioned. \$600,000 should be sufficient for this work.

Review Date:

1/5/2021

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**Submitter Response for 2022-G-19**

**From:** [email: Jawad.paracha@dot.gov]

**Comments:**

600K is total budget. 525K from NCHRP and 75K from FHWA. Thanks!

**Contact Info:**

Jawad Paracha

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Federal Highway Administration

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**Review Date:**

Jan 8, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-20**

**Problem Title**

Identifying Operations Performance Measures and Targets

**Background**

One of the foundations of a successful TSMO program is performance measurement, the focus being on effective operations of the system rather than before-and-after analysis of projects or developing needs for investment. Availability of data (HERE, Inrix, ATSPM, Bluetooth, MVDS, Toll Tags, Connected Vehicle, etc) needed to measure performance has never been better.

The challenge is to understand what performance measure should be looked at to determine the impact of operations and what constitute reasonable targets for some of these different metrics and effective methods for setting targets to allow system operators to evaluate themselves to determine how well they are managing their freeways, arterials, and express lanes. Performance is complex with different realistic outcomes based on level of congestion and goals in urban, suburban, and rural areas. Growth in the background demand traffic means that baselines need to adjust over time for measures such as number of hours of congestion.

Future-focused investments, like CAV, have significant long-term impacts. Should performance measures should be consider in the light of this emerging technology.

**Literature Search Summary**

A literature search brought up an extensive and well-planned effort on performance measurement being overseen by FHWA: the Operations Performance Measures and Management (OPMM) Program Road Map. The proposed research in this problem statement differs from the overarching OPMM effort in several significant ways.

OPMM shows how external measures can be expressed to deal with the longitudinal performance measures use as Travel Time or Travel Time Reliability. The urban congestion trends looks at PTI, TTI, and hours of congestion. There is a discussion of using mode neutral performance measures to balance transit. There are also links to project-specific performance measures

There are great pieces in place for most of the components mentioned. Rolling them together to determine the set that are agnostic to implemented technology, forms a baseline. Further the existing research cab provide a means to add context for how the baseline would adjust over time.



Missing from the effort thus far target setting from this baseline. Developing targets needs to consider what a realistic impact could be. How it can be separated from the background growth in a meaningful way to show the impact of operational strategies are having on the performance measures.

This research would leverage the great work done by OPMM, add the new component of target setting, and wrap everything into a set of guidance.

### **Research Objective**

To develop operations performance measures and targets that apply to the Freeway, Express Lane, and Arterial Networks that take into account data availability, accuracy, and precision, and that can be used with current and future technologies to allow system operators to determine their level of performance relative to benchmarks.

### **Urgency and Potential Benefits**

Performance Measurement is one of the core pillars as reflected by its place in the capability maturity model. Nationally, investments in arterials, express lanes, and freeways are ongoing, making performance measurement of these systems a critical issue. Best use of data available from third parties, connected vehicles, and other sensors is an issue for all agencies.

### **Implementation Considerations and Supporters**

These performance measures could be implemented at a statewide level or within regional areas, depending on the structure of the implementing organizations. Implementation would vary by location. Understanding the focus is on improving performance and not just a report is critical. This would affect more of the boots on the ground and therefore a more direct outreach such as webinars or a guidebook is needed.

The development of a guidebook that shows the discuss not only the conclusion of what performance measures and targets are appropriate but also discusses how they can be used to improve operations. This should be as short as possible. No more than 15 pages. A similar focus on a webinar would aid in sharing the message with states, but again brevity is key. Peer to peer after early adopters use the material would aid in widespread use, but is more of a long-term prospect.

### **Recommended Research Funding and Research Period**

Total duration: 18 months

Total cost: \$275,000

### **Problem Statement Author(s)**

Anyone may author or contribute to an NCHRP problem statement, and should be identified in this section.

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### **Others Supporting the Problem Statement**

- N/A

### **Potential Panel Members**

- N/A

### **Person Submitting the Problem Statement**

Provide contact information for the individual submitting this problem statement.

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  - Florida DOT
- 

### **NCHRP Review of G-20**

#### Reviewed By:

B. Ray Derr  
rderr@nas.edu

#### Comments:

The proposed research is appropriate for the NCHRP but many aspects of the problem statement are being addressed by current efforts.

- NCHRP Project 08-145, "Utilizing Cooperative Automated Transportation (CAT) Data to Improve Freeway Operational Strategies," (<https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4956>) will be looking at freeway performance measurement but will not be looking at setting targets for performance. That contract is expected to start around 4/1/21.
- NCHRP Project 08-119, "Data Integration, Sharing, and Management for Transportation Planning and Operations," (<https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4543>) is developing several products to help agencies manage performance data from several sources. The products are (1) Pilot Integration of ITS Transit Data in an Integrated Corridor Management (ICM) System, (2) Assessment of Real-World Connected Vehicle Datasets, (3) Guidance and Demonstration for Improved Conflation and Geodata Reference Process, (4) Pilot Integration of Big Data for Freight Transportation Planning and Operations, (5) Data Sharing Resources Guide for Shared Mobility Data, (6) Pilot Integration of IoT Data with the WZDx, (7) Demonstrated Use and Value of Crowdsourced Data Integration, and (8)

Short Documents Synthesizing Outputs/Lessons Learned from Developing TIM Big Data Pipelines and Use Cases.

- NCHRP Project 03-137, "Algorithms to Convert Basic Safety Messages into Traffic Measures," (<https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4550>) will be finished in early 2021.
- NCHRP Problem Statement 2022-G-21, "Future Proofing Automatic Traffic Signal Performance Measures Systems for Scalability, Transferability, and CAV Integration," has also been submitted for the current NCHRP cycle. It will look at extending the ATSPM capabilities in several ways, including incorporating all travel modes and considering performance at a broader scale than the intersection.

I recommend the authors review the work described above and determine whether the problem statement should be rescoped. None of them address setting performance targets and guidance for this could be useful.

Review Date:  
12/18/2020

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## **FHWA Evaluation of G-20**

Reviewed By: HOFM/Jeff Purdy, HRDO/Govind Vadakpat

### Comments:

HOFM/Jeff Purdy - This is an important subject matter that will help inform efforts we have underway at FHWA with TPM. It is not clear if this will relate to the MAP-21 performance measures from LOTTR, TTTR, and PHED. This should consider corridor-specific data to be able to assess effectiveness of TSMO strategies and will need to compare that to other factors, such as growth in VMT and other improvements made to the corridor. Consideration should also be given to how corridor specific performance improvements can be projected for future performance and how this can be rolled up to the MPO or state level for overall targets. Consideration of future CAV implementation seems like it should be a separate research project, and this project should focus on current or near-term TSMO strategies.

HRDO/Govind Vadakpat - (1) The objectives need to be clarified. How is this effort different than the methodologies established by FHWA's Transportation Performance Management (TPM) program? (2) Is the focus of this project to incorporate emerging technologies to incorporate into the performance measurement framework or to generate new performance targets for various facilities?

Review Date:  
12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-21**

**Problem Title:** Future-Proofing Automatic Traffic Signal Performance Measurement Systems for Scalability, Transferability, and CAV Integration.

**Background:**

In the United States, more than 300,000 traffic signals are currently in operation. According to the Federal Highway Administration, the operation and performance of most of these signals are assessed through citizen complaints. Historically, agencies have been forced to rely on manual counts input into software and simulation models to develop timings, with the presumption that if there are no public complaints, then everything is working acceptably, often compromising on performance and efficiency as user demand changes.

Automated Traffic Signal Performance Measures (ATSPMs) started in the mid-2000s with the collection and analysis of high-resolution event-based data for traffic signal performance. Since then, researchers at Purdue University along with practitioners at the Indiana Department of Transportation, Georgia Department of Transportation, and Utah Department of Transportation have evolved the use of event based data into a method of assessing and improving the performance of traffic signals, traffic signal systems, and traffic signal system business practices. From a technical standpoint, the suite of ATSPMs can allow an agency to monitor capacity, progression, multimodal, and maintenance performance measures without the added expense of a central- or adaptive traffic signal system. These performance measures can be developed through robust communication and typical traffic signal detector information, though additional detection is required to take advantage of all the performance measures. For the sake of consistency, we would like to first introduce some of the commonly used terminology throughout this proposal:

High resolution controller data schema- A well-documented schema for high resolution controller data was developed and documented in a research effort led by Purdue University. This standard has been implemented by multiple traffic signal controller manufacturers to log traffic controller change events ranging from detector on and off to pre-emption calls.

Geo-spatial metadata- This term is used in this proposal to describe the information that is collected at an intersection to associate high resolution controller data to the roadway. This metadata can include information such as detector to roadway mapping, type of detector, right of way rules, right of way to phase mapping, speed limits etc. Currently there is no well documented open-source standard available for recording this information.

Signal timing plans- This information will include the signal timing details ranging from cycle, splits and offsets to maximum allowable headway that are used to determine the sequence and duration of timing intervals.

An open source software was developed by Utah DOT for delivering ATSPMs through a web-based system. Other agencies such as Georgia DOT have developed extensions to the software, and several vendors have integrated ATSPMs into their own proprietary systems as well. These systems primarily present raw data in graphic representation with the goal of providing visual tools for signal operators.

The experiences of users of ATSPMs and those who have been actively developing the methodology have revealed the following limitations of the current high-resolution data scheme on which the performance measures are founded:

Lack of common methods for describing geo-spatial information (“metadata”). While the current open-source tool uses a well-documented schema defined for high-resolution controller data, no standards have been established for geospatial information associating lanes with a particular phase or detector with a particular approach. This leads to differences between agencies on how to mark and store this metadata. As an example, GDOT has to maintain this geo-spatial information in three different formats: one for the ATSPM system, second for their central software system, and finally for their connected autonomous vehicle system. Due to the lack of commonly accepted schema or easy conversion from one format to another, an agency essentially duplicates its effort in creating this information and managing it. In addition, since there are no guidelines about managing this information each agency handles complex cases slightly different and with no means to transfer this knowledge. This research will develop a unified methodology, guidance document and easy to use tool that builds upon the state-of-the-art implementation of current detector mapping and phase mapping, available MAP (SAE J2945 standards) standard and internal tools developed by different commercial ATSPM providers. This will eliminate the need to maintain duplicate geo-spatial information repositories for the same intersection. Addition of consistent management of information will pave the pathway for creating scalable innovative solutions that don’t have to be customized for each individual agency.

High resolution controller data only stores changes in states - The only form of dynamic information that was standardized for ATSPMs was on and off events. These were the most common information available at an intersection at that time. The recent advances in connected autonomous vehicle (CAV) and sensor technology have enabled access to short term trajectory information as the vehicle/pedestrian approaches the intersection, e.g. spatial coordinates, heading, speed, timestamp, and mode. This research will explore the possibility of expanding existing techniques and schemas for storing the dynamic data at an intersection to include short-term trajectory information. This ability can significantly improve performance measure reporting beyond changes in states at a signalized intersection. As an example, short-term trajectory information can be potentially used to measure and report safety measures such as the time-to-conflict which can’t be done

currently. This capability will also ensure the traffic signal information management system can integrate new data sources by providing it with an ability to store messages from connected vehicles and new sensor technologies.

Unavailability of data management and archival process- The current system was designed to handle streaming data at a reasonable scale. Over time, the agencies have faced an important decision on how historical data should be managed. Questions such as ‘How long the data is maintained at the highest resolution?’ and ‘What is the optimal scheme for compressing the data over time and ongoing issues?’ are generally answered differently by various agencies. The inclusion of trajectory data will further exacerbate this issue. There is a need rethink the data architecture to better manage the continuously growing data. This project will carefully analyze the life-cycle of the data from data creation, data use to data archiving to provide guidelines for efficient management. As an example, GDOT could reduce their data size from 40TB to less than 10 TB by just compressing the data into paraquet format. There is a need to design statistical approaches for data pruning, efficient approach for data processing and sharing, and well thought out processes for deriving information that needs to be stored for a longer time rather than maintaining raw data for perpetuity.

Lack of holistic performance measurement- The current performance measures produced by open-source ATSPM software are focused on automobile vehicle efficiency. There is a need to expand these performance measures to include safety, transit, walking cycling, and micro-mobility traffic, and network/citywide performance by exploring emerging data sources such as machine vision and crowd-sourced micro-mobility data. These shortcomings limit the scope of the data to a static perspective on intersection operations that risks becoming obsolete with the introduction of new technologies into transportation systems, such as connected and automated vehicles. ATSPM systems have demonstrated the value in being able to document and query records of intersection operation. To enable this approach to intersection management to be maintained into the future, there is a need to reconcile existing approaches to managing intersection event data with use cases and extensions that will appear in a more connected future.

### **Literature Search Summary:**

The development of ATSPMs began with the collection of event-based data by researchers at Purdue University in the mid-2000s and the identification of tactical methods to control traffic within NCHRP 3-66. Since these original works, researchers have emphasized the development of event-based data acquisition systems that have the capability of generating high-level performance measures as well as enough data resolution capable of being used for fault recreation and signal fine tuning. Researchers at Purdue University as well as practitioners at the Indiana and Utah Departments of Transportation spearheaded the effort to move Highway Capacity Manual operational parameters from the post-processed environment to real-time performance measures in a mainstream operational environment. Whereas historical performance measure data were limited to hourly volumes, peak hour factors, and v/c values over long analysis periods, these measures use event-based data to empower an agency with the ability to make data-driven decisions regarding detector and communication health, traffic signal

coordination and split efficiency. Although this work has been a game-changer in the operation and management of traffic signal systems, thus far it has focused mostly on vehicular performance measures with a limited investigation into multimodal performance, lacks a standard for metadata, is limited to event-based actuations, and lacks practices to manage ever-growing data. Listed below are some important literature in this domain:

- Federal Highway Administration. *Automated Traffic Signal Performance Measures*. Center for Accelerating Innovation, Federal Highway Administration, Washington, D.C. [www.fhwa.dot.gov/innovation/everydaycounts/edc\\_4/atspm.cfm](http://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/atspm.cfm).
- Sturdevant, J. R., T. Overman, E. Raamot, R. Deer, D. Miller, D. M. Bullock, C. M. Day, T. M. Brennan, H. Li, A. Hainen, and S. M. Remias. Indiana Traffic Signal Hi Resolution Data Logger Enumerations. Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2012. doi: 10.4231/K4RN35SH
- <https://udottraffic.utah.gov/ATSPM/>
- Day, C. M., E. J. Smaglik, D. M. Bullock and J. R. Sturdevant. Real-Time Arterial Traffic Signal Performance Measures. Publication FHWA/IN/JTRP-2008/9. Joint Transportation Research Program, Purdue University, 2008
- Day, C. M., D. M. Bullock, H. Li, S. M. Remias, A. M. Hainen, R. S. Freije, A. L. Stevens, J. R. Sturdevant, and T. M. Brennan. Performance Measures for Traffic Signal Systems: An Outcome-Oriented Approach. Purdue University, West Lafayette, Indiana, 2014.

### **Research Objective:**

The proposed project will address shortcomings of the current conceptions of high-resolution data on which ATSPMs are founded. This will “future-proof” the data and the systems that rely on it by enabling it to integrate new data streams and enhancing its scalability and transferability to multiple agencies and jurisdictions. The main objectives of this research are as follows:

- Reconcile the diverse approaches taken to the intersection metadata problem: for example, the conception of an intersection in SAE J945 standard as compared to methods of describing detector layouts for signal control.
- Develop a standard schema for saving geospatial information required for current ATSPM systems
- Develop an open-source tool for easily generating the geo-spatial information for a given intersection
- Expand dynamic data storage standards, schema, and format to include storage of short-term trajectories available via BSM message or advanced sensors.
- Design data compression and aggregations methods to enable long-term storage of critical information to manage economics and processing speed of the system
- Enhance the performance measures to provide a more holistic view of the system.

### **Urgency and Potential Benefits:**

ATSPM systems are game changer in the field of traffic signal performance assessment and better traffic signal management. The proposed update in the system will make it more efficient and easier to implement the system at wider scale.



**Implementation Considerations and Supporters:**

The results of this research will be used by Traffic Operations and Traffic Signal Management of agencies. The tool and recommendation developed during the course of this research will make it easier for DOTs to implement a scalable system which will ready to consume data from Connected Vehicles in future. The tools could be immediately applied by agencies and vendors implementing the ATSPM system.

**Recommended Research Funding and Research Period**

Research Funding: 500,000\$. Research Period: 24 months.

**Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

Transportation Research Board Standing Committee on Traffic Signal Systems  
(ACP25)

**Potential Panel Members**

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**Person Submitting the Problem Statement**

*Peggi Knight, PE*

## **NCHRP Review of G-21**

Reviewed By:

B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. Many state and local DOTs have incorporated ATSPM into their signal system operations and the proposed work would increase its utility. The authors are extremely familiar with all of the work underway in this area and present a clear description of the work that is expected to be done.

Review Date:

12/18/2020

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## **FHWA Evaluation of G-21**

Reviewed By: HOP/HOTM

Comments:

HOP/HOTM - Given current investments and the transformative nature of ATSPM data and data visualization, it is imperative that shifts in intersection metadata and intersection geospatial schema and format be incorporated into how the data is collected and stored. This research could greatly enhance the next generation of performance measures produced using high resolution data and would protect the current methodology for ATSPM data collection from obsolescence as technology advances with the introduction of CAV.

Review Date:

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## **Submitter Response for 2022-G-21**

**From:** [email: Peggi.Knight@iowadot.us]

**Comments:**

**FHWA Evaluation of G-21**

Reviewed By: HOP/HOTM

Comments:

HOP/HOTM - Given current investments and the transformative nature of ATSPM data and data visualization, it is imperative that shifts in intersection metadata and intersection geospatial schema and format be incorporated into how the data is collected and stored. This research could greatly enhance the next generation of performance measures produced using high resolution data and would protect the current methodology for ATSPM data collection from obsolescence as technology advances with the introduction of CAV.

**Response:**

We concur. This proposed project will ensure that agencies' investment in their current ATSPM system doesn't become obsolete.

**NCHRP Review of G-21**

Reviewed By:  
B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is high. Many state and local DOTs have incorporated ATSPM into their signal system operations and the proposed work would increase its utility. The authors are extremely familiar with all of the work underway in this area and present a clear description of the work that is expected to be done.

**Response:**

We concur. The proposed work will ensure future-proofing the current system.

**Contact Info:**

[email: Peggi.Knight@iowadot.us]

Anuj Sharma  
Pitts-Des Moines Inc. Professor in Civil Engineering



**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-22**

**Problem Title:** “Develop Crashworthy Hardware Mounted on Median Concrete Barrier to Prevent Unlawful Pedestrian Crossing Without Reducing Sight Distance”

**Background**

Pedestrians are among the most vulnerable road users, especially at non-intersection locations. Median fencing is provided on a case by case basis and as a last resort where unlawful pedestrian crossing is an ongoing patterned problem. Occasionally, some DOTs need to mount chain link fences on top of median concrete barrier to prohibit the unlawful and potentially dangerous crossing of the highway by pedestrians where median concrete barrier exists. Because chain link fencing, viewed from an angle, can reduce sight distance, the fencing must stop at a significant distance in advance of the intersection. Pedestrians could still potentially use this unprotected gap for unlawful crossings.

Based on these concerns, a need exists to develop a crashworthy hardware that could be mounted on median concrete barrier installation for the purpose of prohibiting the unlawful pedestrian crossing without reducing stopping sight distance or intersection sight distance in the vicinity of intersections.

This issue addresses goals of AASHTO 2014-2019 Strategic Plan vision which “*supports members in the development of transportation solutions that create economic prosperity, enhance quality of life, and improve transportation safety in our communities, states, and the nation as a whole.*” The AASHTO Technical Committee on Roadside Safety (TCRS) Strategic Plan stated that its vision statement is to “*Lead roadside policy development, support safety innovations, and be an information resource to promote a decline in roadway departure related deaths and incapacitating injuries.*”

**Literature Search Summary**

Limited research has been conducted regarding median concrete barrier with mounted hardware that would prohibit pedestrian crossings while providing sight distance. A literature search on TRID website provided little to no results. Currently, TTI has a research titled “MASH TL-4 Concrete Median Barrier with Fence Mounted on Top (613131).” This research is to investigate the crashworthiness of a 36-inch tall concrete single slope median barrier with chain link fence mounted on top under MASH 2016 evaluation criteria. The following information below was obtained from this research problem statement on TTI’s website.

Buth and Menges (1995) conducted a research study which included the evaluation through full-scale crash testing of a 31-inch tall New Jersey shape concrete barrier with a vandal protection fence mounted on top. Testing was conducted following the

AASHTO performance level 2 impact conditions, which included a 5562-lb pickup truck impacting the test article at a speed of 62 mph and an angle of 20 degrees. The purpose of the testing was to evaluate the strength of the section in containing and redirecting the pickup and the interaction of the vehicle with the fence. The impact performance of the vandal protection fence on New Jersey safety shape railing was considered satisfactory according to the guidelines set forth in AASHTO.

In 1972, Post et al. conducted a research study which included the evaluation through full-scale crash testing of a rigidly fixed 32-inch tall Texas CMB barrier with chain link fabric fence and a luminaire mounted on top. The Texas CMB is similar to the New Jersey Median Barrier in dimensions and shape. A total of four tests were conducted with the purpose to evaluate the interaction between the impacting vehicle and the luminaire hardware posted on top of the concrete barrier.

While the research mentioned above might provide some insight into the issue, the uses of chain link fence does not provide guidance on solving the reduced sight distance and intersection sight distance issues.

### **Research Objective**

The objective of this research is to develop a crashworthy safety hardware that could be mounted on top of the median concrete barrier installation for the purpose of prohibiting the unlawful pedestrian crossing of the highway without reducing stopping sight distance or intersection sight distance in the vicinity of intersections. Engineering analysis will aid in the selection of system details to be considered for testing. The structural capacity and occupant risk factors of the proposed system will be evaluated with respect to MASH 2016 TL-4 criteria through full-scale crash testing.

- a. The desired outcome of this research will be guidance for incorporation in the future edition of AASHTO Roadside Design Guide. The final product will include guidance to agencies for the installation of a crashworthy system for the purpose of prohibiting unlawful pedestrians crossing while maintaining sight distance.
- b. The research contractor will require the following major tasks:
  - Literature review of previous research related to median concrete barrier systems that have been investigated and/or tested with mountable safety hardware on top
  - Surveying state DOTs for permanent median concrete barrier geometries and mountable hardware configurations and scenario
  - Using the results of the literature review, state DOTs survey, and engineering analysis to identify common design details of the system to be considered for further investigation
  - Determine design details of the proposed hardware mounted on the concrete barrier system to be advanced for testing
  - Evaluate the proposed system through full-scale crash testing to MASH 2016 TL-4
  - Provide generalized guidance for system

- Provide a summary report to document all design, analysis, testing, conclusions, and recommendations

### **Urgency and Potential Benefits**

There is an urgent need to develop guidance for the agencies. The information obtained from this research will provide State DOTs with an acceptable median concrete barrier system with a hardware mounted on top, evaluated under MASH 2016 TL-4 conditions. A successfully crash tested system would reduce the risks of injury or fatality for impacting errant vehicles and pedestrians performing unlawful crossings. This research will provide a measure of assurance in the placement of a hardware on top on median concrete barrier and a higher level of safety for the traveling public.

The consequences of not conducting this research is that needless severe injury and fatal crashes will likely continue to occur due to the hazard posed by the current design criteria and the resulting unprotected gap in the fence that is left to accommodate the sight distance. Continuing without such guidance will result in the inconsistent and potentially unsafe practices by user agencies.

State Transportation Agencies may utilize the results of this research for policy development for the placement of the system. It is anticipated that the results of this research will be incorporated into the future edition of AASHTO Roadside Design Guide.

### **Implementation Considerations and Supporters**

The results of this research will assist state and local standards engineers to update the standard drawings and design manuals to provide guidance on the installation of the system. With proper review, the AASHTO TCRS could assist implementation through adopting the research results into the future update of AASHTO Roadside Design Guide and MASH. Implementation could also be supported through a discussion of the findings at a TRB AKD20 meeting and the conduct of the TRB webinar.

### **Recommended Research Funding and Research Period**

Research Funding: \$600,000

Research Period: 36 months

### **Problem Statement Author(s)**

Hung Tang, New Jersey Department of Transportation, AASHTO Technical Committee on Roadside Safety (TCRS), (609) 963-1839, hung.tang@dot.nj.gov

### **Others Supporting the Problem Statement**

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### **Potential Panel Members**

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### **Person Submitting the Problem Statement**

Nileshkumar Patibandha, New Jersey Department of Transportation, (609) 963-1809, Nileshkumar.patibandha@dot.nj.gov

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### **NCHRP Review of G-22**

Reviewed By:  
David M. Jared  
djared@nas.edu

#### Comments:

This problem statement poses a good question but doesn't offer much to build on or much expectation of success. It also lacks broad support, leaving one uncertain as to how widespread a problem this is. I would consider this a lower-priority topic.

Review Date:  
1/6/2021

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### **FHWA Evaluation of G-22**

Reviewed By: HRDS/Eduardo Arispe

#### Comments:

Developing something that can discourage pedestrian crossings that doesn't obstruct sight distance and meets MASH seems like a tough task for the number of crashes that



might be involved. We also wonder what can be obtained from surveying DOTs and literature search.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-22**

Submitted By:  
Kelly Hardy  
AASHTO Staff  
Committee on Safety

Priority #: N/A

Comments: While safely guiding pedestrians across roadways is a high safety priority, few severe crashes occur in locations prohibiting pedestrian crossings with physical barriers. There is potential for this project for saving lives, this is not the main cause of the majority of pedestrian crashes in some states. Rating 2.3

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-23**

**Problem Title**

Leveraging Existing Traffic Signal Assets to Obtain Quality Traffic Counts

**Background**

State DOTs, MPOs, and counties manage extensive traffic count programs and continue to have a need for adequate coverage of traffic count data, including bicycle and pedestrian counts. The counts support decision making that aims to enhance safety and mobility for the traveling public. Meanwhile, there are thousands of existing traffic detection devices throughout the nation that serve traffic management operations. However, many non-traffic operations customers of traffic count data such as traffic engineers, traffic monitoring staff, transportation and active transportation planners, data scientists and other non-transportation stakeholders are in need of traffic counts to combine data sets in new ways to support various business processes.

As sensor detection technologies mature in assisting traffic operations and ITS programs, traffic count program providers recognize the potential benefits of using existing infrastructure and data to supplement their counts. However, issues arise concerning the diverse efforts underway that are not summarized, publicized, or leveraged. Furthermore, there are concerns associated with using the data from traffic signals gathered for traditional traffic volume measurement that are not fully understood. For example, typical issues often encountered with capturing and harnessing data from traffic signal equipment include:

- Inconsistency in data quality that varies across vendors and technologies
- Inconsistency in availability of sensors at all intersections
- Variable configuration of sensor equipment causing possible gaps in data availability and quality even though the equipment itself may be capable of counting vehicles, bikes, and pedestrians.

The suitability of traffic count data from already installed and existing traffic devices will be ascertained during this study to determine if existing traffic equipment can be used to collect, store, and disseminate data for purposes other than traffic operations. The research will evaluate a minimum of at least five types of currently installed traffic devices and provide an assessment of traffic count data suitability for non-operational traffic data usage evaluation.

Research questions to be addressed include:

1. Is it possible to obtain accurate ( $\pm 10\%$ ) traffic count data from existing traffic signal assets? If yes, the method of obtaining traffic counts will be documented. If not, the reason why traffic count data cannot be obtained will be documented.
2. What is the quality and completeness of traffic count data obtained from existing traffic signal assets?
3. What is the appropriate use of traffic count data obtained from existing traffic signal assets? Is the traffic signal data limited to operation usage only, why or why not?
4. What methods of data handling, storage, and quality assurance and quality checking (QA/QC) need to be implemented to obtain traffic counts from existing traffic signal assets?
5. What challenges exist in obtaining traffic count data from existing traffic signal devices?
6. What agencies are currently collecting traffic count data from existing traffic signal devices? What are their incremental costs for these efforts?

This problem statement is consistent with the AASHTO Committee on Data Management and Analytics Strategic plan and directly supports the following Committee Goals and Strategies: Goal 3, Strategy 1 – Work to understand needs and develop guidance, and communicate data standards; Goal 4 – Strategy 2 – Document and share with member agencies successful industry practices on the application of data and analytics to better inform decision-makers and support the decision-making process; Strategy 3 – Facilitate the development and advancement of tools to support decision-making data and analytic needs; Strategy 5- Explore and summarize national trends and successful practices related to data management and analytics; Goal 5 – Strategy 3 – Sponsor, coordinate and disseminate research to advance best practices in the management, use and standards related to data and analytics.

### **Literature Search Summary**

Several studies (<sup>33,34,35,36</sup>) have examined the accuracy of traffic volume estimates developed using a combination of traffic, probe, and U.S. Census data; however, there is limited to no information in the literature about how to obtain traffic counts from traffic signal equipment. An existing literature review should be conducted and summarized in a best practice, lessons learned, and current state of the practice evaluation document.

### **Research Objective**

The objectives of this research are to:

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<sup>33</sup> Turner, S., and P. Koeneman. Using Mobile Device Samples to Estimate Traffic Volumes. *Final Report MN/RC 2017-49*, Minnesota Department of Transportation, December, 2017.

<http://mndot.gov/research/reports/2017/201749.pdf>.

<sup>34</sup> Tsapakis, I., L. Cornejo, and A. Sanchez. *Accuracy of AADT Estimates from Probe Data at Border Crossings*, CIITR Project, January, 2020. <https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-2020-1.pdf>.

<sup>35</sup> Turner, S., and I. Tsapakis. *Task 2 Summary Report Evaluation Methods and Results for Validating AADT Estimates from Mobile Device Data*. Minnesota Department of Transportation, July, 2020.

<sup>36</sup> Federal Highway Administration, *Exploring Non-Traditional Methods to Obtain Vehicle Volume and Class Data*. Transportation Pooled Fund Study TPF-5(384), FHWA, Washington, D.C. (expected in 2021).

- a) Gather the active support and participation of agencies across the nation that include city, county, state, federal, and private entity partners.
  - b) Identify and summarize existing and in-development methods for obtaining traffic counts from existing traffic signal assets including, but not limited to, signalized intersections, cross walk signals, and other traffic detection devices. Technologies including video, loops, magnetometers, radar and autoscope should be considered.
  - c) Identify good practices that can be adopted by the traffic monitoring community.
  - d) Identify challenges associated with leveraging the data from these devices.
  - e) Summarize improvements or solutions to these challenges including, but not limited to, standards, pooled fund studies, additional research needs.
- Prepare a final report documenting the results of this study in a form to be used as a “best practice guide for obtaining traffic counts from existing traffic devices”. Future communication of the results can be disseminated through webinars, training, and peer exchanges.

### **Urgency and Potential Benefits**

This need was first identified by the TRB Traffic Monitoring Committee ACP70 in 2016. Although there have been advancements in this area since then, the need still exists and is even more prevalent with advanced technology and the development of new data sources from controllers and detection equipment at intersections. These data support Automated Traffic Signal Performance Measures (ATSPM) and more recently have changed the ability to count traffic with traditional methods because of the COVID-19 pandemic.

Being able to leverage traffic count data from existing signal and intersection control equipment will not only save money for traffic count programs, but will improve safety of traffic count personnel by eliminating field work at many higher risk locations where traffic signals are placed. Taking advantage of counts from existing traffic operations devices will also benefit signal operating agencies by potentially introducing joint funding opportunities.

Those benefiting from this research include state, county, MPO, and city traffic program managers; signal operating agencies; and the public at large (due to resource saving and increased safety and mobility due to improved data and decision-making).

### **Implementation Considerations and Supporters**

The following state DOT offices will be involved in implementing the results of this research: Planning, Programming, Traffic Operations, Transportation System Management and Operations (TSM&O), and Design.

States will be able to implement the research by adopting lessons learned from other entities. Implementation will be supported with communication methods such as webinars, training, and peer exchanges. The AASHTO Committee on Data Management and Analytics will be a key benefactor of these results.

### **Recommended Research Funding and Research Period**

*Funding Requested: \$250,000, Research Period: 18 months.*

**Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

- TRB Traffic Monitoring Committee (ACP70)
- Traffic Signal Systems Committee (ACP25)
- Urban Data Committee (AED20)
- TRB Regional TSMO - Data for Operations Subcommittee ACP10(1,3)
- Virginia DOT, North Carolina DOT, Ohio DOT

**Potential Panel Members**

- Scott H. Brady, Planner VI, (808) 768-8355, Department of Transportation Services, Regional Planning Division, City and County of Honolulu
- Chade Saghir, SEMCOG, 313-324-3342, [saghir@semcog.org](mailto:saghir@semcog.org)
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*If this problem statement is submitted by an AASHTO Committee or Council,*  
please recommend Committee or Council members as potential panel members.

- Member name, state, AASHTO Committee or Council, phone, and email address

**Person Submitting the Problem Statement**

*Kent L. Taylor*  
919 345 9829

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North Carolina Department of Transportation

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**NCHRP Review of G-23**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

Comments:

This topic will be of interest to transportation practitioners requiring traffic counts. Review of traffic signal technologies for use to capture traffic counts could produce cost savings in the long run but will present challenges that will be explored in this study. The

suggested tasks will require additional resources. A budget of 450K and a 30 months timeframe.

Review Date: 12/21/2020

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## **FHWA Evaluation of G-23**

Reviewed By: HOP/HOTM

Comments:

HOP/HOTM - The research objectives focus in on the feasibility, current practices and challenges of using existing infrastructure to support collection of traffic count data. A supplemental objective that was not articulated was the benefit/cost associated with the approach. It is likely that this information would be readily available or could be synthesized as part of this research statement.

Review Date:  
12/18/2020

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## **Submitter Response for 2022-G-23**

**From:** [email: kltaylor@ncdot.gov]

**Comments:**

In response to the FHWA review, we agree with their recommendation to add a benefit/cost objective as part of the study. A sixth objective can be added to Section 5 Research Objective. For example:

f) Determine benefits and costs of obtaining traffic count data from traffic signals.

In response to the NCHRP review, we concur with the recommendation for additional funding and time for this study. Taking into account the addition of a sixth objective, increasing the budget and the duration of the project as suggested by the reviewer is considered appropriate. Recommend adjusting the budget to \$450,000 and 30 months as suggested by the reviewer.

**Contact Info:** Kent Taylor  
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Raleigh, NC 27699-1554

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kltaylor@ncdot.gov

Review Date: 1/16/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**NCHRP PROBLEM STATEMENT for Research Beginning in FY 2022**

**Problem Number: 2022-G-24**

**Problem Title**

Integrating Safety into Development Reviews

**Background**

The criteria for development reviews has historically been focused on the evaluation of traffic operations with limited focus on safety or multimodal considerations. A more extensive application of traffic operations may have evolved from the availability of the Highway Capacity Manual (HCM) that provided quantitative measures to evaluate operational effects of the additional traffic and roadway access. However, a growing issue with operational measures is that there has been a shift in the perception by many of congestion. What had been viewed as a negative impact that needed to be mitigated, is now viewed by some as a positive effect that helps discourage driving and the associated increases in vehicle-miles traveled.

Safety has been a consideration, but is often dealt with more subjectively and qualitatively or based on design standards. As a result, safety impacts of new developments or redevelopments may not be adequately addressed. At all levels, transportation agencies are adopting “Vision Zero” goals and policies for reducing fatalities. They are seeking every opportunity to achieve these goals. Being able to quantify and then incorporate safety measures both at the planning stage during the Transportation Impact Study, and later in the design stage during the access permitting would be beneficial.

Quantifying safety measures had been limited due to the lack of a safety equivalent of the Highway Capacity Manual (HCM). However, the development of crash modification factors, publication of the Highway Safety Manual (HSM) in 2010, and subsequent research has now provided quantitative tools that enable the application of safety measures in the evaluation.

As indicated on the HSM website, the HSM provides practitioners with information and tools to consider safety when making decisions related to design and operation of roadways. It may be used to assist practitioners in selecting countermeasures, prioritizing projects, comparing alternatives, and quantifying and predicting the safety performance of roadway elements. The HSM website notes that, prior to the HSM, there was no widely accepted tool available to quantitatively assess the impact of infrastructure decisions on safety. Its availability provides effective tools to assist the review process and be more effective identifying and addressing safety impacts.



Other tools, both quantitative and qualitative, that are related to multimodal considerations may be available to help in the access review process. Another new tool that would help in the development access review process is Intersection Control Evaluation (ICE). This tool can be used to objectively screen alternatives and identify an optimal geometric and control solution for an intersection that could be created or changed to accommodate new development access. Agencies that have applied ICE policies are realizing several benefits, including the implementation of safer, more balanced, and more cost-effective access solutions related to intersection or encroachment approvals, new traffic signal requests, and impact studies for development. This research project will:

- Identify the HSM factors and other tools, and assess how they may be integrated into preparing transportation impact studies and the review of access permit applications.
- Develop a practitioner's guide to identify how these safety factors and other tools may be used to predict crashes and develop and rank access management solutions to achieve outcomes that better mitigates adverse impacts.

This research is directly related to the following two goals of the Strategic Plan of the AASHTO Standing Committee on Highway Traffic Safety:

- Goal 1—Partner in development and implementation of a national highway safety strategy and development of appropriate performance measures in order to reduce fatalities and serious injuries on all public roads.
- Goal 2—Institutionalize the HSM and its associated analytical tools to make data-driven decisions, advance the science of safety, and to ultimately reduce fatalities and serious injuries.

The research is also related to the AASHTO Council on Highways and Streets and many committees including: Safety; Traffic Engineering; Planning; Design, Maintenance; and ROW, Utilities, and Outdoor Advertising Control.

### **Literature Search Summary**

There is no current national guidance for incorporating HSM factors into the development review, and access and encroachment permitting processes. In general, research has focused on the process and requirements for performing transportation impact studies. As indicated below, the literature search confirmed there is a need for this research.

- NCHRP Synthesis 304: *Driveway Regulatory Practices*, 2002, found driveway regulation practices vary widely from state to state.
- *Best Practices for Traffic Impact Studies*, Oregon DOT and FHWA, June 2006, found that "Safety is an important consideration for transportation planning and design, but elements of safety analysis are often ignored in TISs". It added that "Safety evaluations of roadways are needed to determine the expected safety performance and to identify modifications that will maintain or improve existing safety conditions ....".
- NCHRP Synthesis 404: *State of the Practice in Highway Access Management*, 2010, found safety was specifically identified as a factor by only about five states.

- *TRB Access Management Manual*, 2nd Edition, 2014, dedicated a chapter to the access permitting process, explaining the general procedures and considerations
- *A Best Practice Evaluation of Traffic Impact Assessment Guidelines in Australia and New Zealand*, from the Australasian Transport Research Forum 2016 Proceedings, November 2016 included a safety element that addressed the emphasis on safety impacts in the guidelines from national and state agencies in Australia and New Zealand. The effort identified the extent to which safety was included, ranging from “no requirement” to “detailed assessment required ....”
- *Incorporating Data-Driven Safety Analysis (DDSA) in Traffic Impact Analyses: A How-To Guide*, FHWA, 2019, indicated that “Incorporating safety into TIAs (traffic impact analyses) will help highlight safety issues during the project development phase before any construction is completed, thereby enabling the development of safer roadways.” It identified general DDSA action items that could be applied to help implement safety in TIAs.
- *Multimodal Transportation Impact Assessment for Site Development: An ITE Recommended Practice Update - Purpose and Need*, August 2017 (Draft), noted an update is needed for a variety of reasons, including an “increasing understanding of differences in travel behavior across a variety of land use types and contexts from urban to rural”, “an interest in measures of effectiveness beyond traditional auto Level of Service (LOS) ...”, and “a recognition that traditional level of service measures based on roadway capacity thresholds often result in “free rider” or “last-in” concerns ...”.
- California Governor’s Office of Planning and Research, *Technical Advisory on Evaluating Transportation Impacts in California Environmental Quality Act (CEQA)*, December 2018, proposed “changes to the CEQA Guidelines that identify vehicle miles traveled (VMT) as the most appropriate metric to evaluate a project’s transportation impacts...” and that “automobile delay, as measured by “level of service” and other similar metrics, generally no longer constitutes a significant environmental effect under CEQA”.

## Research Objective

The objective of this research is to develop guidance for agencies and other stakeholders to use to update their development review and permitting processes to better integrate safety and other measures that identify and mitigate potential adverse impacts to achieve a better outcome. Major tasks associated with this research are expected to involve:

- Locating and assembling documented information and complementary research as well as surveying agencies to identify the process and tools used, deficiencies in the process, and suggestions for areas for improvement.
- Identifying and assessing more recently developed tools, including their benefits and limitations, to consider for possible integration into the access review process.
- Developing guidance regarding recent tools and options to enhance current access-review processes to better address adverse impacts and determine mitigation.

The research effort could include surveys, focus groups, or the like to assist in meeting the objectives. The results will be presented in a report that includes guidelines an agency could use to evaluate its current access review process and to identify tools and other enhancements that could be applied to better address safety and/or other considerations.

### **Urgency and Potential Benefits**

This research will help inform management of location and design of access related to development by addressing potential safety impacts. There is a real need for safety to be fully integrated into the development review process by applying tools that did not exist when the process was established. This research effort will help address the nearly 3.5 million access related crashes that occur annually across the US and assist agencies to reach their Vision Zero goals.

### **Implementation Considerations and Supporters**

The development review and permit management functions may be located within an agency's traffic, planning, operations, design, maintenance, and/or right-of-way units and involve coordination among multiple units. As a result, staff responsible for implementing the results could be based throughout the agency. In addition, guidance developed by this research may be used by professionals at all levels of government to help them make development and access management decisions that better reflect safety and other tools that may not be part of the current decision-making process. This research would be useful to state and city DOTs, metropolitan planning organizations, regional planning agencies, developers, and others interested in mitigating the safety impacts of development.

### **Recommended Research Funding and Research Period**

The cost to complete the research will be approximately \$400,000, requiring approximately 24 months.

### **Problem Statement Author(s)**

- Jerry Gluck, Member - ACP60, 212-973-2962, AECOM, [Jerome.Gluck@aecom.com](mailto:Jerome.Gluck@aecom.com)
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### **Others Supporting the Problem Statement**

- N/A

### **Potential Panel Members.**

- Mike Reese, AKD10 member, NCDOT, 919-814-4938, [mikereese@ncdot.gov](mailto:mikereese@ncdot.gov)
- Marsha Fiol, AEP10 member, VDOT, 804-786-2985, [Marsha.Fiol@vdot.virginia.gov](mailto:Marsha.Fiol@vdot.virginia.gov)

**Person Submitting the Problem Statement**

- Mike Reese, AKD10 member, NCDOT, 919-814-4938, mikereese@ncdot.gov
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**NCHRP Review of G-24**Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

Comments:

The objective of this project is very clear and the problem stated should be solvable through this project. The current project and interim results of NCHRP Project 17-71 updating the HSM should be reviewed to inform this project. The budget and timeline for this project are appropriate.

Review Date:

1/5/2021

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**FHWA Evaluation of G-24**

Reviewed By: HRDS/Clayton Chen

Comments:

HRDS/Clayton Chen - FHWA has promoted and continues to promote the integration of safety into all stages of the project development cycle through various programs and initiatives as noted in this proposal. Much more is needed to help provide guidance on how State and local agencies can update their processes for development reviews.

Review Date:

12/18/2020

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-25**

**Problem Title**

Simulating Mixed Heterogeneous Traffic Flows for Better Assessment of Heavy Vehicles

**Background**

Heavy vehicles have significant impacts on the system performance of our facilities. These impacts increase when these vehicles operate on grades, especially in situations when there is a need to accelerate and/or decelerate; particularly when they carry heavy loads. Traffic analysis models and tools are needed to assess the impacts of capacity improvements, new automated and connected vehicle technologies such as vehicle platooning, as well as transportation system management and operations (TSMO) strategies such as freight signal priority and transit signal priority. When evaluating facilities with analysis tools, traffic flow dynamics at both the macroscopic (e.g., capacity, jam density) and microscopic (e.g., lane-changes, shockwave propagation patterns) levels should reflect real-world conditions to provide confidence in the ultimate project decisions informed by the use of these models. In current practice, several of the popular macroscopic simulation, mesoscopic simulation, and Highway Capacity Manual (HCM) tools use passenger car equivalents (PCEs) to represent non-passenger car traffic. This is an oversimplified treatment, and does not replicate the mobility or safety effects observed in the real world. This inadequacy was further exposed by the mixed flow model (MFM) developed for the HCM 6<sup>th</sup> Edition.

Simulation provides an excellent environment for examining the behavior of heterogeneous traffic streams. However, the realism or validity of various vehicle type behaviors within popular microsimulation tools is not well understood. Of special concern are the proper treatment of vehicle kinematics (i.e., acceleration and deceleration cycles), and the decision making processes leading to different trajectory management. For example, truck drivers (or truck operating systems) likely plan ahead more than passenger car drivers/systems when making lane changing choices, anticipating future turning movements as a function of the surrounding gaps. In addition, traffic analysis models often neglect the effects of trucks on the behavior of passenger cars in their vicinity.

The purpose of the RNS is to motivate support of a project that would enhance and improve the manner in which various types of vehicles interact in the presence of heavy vehicles and associated platooning technologies. Recent research work suggests that the trucks diminish roadway capacity, reduce composite vehicle speeds, and increase speed variations on facilities having significant truck percentages. These effects are exacerbated by the presence of significant grades and/or fewer lanes.

This project is proposed to deliver 1) suggested changes to commonly used simulation models for “car” following and lane changing that would better account for differences in the ways these actions pertain to heavy vehicles; 2) Determining the impacts of platooning on traffic operations; 3) providing case study examples that illustrate how these changes to simulation models affect the decision process to select between capacity and TSMO improvements; and 4) a report that documents the findings and describes the suggested procedural changes and recommended changes to guidance.

### **Literature Search Summary**

Limited research has been conducted to incorporate the impact of different types of vehicles in simulation models. Such impacts may change as a function of 1) the traffic state, 2) the network geometry, and 3) the weather conditions. Most existing traffic studies focused on re-calibrating existing lane-changing and acceleration models using microscopic (trajectory) and macroscopic (flow-density-speed) data collected through i) driving simulators, ii) probe vehicles, and iii) traffic detectors. Research studies considering the possible automated vehicle (AV) and connected vehicle (CV) impacts as a function of heterogeneous traffic composition are even more rare, given the lack of data to support the proposed modeling approaches. Dowling et al. (2014) focused on incorporating the impact of trucks on highway performance by modifying the existing methods proposed in the HCM. Through microsimulation, Ramezani et al. (2018) attempted to quantify the improvement associated with truck platooning - as a traffic control technique - with the objective of reducing travel time and avoiding congestion in a heterogeneous traffic environment. One of the few studies that looked into microscopic truck driver behavior as a function of weather and work-zone conditions in a connected warning environment is that of Raddaoui et al. (2020). The authors used a simulator while hiring professional truck drivers in order to analyze the resulting trajectory data. The results showed that added warnings and information may result in driver distraction, thus degrading the traffic conditions in a challenging driving environment. A similar study was conducted with the George Washington University Truck Driving Simulator focusing on the collision risk associated with drowsiness, and how automation and warning systems may lead to improved vehicle dynamics (Eskandarian and Mortazavi, 2007). Despite the existing efforts to focus on different types of vehicles/drivers and the associated traffic implications, there is no coordinated research work that aims to translate the findings into standardized highway capacity and traffic simulation methodologies.

Looking at the possible impact of connectivity and automation of traffic performance, Ni et al. (2011) developed a methodology to estimate the capacity impacts of CVs. Bierstedt et al. (2014) looked at the effects of next-generation vehicles on travel demand and highway capacity in a Fehr and Peers Think Working Group initiative report. Finally, studies by UC Berkeley PATH (1997) showed that, with full market penetration of automated vehicles, capacity could reach 4,000 vehicles per hour per lane. There is no body of literature that looks at connected and automated vehicles (CAVs) while considering a heterogeneous traffic environment under different geometric and environmental conditions, especially given the lack of the corresponding

field/empirical data. Therefore, simulation models, if calibrated and applied properly, could serve as surrogates for the real world.

CAV testbeds are developed under the U.S. DOT's Analysis, Modeling, and Simulation (AMS) Testbed Development and Evaluation project: six AMS testbeds modeled a number of CV mobility-based freeway applications, including Queue Warning (Q-WARN), SPD-HARM (Speed Harmonization), freight-specific applications, and incident response applications. Accordingly, only one test-bed seems to be geared toward heavy vehicles with the supporting data available at the U.S. Department of Transportation's (USDOT's) Intelligent Transportation Systems (ITS) DataHub and ITS CodeHub repositories. New data may be provided under the Autonomous Driving System (ADS) Demonstration Grant recently announced by the USDOT in 2019. Among the awardees, only one project will look at connected and automated trucks. This only amplifies the need to rely on simulation, to better understand CV/AV technology impacts on heterogeneous traffic performance.

The USDOT, U.S. Department of Energy, and Federal Highway Administration (FHWA) are all currently developing AMS frameworks for CAV systems. These frameworks will help understand and analyze the changes entailed by CAV technologies to the supply of mobility services, travel demand and behavioral changes, and network/facility operational performance. Future work with this framework will include developing new models and logic for a suite of CAV applications, using field data to the extent possible. This framework, new models, and new logic could potentially be leveraged for this proposed research.

## References

Richard Dowling, George List, Bo Yang, Erica Witzke, and Aimee Flannery (2014). "Incorporating Truck Analysis into the Highway Capacity Manual". NCHRP Report 31 ([https://itre.ncsu.edu/wp-content/uploads/sites/2/2017/04/ncfrp\\_rpt\\_031.pdf](https://itre.ncsu.edu/wp-content/uploads/sites/2/2017/04/ncfrp_rpt_031.pdf))

Hani Ramezani, Steven E Shladover, Xiao-Yun Lu, and Fang-Chieh Chou (2018). "Microsimulation Framework to Explore Impact of Truck Platooning on Traffic Operation and Energy Consumption: Development and Case Study". PATH Research Report for FHWA Exploratory Advanced Research Program Cooperative Agreement DTFH61-13-H00012 - Tasks 1.4 and 2.7 ([https://path.berkeley.edu/sites/default/files/fhwa\\_report\\_-\\_2-27-2018\\_.pdf](https://path.berkeley.edu/sites/default/files/fhwa_report_-_2-27-2018_.pdf))

Omar Raddaoui, Mohamed M. Ahmed, and Sherif M. Gaweesh (2020). "Assessment of the effectiveness of connected vehicle weather and work zone warnings in improving truck driver safety". IATSS Research (<https://www.sciencedirect.com/science/article/pii/S0386111219300093>)

Azim Eskandarian, and Ali Mortazavi (2007). "Evaluation of a Smart Algorithm for Commercial Vehicle Driver Drowsiness Detection". 2007 IEEE Intelligent Vehicles Symposium, Istanbul, 2007, pp. 553-559, doi: 10.1109/IVS.2007.4290173.

Hörl, Sebastian, Francesco Ciari, and Kay W. Axhausen (2016). "Recent perspectives on the impact of autonomous vehicles".

### **Research Objective**

The objective of this project is to analyze the impacts of mixed traffic streams, with different vehicle type compositions including heavy vehicles with different attributes, power-to-weight ratios, and automation levels. This research will address both freeway and arterial flow conditions. From a driving decision perspective, the following maneuvers will be investigated: acceleration (including acceleration from a complete stop, decelerating to a complete stop, accelerating, decelerating, cruising, emergency braking, mandatory and discretionary lane changing, merging, diverging, weaving, and platooning). The weather conditions will also be considered. Various roadway geometry and control configurations will be studied including signal control; on-ramps and off-ramps without ramp metering; number of lanes; and highway grades. Different combinations of vehicles in the traffic stream will be studied. Non-CAV detector/camera, probe vehicles, data from drones, and simulator data will be utilized for base-calibration. The research results will also be documented and made available to researchers, developers, and vendors, so that they can implement corresponding improvements within their respective travel demand models, macroscopic simulation models, mesoscopic simulation models, and microscopic simulation models.

### **Implementation Planning**

As this research will result in recommended adjustments to the HCM and the Transportation Systems Simulation Manual (TSSM) methodologies, the target audience includes transportation engineers and planner, freeway management personnel, and educators. Ultimately, the improvement in the consideration of heavy vehicles in a connected and automated traffic system will lead to more accurate analyses of future highway systems, and will lead to improved decision making.

### **Estimate of Problem Funding and Research Period**

Recommended Funding:

\$650,000

Research Period:

36 months

### **Urgency and Potential Benefits**

High. This research will produce dynamic passenger car equivalent factors (DPCEs) that depend on the type of maneuver, traffic state and roadway geometry being considered. Such DPCEs will significantly improve current HCM methodologies by properly accounting for the impact of heavy vehicles (HVs).

### **9Person(s) Developing the Problem Statement**

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**Potentially Interested AASHTO Councils and/or Committees**

TRB Standing Committee on Traffic Simulation (ACP 80)

Co-Chair: Mohammed Hadi, [hadim@fiu.edu](mailto:hadim@fiu.edu)

Co-Chair: Sanhita Lahiri, [Sanhita.Lahiri@VDOT.Virginia.gov](mailto:Sanhita.Lahiri@VDOT.Virginia.gov)

TRB Standing Committee on Traffic Flow Theory and Characteristics (ACP 50)

Chair: Soyoung Ahn

TRB Standing Committee on Highway Capacity and Quality of Service (ACP 40)

Chair: Tom Creasey

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- **California Department of Transportation (CALTRANS)**

- **Florida Department of Transportation**

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**NCHRP Review of G-25**Reviewed By:

B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for the NCHRP and the expected benefit is medium. I agree that the heavy vehicle operational characteristics described are important in operational analysis. It would be helpful if the authors could provide additional information on (1) the nature and magnitude of the inadequacies in current analysis approaches, (2) the scale of errors in decisions due to those inadequacies, and (3) how the research results might inform better decisions.

Review Date:

12/18/2020

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**FHWA Evaluation of G-25**

Reviewed By: HOFM/Birat Pandey, HRDO/Rachel James

Comments:

The authors of this RNS selected a topic of great importance to the traffic analysis tools field. They did an excellent job of articulating the need and identifying research milestones that will contribute to the improved simulation of heterogeneous traffic flow, particularly with respect to heavy vehicles. The RNS is relevant to analysis challenges in the field today (i.e., how do heavy vehicle operators alter their behavior relative to passenger car drivers), as well as challenges the field will face in the future (i.e., the impact of automated truck platoons on traffic flow). There are a number of research studies that have explored inter-driver heterogeneity with respect to vehicle type and the

impact of multiattention on car-following behavior. I recommend the authors look at some of the following literature to add support to their proposed study:

1. Aghabayk, K., Sarvi, M., Forouzideh, N., & Young, W. (2013). New car-following model considering impacts of multiple lead vehicle types. *Transportation Research Record*, (2390), 131–137. <https://doi.org/10.3141/2390-14>
2. Abbas, M., Medina, A., Chong, L., Higgs, B., McGhee, C., Fontain, M., ... Ova, K. (2012). Driver behavior in traffic. Final Report: FHWA-HRT-12-036. Blacksburg, VA. Available from <https://rosap.ntl.bts.gov/view/dot/25687>.
3. Durrani, U., Lee, C., & Maoh, H. (2016). Calibrating the Wiedemann's vehicle-following model using mixed vehicle-pair interactions. *Transportation Research Part C: Emerging Technologies*, 67, 227–242. <https://doi.org/10.1016/j.trc.2016.02.012>.
4. Higgs, B., & Abbas, M. (2015). Segmentation and clustering of car-following behavior: Recognition of driving patterns. *IEEE Transactions on Intelligent Transportation Systems*, 16(1), 81–90. <https://doi.org/10.1109/TITS.2014.2326082>.
5. Hoogendoorn, S. P., & Ossen, S. (2006). Empirical analysis of two-leader car-following behavior. *European Journal of Transport and Infrastructure Research (EJTIR)*, 6(3), 229–246.
6. Hoogendoorn, S. P., Ossen, S., & Schreuder, M. (2006). Empirics of multianticipative car-following behavior. *Transportation Research Record: Journal of the Transportation Research Board*, 1965, 112–120. <https://doi.org/10.3141/1965-12>
7. Hoogendoorn, S. P., Ossen, S., & Schreuder, M. (2007). Multi-anticipative car-following behavior: An emperical analysis. In A. Schadschneider, T. Poschel, R. Kuhne, M. Schreckenberg, & E. Wolf, Dietrich (Eds.), *Traffic and Granular Flow '05* (pp. 687–697). Washington D.C.
8. Nodine, E., Lam, A., Yanagisawa, M., and Najm, W. (2016). Naturalistic Study of Truck Following Behavior. Volpe Final Report. Available from: <https://rosap.ntl.bts.gov/view/dot/12251>.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for G-25**

Submitted By:  
Kelly Hardy  
AASHTO Staff  
Committee on Safety

Priority #: N/A  
Comments: Sounds interesting. Rating 3

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2021 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-26**

**Problem Title**

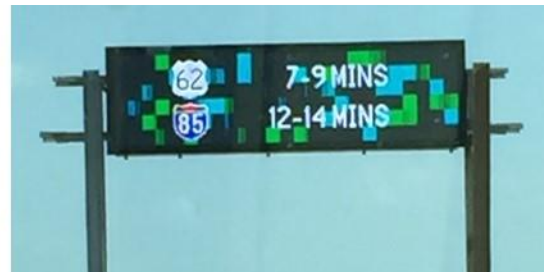
Machine Vision Interface with Light Emitting Diode Traffic Control Device Displays

**Background**

Light emitting diode (LED) traffic control device (TCD) displays such as message signs, pavement markings, and traffic signals are critical elements of the nation's transportation system management operations (TSMO) infrastructure, but incompatibility with onboard vision systems threaten the reliability and safety of automated vehicles.

LEDs use pulse width modulation to control light intensity, color balance, and power dissipation. LEDs flash on and off at a rate too high to be visible to the human eye, typically at refresh rates of 60 – 240 Hz. Full color matrix displays may refresh red, green, and blue LEDs at different rates. To control brightness, LEDs are unlit during much of each refresh cycle and, to limit maximum power demand, not all LEDs light at the same time. LEDs are also common in vehicle lighting (headlights, turn signals, brake lights, etc.) systems.

Cameras in automated vehicles (AVs) must detect electronic displays and recognize the message provided, but because shutter speeds are high to avoid motion blur, some or all of the LEDs may be lit or unlit at the instant of image capture. In the following figure, the left traffic signal appears to be dark, even though both signals appear lit to a human. Similarly, portions of the dynamic message sign appear to be either off or wrongly colored to the camera but not to a human. An AV could easily be misdirected by its vision system misinterpreting either device.



In the coming decades, hundreds of thousands of LED TCDs and millions of AVs will be deployed. Unless practical solutions are identified, the safety of automated vehicles will remain seriously compromised. Furthermore, the remaining life of existing TCDs and vehicle require that solutions be applicable to devices already deployed. Life cycles of TCD displays range from 5 years for portable devices to more than 25 years for more

expensive items such as overhead signals and dynamic message signs. The typical vehicle on the roadway is approximately 12 years old<sup>37</sup>.

Solutions—which may include changes to TCD electronics, modifications to vehicle image capture and image processing systems, or both—must be technically and financially acceptable to TCD manufacturers, automotive manufacturers, and infrastructure owners and operators and must meet the needs of both human drivers and automated driving systems. Solutions could potentially be embedded within relevant standards and regulations currently scheduled for update, including:

- National Electronic Manufacturers Association (NEMA) TS 4 Dynamic Message Sign standard
- American Association of State Highway & Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (Greenbook), and
- United States Department of Transportation (USDOT) Federal Highway Administration (FHWA) Manual on Uniform Traffic Control Devices (MUTCD)

Research is needed now to support the scheduled updates. Waiting ten years for the next update cycle would significantly delay infrastructure changes needed to prepare the nation's transportation network and automotive fleet for safe deployment of automated vehicles.

### **Literature Search Summary**

TRID Search terms “Machine Vision and LED”, “LED Flicker”, and “AV Machine Vision” produced no recent or relevant results. Existing literature does not address the relationship between image creation and image capture, or the processing needed for automated vehicles to interpret LED traffic control device displays correctly.

### **Research Objective**

The objective of this research is to thoroughly assess the problem of operational incompatibility between LED traffic control displays and onboard vehicle vision systems and to identify practical solutions that are technically and financially acceptable to TCD manufacturers, automotive manufacturers, and infrastructure owners and operators. Major tasks or activities of the work should include:

#### Phase 1

- Identify equipment and process capabilities and constraints of LED-based automotive and traffic control device equipment and automated vehicle sensors through a global assessment of automotive and electronic equipment state of the practice.

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<sup>37</sup> IHS Markit [https://news.ihsmarkit.com/prviewer/release\\_only/slug/automotive-average-age-cars-and-light-trucks-us-rises-again-2019-118-years-ihs-markit-](https://news.ihsmarkit.com/prviewer/release_only/slug/automotive-average-age-cars-and-light-trucks-us-rises-again-2019-118-years-ihs-markit-)

- Identify related and potentially affected standards such as NEMA TS 4 and TS 10, Institute of Transportation Engineers (ITE) signal specifications, FCC Part 15 on electrical interference, and others.
- Identify potential solutions—which may include physical, electronic, or operational changes to traffic control devices, vehicle image capture and image processing systems, or both—that meet the needs of both human drivers and automated driving systems.

#### Phase 2

- Demonstrate in a controlled setting the potential solutions and critically assess their feasibility and effectiveness.
- Develop an implementation plan, including a strong outreach effort, to engage traffic control device manufacturers, automotive manufacturers, infrastructure owners and operators, and relevant standards making organizations in collaboratively addressing the ADS sensor and LED equipment pairing issue.

The implementation plan could form the basis for a second phase of work to convene collaboration events involving traffic control device manufacturers, automotive manufacturers, infrastructure owners and operators, and relevant standards organizations.

#### **Urgency and Potential Benefits**

This research is needed now to support scheduled updates of core standards. A collaborative, industry-supported solution will enable LED display detection and comprehension by AV machine vision interfaces, facilitate information processing by the AV, and support the safe deployment of AV on the nation's transportation network.

#### **Implementation Considerations and Supporters**

Within state DOTs, traffic engineering, intelligent transportation systems (ITS), and transportation system management and operations (TSMO) groups would adopt new standards and incorporate them into TCD specifications. Published standards and model specifications supported by AASHTO and the traffic control device and automated vehicle industries would most effectively ensure wide and consistent adoption.

Due to the nature of the topic and because this research will benefit not only state DOTs but also the traffic control device and automotive industries, a significant number of organizations will be interested in the research results and could help support implementation

- AASHTO Committee on Traffic Engineering (CTE)
- AASHTO Committee on Transportation System Operations (CTSO)
- American Traffic Safety Services Association (ATSSA)
- Illuminating Engineering Society of North America (IESNA)
- International Commission on Illumination (CIE)
- International Municipal Signal Association (IMSA)

- Institute of Transportation Engineers (ITE)
- National Committee on Uniform Traffic Control Devices
- National Electrical Manufacturers Association (NEMA)
- Society of Automotive Engineers (SAE)
- USDOT, Federal Highway Administration
- USDOT, National Highway Traffic Safety Administration
- American Society for Testing and Materials (ASTM)

### **Recommended Research Funding and Research Period**

The estimated cost of this project is \$400,000.

The estimated duration is 24 months.

### **Problem Statement Author(s)**

- Members of the National Committee on Uniform Traffic Control Devices, Guide and Motorist Information and Regulatory and Warning Signs Technical Committees Signs for Connected and Automated Vehicles Joint Task Force.
  - Roxane Y. Mukai, Operations Engineer, Maryland Transportation Authority, 410-537-8389, rmukai@mdta.state.md.us (Co-Chair, NCUTCD GMITC and RWSTC CAV JTF)
  - Paul Ciupa, AECOM, pciupa4800@gmail.com. (Retired Cuyahoga County, NCUTCD IMSA delegate)
  - Jose Herrera-Alonso, Regulatory Affairs Specialist, 3M, 651-736-9648, jherreraalonso@mmm.com
  - Joanne Conrad, Senior Regulatory Specialist, Tapco, 262-649-5200, joanne@tapconet.com. (Vice Chair, ATSSA Sign Committee)
  - John Hansen, Principal, 2ITSHelp, 719-330-4402, jhansen@2itshelp.com. (NCUTCD ITE associate delegate)
- David L. Huft, Research Program Manager, South Dakota Department of Transportation, 605.773.3358, dave.huft@state.sd.us

### **Others Supporting the Problem Statement**

- *ATSSA Sign Committee, Angel Ramos(staff) and Joanne Conrad (Chair), 540-729-1951, angel.ramos@atssa.com*
- *IMSA, Toby Cummings and Paul Ciupa, 321-349-3600, toby\_cummings@imsasafety.org*
- *ITE, Ransford S. McCourt, 503-753-8996, 503.randy.mccourt@gmail.com*
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- *NEMA, Steve Griffith and Kezhen Shen (TS-4 and TS-10), 703-841-3288, kezhen.shen@nema.org*

### **Potential Panel Members**

David L. Huft, Research Program Manager, South Dakota Department of Transportation, 605.773.3358, dave.huft@state.sd.us

**Person Submitting the Problem Statement**

David L. Huft  
Research Program Manager  
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605.773.3358  
dave.huft@state.sd.us

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**NCHRP Review of G-26**Reviewed By:

Lawrence D. Goldstein  
lgoldstein@nas.edu

Comments:

This appears to be an interesting and useful study. The proposal is well-written and comprehensive, but I question whether sufficient funding is proposed.

Review Date:

12/14/2020

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**FHWA Evaluation of G-26**

Reviewed By: HOP/John Harding  
HRDO/Carl Andersen

Comments:

Recommend addressing/including international coordination and cooperation. Potential solutions have impact on standards used internationally, and on the global vehicle and vehicle sensors industry.

Review Date:

12/18/2020

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**Submitter Response for 2022-G-26**



**From:** [email: dave.huft@state.sd.us]

**Comments:** The suggestion by FHWA to include international coordination is insightful, especially because the automobile market is international and international standards will be involved. The problem statement mentions the interest of the Illuminating Engineering Society of North America (IESNA) and the International Commission on Illumination (CIE). Expanding the scope to examine international practice and standards could require slightly more funding, as suggested by the NCHRP staff. Because this study can leverage the efforts of organizations like IEEE, the National Committee on Uniform Traffic Control Devices, SAE, relevant AASHTO committees, and international standards groups, I believe \$500,000 should suffice.

**Contact Info:** Dave Huft, South Dakota Department of Transportation, 700 East Broadway Avenue, Pierre, SD 57501-2586 605.773.3358 dave.huft@state.sd.us

Review Date: 02/05/2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-27**

**Problem Title**

Incorporating Demand, Capacity, and Operational Impacts of Incidents and Safety Treatments in the HCM Freeway Facilities Methodology

**Background**

With the advent of Advanced Traveler Information Systems, both public and private, traveler information on incidents (either planned or unplanned) may potentially impact the resulting demand in the incident influence area as drivers divert from their current route to avoid incident-related congestion. The diversion due to incidents is potentially a function to both pre-trip and en-route travel information, as well as the characteristics of the facility and the adjacent surface transportation network. In addition, safety countermeasures have the potential to reduce crash rates and improve operations along a facility. The benefit of safety countermeasures has been documented through the establishment of Crash Modification Factors (CMFs), or Crash Reduction Factors (CRFs) using nationwide data.

The HCM 6<sup>th</sup> Edition procedure for Freeway Facilities incorporates incidents in the Reliability Analysis. This procedure requires crash rates to be manually entered or estimated based on Highway Safety Manual's equation. The current reliability method does not adjust the demands of any segment on a facility when an incident is present due to demand diversion. In addition, there is currently no method of incorporating crash modification factors (CMFs) or crash reduction factors (CRFs) due to safety countermeasures in the HCM freeway reliability analysis. Data are needed in order to develop estimated incident-induced demand diversion and the methodology must be updated to incorporate demand and capacity adjustments due to demand diversion and/or safety countermeasures along the facility. In addition, the new Chapter 38 in the HCM presents methodologies to analyze freeway-arterial networks during oversaturation, which could incorporate the impact of diversion at the network level, capture the interactions between the facilities, and greatly improve the reliability method accuracy.

Another issue arises in how incidents are assigned at the facility level. Currently, the reliability methodology aggregates expected number of incidents for the entire facility and then randomly assigns locations to incident scenarios. This method will need to be modified to take into account the changes in segment-level crash rates.

**Literature Search Summary**

The literature contains a broad range of research into the topic areas of crash modification factors included in the CMF Clearinghouse, incident impacts on freeway operations including capacity and speed, as well as the benefits of incident management

systems. Less research is available on the changes in demand due to the presence of incidents. Below is a list of relevant sources:

1. CMF Clearinghouse, [www.cmfclearinghouse.org/](http://www.cmfclearinghouse.org/)  
Highway Safety Manual 2010. American Association of State Highway and Transportation Officials. 2011.
2. Zegeer, John, et al. Incorporating Travel Time Reliability into the Highway Capacity Manual. No. SHRP 2 Report S2-L08-RW-1. 2014.
3. Khattak, Asad J., Joseph L. Schofer, and Mu-han Wang. "A simple time sequential procedure for predicting freeway incident duration." *Journal of Intelligent Transportation Systems* 2.2 (1995): 113-138.
4. Bonneson, J. A., et al. "NCHRP Project 17-45: Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges." (2012).
5. Srinivasan, S., Haas, P., Alluri, P., Gan, A., & Bonneson, J. (2016). Crash Prediction Method for Freeway Segments with High Occupancy Vehicle (HOV) Lanes. In Transportation Research Board 95<sup>th</sup> Annual Meeting (No. 16-6333).
6. Highway Economic Requirements System – State Version: Technical Report, Federal Highway Administration, August 2005.
7. Konduri, S., Labi, S., and Sinha, K. C. Incident Occurrence Models for Freeway Incident Management. *Transportation Research Record*, Issue Number 1856, pp. 125-134. Transportation Research Board. 2003.
8. Skabardonis, A., Petty, K. F., and Varaiya, P. P. The Los Angeles I-10 Field Experiment: Incident Patterns, *Transportation Research Record*, Issue Number 1683, pp. 22-30, Transportation Research Board, Washington DC, 1999.
9. Skabardonis, A., Petty, K. F., Bertini, R. L., Varaiya, P. P., Noeimi, H., and Rydzewski, D., The I-880 Field Experiment: Analysis of the Incident Data, *Transportation Research Record*, Issue Number 1603, pp. 72-79. Transportation Research Board, Washington DC, 1997.
10. Ghosh, Indrajit, Peter T. Savolainen, and Timothy J. Gates. "Examination of factors affecting freeway incident clearance times: a comparison of the generalized F model and several alternative nested models." *Journal of Advanced Transportation* 48.6 (2014): 471-485.
11. Gordon, R. (2016). Non-Recurrent Congestion: Improvement of Time to Clear Incidents. In *Intelligent Transportation Systems* (pp. 41-90). Springer International Publishing.
12. Aghdashi, Seyedbehzad, Nagui Rouphail, and Ali Hajbabaie. "Estimation of incident propensity for reliability analysis in the Highway Capacity Manual." *Transportation Research Record: Journal of the Transportation Research Board* 2395 (2013): 123-131.
13. Aghdashi, Seyedbehzad, et al. "Generating Scenarios of Freeway Reliability Analysis: Hybrid Approach." *Transportation Research Record: Journal of the Transportation Research Board* 2483 (2015): 148-159.

### **Research Objective**

There is a significant need to move towards performance-based design and combined analysis of the operational and safety impacts of transportation facilities and design

improvements and the HCM plays an important role in these analyses. The major objective of this research is to enhance the HCM 6<sup>th</sup> Edition freeway facilities methodology to better incorporate incidents and strategies deployed to impact the frequency or duration of incidents at a segment level. This includes making the methodology compatible with research contained in the CMF Clearinghouse.

The following tasks are proposed to achieve this goal:

*Task 1: Literature Review.* Develop extended literature review on aspects of incidents on freeways including operational effects such as changes in demand and capacity, management strategies and their effectiveness, and how the benefits of safety countermeasures may be incorporated into the freeway facilities methodology.

*Task 2: Draft Methodology and Data Collection Plan.* Describe candidate frameworks under which the effects identified in the literature may be fully incorporated into the freeway facilities methodology to realistically model the impact of incidents and propose a candidate framework for full development. Describe data sources to be used within the proposed frameworks.

*Task 3: Methodology Development.* Develop the framework as determined by the panel into an improved freeway facilities incident methodology.

*Task 4: Data collection and model validation.* Obtain the appropriate data to develop CMFs or CRFs within the framework. Demonstrate the effectiveness of the updated methodology through real world case studies. Develop a set of default input data as required for any new algorithm and enable simple implementation of CMFs/CRFs from the CMF Clearinghouse.

*Task 5: Update HCM.* Propose updates to Chapter 11 of the HCM and develop a computational engine that can implement the proposed methodologies.

### **Urgency and Potential Benefits**

High. This research will produce new analytical methodologies and tools for improving the Highway Capacity Manual freeway facilities and reliability methodologies. The proposed research will address several limitations of the current methodologies, and will address the interdependency between demand, incidents, and operations. Failure to fund this problem statement will result in cost-prohibitive use of microsimulation.

### **Implementation Considerations and Supporters**

As this research will result in new and/or improved Highway Capacity Manual methodologies, the target audience includes transportation engineers and planner, freeway management personnel, and educators.

### **Recommended Research Funding and Research Period**

Research Funding: \$400,000

Research Period: 36 months

### **Problem Statement Author(s)**

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**Others Supporting the Problem Statement**

TRB Standing Committee on Highway Capacity and Quality of Service (ACP40)  
Chair: Tom Creasey, Tom@caliper.com

**Potential Panel Members**

N/A

**Person Submitting the Problem Statement**

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**NCHRP Review of G-27**

Reviewed By: Camille Crichton-Summers [ccrichton-summers@nas.edu](mailto:ccrichton-summers@nas.edu)

Comments:

This research seeks to improve upon existing analytical methodologies and tools that will better incorporate incident durations in the Highway Capacity Manual addressing limitations. The problem statement is well prepared. The timeframe is reasonable, but the budget should be increased to 450K.

Review Date: 12/21/2020

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**Submitter Response for 2022-G-27**

**From:** [email: bill.knowles@txdot.gov]--New Email: knowleswe@cdmsmith.com

**Comments:** We agree that the budget should be increased to \$450K.

**Contact Info:** William Knowles, P.E.  
knowleswe@cdmsmith.com

**Review Date:** January 8, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-28**

**Problem Title**

Identify Relationship Between Traffic Operational Performance and Safety Evaluation for Highway Facilities

**Background**

It is generally believed that traffic safety is related to traffic operational performance. Traffic capacity depends upon traffic volume, roadway geometry and traffic control. The Highway Capacity Manual (HCM) uses v/c ratio, density, speed, and delay as performance measures for various facilities types. The Highway Safety Manual (HSM) reports the expected average crash frequency based on traffic volume and geometric conditions, and traffic control. However, both the HSM and HCM fall short in providing a clear relationship between the safety and operational performance of roadways.

The Highway Capacity Manual (HCM) assigns level of service (LOS) based on performance measures. The Highway Safety Manual (HSM) introduced the level of safety service (LOSS) concept in which a site is classified into one of the four LOSS levels. The LOSS is relative to existing conditions and based on the difference between the observed and predicted crash frequency.

It is possible to investigate the relationship between capacity and safety for highway facilities under given conditions, which can then be utilized as a design control. Crash frequency and rates can be related to the capacity related performance measures, and a relationship can be identified between safety and operation.

**Literature Search Summary**

Limited research has been done to study the relationship between LOS and traffic safety for various types of facilities including:

- Relationship Between Level of Service and Traffic Safety at Signalized Intersections: Grouped Random Parameter Method, Journal of Transportation Engineering, Part A: Systems, Volume 144 Issue 6 - June 2018.
- Freeway Safety as a Function of Traffic Flow, Institute of Transportation Studies, University of California, Accident Analysis & Prevention, Volume 36, Issue 6, November 2004, Pages 933-946.
- Relating Safety and Capacity on Urban Freeways, Procedia - Social and Behavioral Sciences, Volume 16, 2011, Pages 317-328.

**Research Objective**

The objective of this research to investigate and identify a relationship between operation and safety, capacity related performance measures and crash frequency/rates, and develop a safety quality/performance measure based on operation and capacity.

### **Urgency and Potential Benefits**

High. This project will help state DOTs utilize traffic operation parameters to make better and informed decisions in terms of safety benefits, and provide information for consideration of safety to decision makers, transportation professionals. and the public.

### **Implementation Considerations and Supporters**

The final product of this implementation will be a user friendly decision-making tool suitable for incorporation into Highway Safety Manual, and state DOT manuals and guidelines. This will help transportation professionals utilize traffic operation parameters and performance measures to evaluate and predict traffic safety conditions for roadways and intersections, and evaluate various alternative in terms of safety benefits.

### **Recommended Research Funding and Research Period**

Recommended Funding:

\$600,000

Research Period:

3 years

### **Problem Statement Author(s)**

Khalid Jamil

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Texas Department of Transportation

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### **Others Supporting the Problem Statement**

### **Potential Panel Members**

### **Person Submitting the Problem Statement**

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### **NCHRP Review of G-28**



Reviewed By:  
David M. Jared  
djared@nas.edu

Comments:

I agree that this is a worthwhile topic, but the problem statement provides scant details on how the investigation would be structured and what the scope (\$600K @ 3 years) would entail. I think that more detail on the approach is needed to strengthen this statement.

Review Date:  
1/6/2021

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**FHWA Evaluation of G-28**

Reviewed By: HOTM/Jim Hunt

Comments:

Valuable concept. Would expect the research to depend upon a great deal of crash data to correlate with the LOS at the time of the crash and to develop/generate realistic relationships between safety and LOS characteristics. Is the budget sufficient? In addition, it would be more informative if the research attempted to differentiate between crash frequencies across each crash severity type (KABCO).

Review Date:  
12/18/2020

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**AASHTO Committee Evaluation for G-28**

Submitted By:  
Kelly Hardy  
AASHTO Staff  
Committee on Safety

Priority #: N/A

Comments: Similar to existing Short Term Safety Performance Function and managed lane NCHRP projects, so this will need to be better defined with those outcomes. Better

ways to measure safety as it relates to capacity could have many benefits in urban areas. Rating 3.3

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-29**

**Problem Title**

Develop Crash Modification Factors (CMFs) for Alternative Intersections, Including Displaced Left-Turn (DLT), Median U-Turn (MUT), and Restricted Crossing U-Turn (RCUT).

**Background**

Alternative intersection designs, including DLT, MUT, and RCUT, have been implemented at locations in the United States to reduce congestion. The reduction in the number of traffic signal phases and conflict points at these intersections result in improved traffic operations and safety. Various research has been conducted to develop crash modification factors (CMFs) for typical intersections as well as conversion of traditional intersections to roundabouts. Additional studies have been conducted to evaluate the safety benefit of different intersection configurations.

In the past 10 years, the number alternative intersections have increased substantially in the United States. The operational improvement of the alternative intersections over conventional intersections has been proven. The total number of conflict points for alternative intersections are lower than traditional intersections, and as a result, offer safety advantages over conventional intersections. Studies show significantly lower crash rates with MUTs and RCUTs for both corridor-wide and intersection related data. The data for a DLT at the intersection of Airline Highway and Siegen Lane in Baton Rouge shows that total and severe crashes rates were decreased by 24 percent 19 percent, respectively, after the installation of the DLT; however, there have been safety concerns, especially for DLTs regarding unfamiliar drivers and older drivers. Research is needed to develop CMFs for these types of alternative intersections.

The research would inform engineers, transportation agencies, and the public of the safety benefits of alternative intersections by quantifying the reduction in crash frequency and severity resulting from conversion of traditional signalized intersection to a DLT/MUT/RCUT intersection.

**Literature Search Summary**

Various research has been done by TRB, FHWA, and state DOTs to evaluate the safety benefit of various intersection strategies contained in *Safety Performance Intersection Control Evaluations (SPICE)* including:

- Development of performance matrices for innovative intersections and interchanges, UDOT
- NCHRP Report 420, Impacts of Access Management Techniques (1999)

- FHWA safety Evaluation of Continuous Intersection (2016)
- NCHRP Report 524, Safety of U-Turns at Unsignalized Median Openings (2004)

### **Research Objective**

The objective of this research is to address a deficiency by developing Crash Modification Factors (CMFs) for alternative intersection types, including DLTs, MUTs, and RCUTs.

### **Urgency and Potential Benefits**

The project will help state DOTs make better and informed decisions in terms of safety benefits of alternative intersections, as well as address the current deficiency in the Highway Safety Manual and CMF Clearinghouse. This will help to provide quantifiable information for consideration of alternative intersection strategies to decision makers, transportation professionals and the public. This will also help support progress towards Vision Zero goals across the country.

### **Implementation Considerations and Supporters**

The final product of this implementation will be a tool which will be used to estimate crashes with and without alternative intersections. This will help transportation professionals to evaluate alternative intersection strategies in terms of safety benefits. This tool will be included in Highway Safety Manual, state DOTs manual and guidelines, and CMF Clearinghouse.

### **Recommended Research Funding and Research Period**

#### Recommended Funding:

\$600,000

#### Research Period:

3 years

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

### **Potential Panel Members**

### **Person Submitting the Problem Statement**

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## **NCHRP Review of G-29**

Reviewed By:

B. Ray Derr  
rderr@nas.edu

Comments:

The proposed research is appropriate for hte NCHRP and I expect that the results would be of great interest. Many agencies have been trying alternative intersections and better informaiton on the safety performance would be useful. NCHRP Project 07-25 is substantially complete and is producing a guide for pedestrian and bicyclist safety at alternative intersections and the proposed research should complement that effort.

Review Date:

12/21/2020

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## **FHWA Evaluation of G-29**

Reviewed By: HSA/Jeff Shaw

Comments:

As more DLTs, MUTs and RCUTs are built, the data set to develop useful safety models grows, and this project would be very timely and add considerable value to the state of the practice. However, it would be worthwhile to first investigate whether developing SPFs would be possible before settling for CMFs. Also, the problem statement authors should be aware of the May 2020 report (BDV24-977-27) published by University of Central Florida, as it examined some of these intersections with a data set that spanned 27 States. Several States that could support this and/or offer panel members include Georgia, Indiana, Louisiana, Minnesota, Utah and Wisconsin. It may also carry weight to get the endorsement of the new TRB AKD80 Committee on Roundabouts and Other Intersection Design and Control Strategies.

Review Date:

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## **AASHTO Committee Evaluation for G-29**

Submitted By:

Kelly Hardy

AASHTO Staff

Committee on Safety

Priority #: N/A

Comments: Project should look for Safety Performance Function and CMF development if sufficient sites and years are available. While the number of these alternative intersections does continue to increase, the number is still relatively low. Development of a tool is also a potential challenge, as someone must maintain and distribute the tool in some way. Rating 4

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-30**

**Problem Title**

Crash Modification Factors (CMFs) for Automated Traffic Signal Performance Measures (ATSPMs)

**Background**

Automated traffic signal performance measures (ATSPMs) offer an alternative approach to traditional signal retiming. They are developed using second-by-second data that can be collected over several months or years. The Federal Highway Administration (FHWA) included ATSPMs in Every Day Counts 4, and since then, dozens of agencies have installed this new technology. ATSPMs have been shown to help agencies improve operations at signalized intersections through reduced split failures, arrivals on red, red-light running, and delay.

The right-of-way time that is allocated to different modes and movements can significantly impact behavior – drivers willing to take smaller gaps, pedestrians waiting for the walk signal, or bicyclists clearing an intersection. While not a true adaptive solution, ATSPMs give agencies the opportunity to make near-real-time adjustments based on data from the field. There has been previous research on the safety impacts of Adaptive Signal Control Technology (ASCT), but the same level of research has not been completed for ATSPMs.

This research would quantify reductions in crash frequency and severity resulting from the deployment of ATSPM signal retiming. It would inform public agencies about the safety benefits and help them make funding decisions related to ATSPM systems.

**Literature Search Summary**

The *Highway Safety Manual*<sup>38</sup> and *Crash Modification Factors Clearinghouse*<sup>39</sup> contain crash modification factors and functions (CMFs) that practitioners can apply to facilitate roadway design and operational decisions. The most relevant CMFs to ATSPM signal retiming are related to installing ASCT. There are also countermeasures associated with changing a single traffic signal timing parameter such as yellow change or red clearance. Studies on ATSPM signal retiming that results in improved operations are lacking.

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<sup>38</sup> AASHTO. *The Highway Safety Manual*, American Association of State Highway Transportation Officials (AASHTO), Washington, D.C., 2010, <http://www.highwaysafetymanual.org>.

<sup>39</sup> Carter, D., R. Srinivasan, F. Gross, and F. Council. *NCHRP Report 20-07(314): Recommended Protocols for Developing Crash Modification Factors*, Transportation Research Board of the National Academies, Washington, D.C., 2012, [http://www.cmfclearinghouse.org/collateral/CMF\\_Protocols.pdf](http://www.cmfclearinghouse.org/collateral/CMF_Protocols.pdf).

In addition to the FHWA Every Day Counts program, there have been several recent documents published specific to ATSPMs. *Performance-Based Management of Traffic Signals*<sup>40</sup> details the process of deploying and using different performance measures, and *Evaluating the Benefits and Costs of Implementing Automated Traffic Signal Performance*<sup>41</sup> documents the benefits and costs experienced by case study agencies. Both recognize the potential safety impacts of utilizing ATSPMs, but the lack of current research did not allow for any quantification.

## Research Objective

The primary objectives for this research include:

- Identification and organization of ATSPM signal retiming and/or associated operational improvements with respect to site characteristics (e.g., geometry, volumes, etc.).
- Quantification of crash modification factors and/or functions associated with ATSPM signal retiming (for all modes for specific conflict types and severity) at a quality that could facilitate inclusion in the *Highway Safety Manual* or *Crash Modification Factors Clearinghouse*.
- Development of guidance for the use of ATSPM signal-retiming-related CMFs.
- Documentation of case study costs and benefits associated with safety improvements resulting from ATSPM signal retiming (expanding on information in FHWA-HOP-20-003<sup>42</sup>).

## Urgency and Potential Benefits

Safety is a critical goal for transportation agencies. Knowing the safety impacts of ATSPM signal retiming would help agencies evaluate the benefits and costs of an ATSPM system. While ATSPM systems utilize much of the same technology used for general operations, there are investment costs associated with data management. It is essential to understand the full impact that ATSPM signal retiming could have for roadway users.

## Implementation Considerations and Supporters

This research would lead to quantification of safety improvements resulting from use of ATSPM signal retiming including development of CMFs. The implementation of this research could include publication of the CMFs through the Crash Modification Factors clearinghouse. State DOT personnel using such information to support safety analyses

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<sup>40</sup> Day CM, DM Bullock, H Li, SM Remias, AM Hainen, RS Freije, AL Stevens, JR Sturdevant, and TM Brennan. *Performance Measures for Traffic Signal Systems: An Outcome-Oriented Approach*. West Lafayette, Indiana: Purdue University (2014). <http://dx.doi.org/10.5703/1288284315333>

<sup>41</sup> Day, C., P. O'Brien, A. Stevanovic, D. Hale, and N. Matout. *Evaluating the Benefits and Costs of Implementing Automated Traffic Signal Performance*, FHWA-HOP-20-003, Federal Highway Administration, Washington, D.C., 2020, 124 pp, <https://ops.fhwa.dot.gov/publications/fhwahop20003/>.

<sup>42</sup> Gross, F., B. Persaud, and C. Lyon. *A Guide to Developing Quality Crash Modification Factors*, FHWA-SA-10-032, Federal Highway Administration, Washington, D.C., 2010, 72 pp, <https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa10032/>.



would be the chief implementers. In addition, the information would help improve evaluation of benefits of ATSPM implementations through consideration of safety.

### **Recommended Research Funding and Research Period**

This research is recommended to be funded at \$400,000. A period of 24 months is recommended to complete the research activity. An additional 6 months is recommended for separate activities in community engagement and implementation.

### **Problem Statement Author(s)**

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Brendan Russo, Northern Arizona University (brendan.russo@nau.edu)  
Edward Smaglik, Northern Arizona University (edward.smaglik@nau.edu)

### **Others Supporting the Problem Statement**

Transportation Research Board Standing Committee on Traffic Signal Systems (APC25)  
Contact: Chris Day, Committee Research Coordinator (cmday@iastate.edu)

### **Potential Panel Members**

- Mark Taylor, Utah Department of Transportation, marktaylor@utah.gov
- Peter Savolainen, Michigan State University, pete@msu.edu
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- Chris Day, Iowa State University, cmday@iastate.edu

### **Person Submitting the Problem Statement**

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### **NCHRP Review of G-30**

#### Reviewed By:

David M. Jared  
djared@nas.edu

#### Comments:

Good topic, but the acronym ATSPM should be deleted from the second, third, and fourth objectives. Actual project length needs clarification: are outreach/implementation to be part of this project or funded, say, through NCHRP 20-44? Medium-priority research.

Review Date:  
1/6/2021

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### **FHWA Evaluation of G-30**

Reviewed By: HSA/Jeff Shaw, HOTM/Eddie Curtis

Comments:

We agree that safe transfer of right-of-way is a fundamental performance objective for signalized intersections. However, the problem statement should be revised to reflect that ATSPM, in and of itself, is not a safety mitigation strategy. Rather, it is a data collection, monitoring and analysis approach that serves to inform actions to take to meet performance goals. ATSPM should be viewed as the tool to assess the effect of signal timing strategies on crashes and surrogate safety metrics. With that information, CMFs can be developed that match signal timing strategies to the operational contexts. Realistically, there are likely more combinations of contexts and timing scenarios than this project could fully investigate, so it would be wise to emphasize the Research Objective of “identification and organization of ATSPM signal retiming and/or associated operational improvements with respect to site characteristics (e.g., geometry, volumes, etc.)” as a discrete Phase I task.

Review Date:  
12/18/2020

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### **AASHTO Committee Evaluation for G-30**

Submitted By:  
Kelly Hardy  
AASHTO Staff  
Committee on Safety

Priority #: N/A

Comments: Very timely with wide-spread deployment by some DOTs. CMFs related to signal timing would be very useful. Quantifying those with specific ATSPMs might be challenging, however. Rating 4

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**Submitter Response for 2022-G-30**

**From:** [email: ckergaye@utah.gov]

**Comments:**

We agree with the comments from FHWA and NCHRP.

The problem statement may be amended to clarify the difference between developing CMFs for ATSPMs and developing CMFs for operational improvements.

**Contact Info:**

Cameron Kergaye  
801-633-0359

Review Date:

February 8, 2021

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**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**Problem Number: 2022-G-31**

**Problem Title**

Traffic Analysis Tools for Evaluating Traffic Systems Management and Operations (TSMO) of Work Zones for inclusion into the Transportations Systems Simulation Manual (TSSM).

**Background**

Work Zones are a necessary part of roadway improvement, however they can create significant impacts on system mobility, safety, and reliability. For example, freeway work zones account for nearly 24% of all non-recurring delay, and 10% of total delay annually. Even during off-peak hours, work zones are a major contributor to delays, averaging 11 hours of delay per non-peak urban traveller. Work Zone impacts like excessive queuing, not only affect the route on which it is located, but also affect the adjacent roadway network due to induced route diversion and/or secondary crashes.

Smart work zones deployed as part of Traffic Systems Management and Operations (TSMO) can provide significant benefits. To support the TSMO programs in selecting between alternative solutions, the Federal Highway Administration (FHWA) through their Smarter Work Zone initiative and the Work Zone ITS program has developed software tools for decision support, fact sheets, standard specifications for the nine most common Smart Work Zone ITS technologies, and agency outreach.

In addition, recognizing the need for new data collection practices to support decisions, the FHWA has developed Work Zone Data Exchange (WZDx) Specification with the intent for better use and analysis to make travel on public roads safer and more efficient through ubiquitous access to data on work zone activity. However data analytics alone is not sufficient to help agencies navigate the complex decision making process associated with TSMO at Work Zones. Traffic Analysis (both macroscopic and microscopic), combined with detailed data, can allow for the developments and evaluations of the impacts of mitigation strategies. Advanced diagnostic, predictive, and prescriptive analytics require the use of data and simulation tools in an integrated manner. Simulation allows for analysis of different work zone configurations and strategies, evaluation of route diversions across the network, and sensitivity analysis of the performance under differing conditions (demand, weather, incidents, etc.)

There are issues with the use of both data and simulation models for work zone analysis. While new data and data sources are becoming more and more available, there is a need to consider a number of issues when considering the use of data for analysis such as the access requirements (ex. subscription fees, licenses and certs required, etc.), limitations of data sources (ex. not real-time; accuracy issues; etc.), use

cases for each data source (ex. calibrate models for decision-support; create and validate microscopic model components; etc.). In addition, there is a need to determine how can each data source be best leveraged for use in an integrated manner with simulation models to support work Zone TSMO decisions.

In the area of microscopic and macroscopic analysis of Work Zones, engineers and planners have used tools to predict the queues, delays, and travel times created by work zones within a degree of accuracy, giving them the foresight to design and schedule a work zone that will reduce the total delay. However, many of these tools have not been adopted or integrated into the practices of transportation agency business. This lack of adoption is because: (1) the tools require further work and refinement to develop and validate the associated macroscopic and microscopic models, (2) there has been limited amount of data to use in model development, calibration, and validation, and (3) there is no universally accepted framework nor guidance for how to integrate data and modeling into the TSMO decision-making process. Additionally the developed and utilized models and tools should be flexible enough to capture driver behavior changes associated with the different configurations of the work zones as well as evolving technologies (such as AVs and CVs), without requiring a complete reconstruction of the model algorithms and/or software architecture.

Therefore there is a need for guidance and models for an integrated data and modeling analysis of work zones, to support data driven decision making for planning, design, and/or operations. The research proposed in this problem statement will help develop guidance for simulation and modeling, which will synergistically tie with an upcoming NCHRP project (NCHRP 10-109) that will explore the operational and safety effects of new work zone technologies using new data sources.

This guidance can be ultimately incorporated into the Transportation Systems Simulation Manual (TSSM). The first edition of TSSM has been prepared by the Traffic Analysis Pooled Fund Study, a collection of thirteen member states, and facilitated and managed by FHWA. The TSSM was initiated to provide national guidance on simulation. It is hoped that the TSSM will ultimately become a simulation parallel to the Highway Capacity Manual. Transportation Research Board has initiated the transfer of the TSSM from the Pooled Fund Study to the newly formed Standing Committee on Traffic Simulation, which includes seven DOT representatives that were also on the Pooled Fund Study Team.

### **Literature Search Summary**

Accurate work zone simulation models can inform a transportation agency's decision-making by predicting the safety and operational impacts of alternative work zone designs, informing an agency's Traffic Management Plans (TMPs) and assisting in the planning and deployment of strategies and traffic control devices that ultimately lead to a reduction in crashes and congestion (Berthume et. al. 2020).

Work zone modeling and simulation efforts have attempted to predict work zone impacts and assist practitioners in selecting and deploying the optimal set of countermeasures and traffic control devices. Some research focused on improving work zone capacity predictions (Heaslip, Kondyli, et al. 2009, Yeom, Hajbabaie, et al. 2015). Other research compared the performance of existing work zone models, so that practitioners could select the “best” model for answering different questions (Collura, et al. 2010, Schnell, Mohror and Aktan 2002). The work zone models and tools have had varying levels of success. For instance, Schnell et al. noted that the models they tested consistently underestimated queue length, and in some cases were unsuitable for work zone modeling (Schnell, Mohror and Aktan 2002).

The developed models require further testing and development to ensure field accuracy. Berthaume et. al. developed and tested a microscopic work zone model that integrates into commercially available microsimulation platforms, however, researchers indicated that the model and software would benefit from independent verification and validation (IV&V), and model improvements (Berthaume et. al. 2018, Berthaume et. al. 2020).

Before any model can be used, instructions need to be developed to guide agencies in selecting the best models for each use case. For example, for a certain application, an agency may need a rough estimate of work zone impacts using minimal data inputs. However, for the examination of detailed work zone and alternative route impacts and strategies, an agency will need much more detailed model(s).

## **Research Objective**

The goal of this project is to develop a framework, calibration/validation methodology, models, and guidance for an integrated data and modeling analysis of work zones with different levels of human driving, connectivity, and automation to support data driven decision making for planning, design, and/or operations. The specific objectives are:

- Assess the state of the practice and state of the art of work zone data, analysis, and modeling in light of the availability of data from new sources and the expected impacts of emerging technologies. This includes defining current (and emerging) work zone modeling needs such as the use-cases for microscopic, mesoscopic, and macroscopic modeling of work zones, data needs, minimum capabilities required of a work zone analysis (includes performance measures, accuracy, level of effort to use, model sensitivity, etc.). The state-of-practice assessment will produce an inventory and assessment of work zone models, data sources, tools, and approaches. This project will conduct a Technology Readiness Level (TRL) assessment of models/tools/approaches to determine their level of development, identify limitations of each model/modeling approach, and define how “practice-ready” each is, and list next steps required for advancing each.
- Develop and enhance work zone analysis framework, guidance, and associated models. This may include developing new models and/or advancing existing work zone models, or approaches identified based on the

state-of-practice to enable practical application. This effort should result in a framework and guidance for end-users (i.e. practitioners) to predict work zone impacts considering the availability of detailed data from various sources and the emerging vehicle technology impacts. It should also guide practitioners in leveraging model outputs to improve or inform safety and operations decisions.

Research products from this project will be integrated directly into the TSSM, giving these products an effective channel for technology transfer. This will enable the product to be streamlined to enhance transportation agency's business practices.

### **Urgency and Potential Benefits**

High. This research will produce, advance, or refine models, tools, and methods for predicting work zone impacts to design and deployment decisions aimed at minimizing their operational and safety impacts. This research will fill gaps in the status quo by advancing work zone modeling from the experimental to the practical, formalizing a process and products to be used for work zone planning and operational analysis.

This project will help streamline business practices by standardizing and simplifying decision-making processes regarding work zones through the development of guidance and identification and refinement of decision-making tools. The TSSM, a product that agencies have already identified as needed, is entering publication; by contributing to (and enhancing) the TSSM, these research results will have a high probability of impacting the field.

### **Implementation Considerations and Supporters**

Results and products from this research will be integrated into the TSSM. The target audience includes transportation engineers and planner (especially those using simulation to inform a Traffic Management Plan [TMP], required for work zones on many federally funded freeways), freeway management personnel, and educators. Ultimately, the addition of work zone modeling will lead to more accurate analyses of future work zones and freeway systems, and improved decision-making. The improved decision-making will ultimately lead to work zone design and deployment decisions that could reduce work zone operational disruptions nation-wide, and the optimization of safety strategies and treatments (such as the decision to deploy, as well as the location for deploying, "back of queue" warning message boards).

This problem statement is supported by five states Virginia, Wisconsin, North Carolina, and California, and Florida

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### **Recommended Research Funding and Research Period**

#### Recommended Funding:

\$600,000

#### Research Period:

24 months

### **Problem Statement Author(s)**

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### **Others Supporting the Problem Statement**

TRB Standing Committee on Traffic Simulation (ACP 80)  
Co-Chair: Mohammed Hadi, hadim@fiu.edu  
Co-Chair: Sanhita Lahiri Sanhita.Lahiri@VDOT.Virginia.gov

### **Potential Panel Members**

- Volpe National Transportation Systems Center, Andrew Berthaume, PhD, (617) 945-4997, Andrew.Berthaume@dot.gov
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### **Person Submitting the Problem Statement**

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Virginia DOT

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### **NCHRP Review of G-31**

#### Reviewed By:

Leslie C. Harwood  
LHarwood@nas.edu

#### Comments:

This problem statement is clear and well-written. The objective statement is clear and the research is of importance to all DOTs. The budget and timeline are adequate for this work.

#### Review Date:

1/5/2021

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### **FHWA Evaluation of G-31**

Reviewed By: HRDO/Rachel James, HOTO/Jawad Paracha, HOTM/Doug Laird

#### Comments:

The authors of this Problem Statement selected a topic of great importance to the traffic analysis tools field. I think they did an excellent job of articulating the need and identifying research milestones that will contribute to the improved simulation of work zones. Given that work zones are likely to induce changes to routing decisions (e.g., significant queues may encourage drivers to take alternative routes), the authors should also consider the mesoscopic modeling of work zones and how those types of routing decision models would connect to the microscopic modeling work proposed here.

Review Date:  
12/18/2020

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**Submitter Response for 2022-G-31**

**From:**

Sanhita Lahiri, P.E., PTOE,  
(804)786-1287; sanhita.lahiri@vdot.virginia.gov)

**Comments:**

Please refer to the Research Objective that mentions Mesoscopic models. The intent is to look at all types of models, but also we want to be respectful that if the problem statement is selected, the NCHRP panel should be able to further refine or adjust it.

**Contact Info:**

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Review Date:  
24-Jan-2021

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# **Research Field SP**

SPECIAL PROJECTS

**American Association of State Highway and Transportation Officials  
Special Committee on Research and Innovation**

**FY2022 NCHRP PROBLEM STATEMENT OUTLINE**

**PROBLEM NUMBER: 2022-SP-01**

**TITLE**

Best Management Practices to Address Encampments on State Highway Rights of Way

**BACKGROUND**

Many urban areas throughout the country are experiencing a dramatic increase in the number of people living without permanent residence. For these people, state highway rights of way through cities are often some of the most accessible areas to set up temporary encampments. This growing trend of encampments on state rights of way has presented a series of unprecedented challenges and liabilities for state departments of transportation, in the design, construction, and maintenance of urban freeway roadsides and bridges.

An NCHRP synthesis study on the issues facing DOTs along urban freeway sections was completed in 2019. NCHRP 20-05/Topic 49-06 (Landscape Development and Management for Urban Freeway Roadsides) provides information on the scope of issues and current magnitude of the issue throughout the country. The report identifies urban freeway encampments as one of the most significant challenges facing state agency operations and maintenance of highway systems through our nation's cities. An organized comparison and discussion of agency experience in relation to this topic would benefit all State DOTs and provide a basis for the development of recommended best management practices for tolerance, prevention, and cleanup of encampments.

**LITERATURE SEARCH SUMMARY**

The most relevant existing research on this topic is the recommendation for additional study cited in the NCHRP 20-05/49-06 synthesis study referenced above. A literature search on this topic found eight publications over the last decade documenting the growing extent and impacts of encampments but lacking in recommendations and potential solutions. As the number of people taking shelter on highway rights of way has dramatically increased in recent year transportation agencies are being forced to adapt and develop social services expertise – This project would help fill this gap in highway transportation policy, and set up an ongoing national dialogue on best management practices additional research to find the most practical solutions in response to urban freeway design and maintenance.

**RESEARCH OBJECTIVES**

The project would consist of three research outcomes. The **primary objective** is to document the current scope of the impacts and solutions, and to comparatively study the approaches taken by state transportation agencies in response to encampments along the highways and under bridges.

Specific issues to explore include:

- State agency policy and procedures

- Processes for developing location inventories and activity data
- Agency liability issues/Instances of legal actions/Local agency coordination
- Data sharing agreements with local agencies
- FHWA restrictions/potential solutions/cases where encampments are permitted
- Allowed types of alternate land uses on Limited Access right of way/Equivalent value issues with leasing
- Agency training materials specific to this issue
- Policies and practice specific to construction projects
- Tracking and documentation of campsite occurrence and cleanup
- Cost and funding of cleanup and prevention efforts
- Planting design and maintenance impacts and solutions
- Application of Crime Prevention thru Environmental Design (CPTED) principles
- Bridge and wall design impacts and solutions
- Bridge and drainage infrastructure maintenance impacts and solutions
- Environmental regulatory impacts and solutions
- Employee safety training for dealing with camp removal/clean up
- Employee interaction with encampment residents in daily operations
- Holding personal property following cleanup
- Local laws and coordination with law enforcement
- Adjacent neighborhood safety issues
- Partnering with local businesses and advocacy groups
- Use of contractors for cleanup
- Use of corrections crews for cleanup
- Use of state employees for cleanup
- Camping in Safety Rest Areas
- Parked/abandoned RVs

A **secondary objective** is the development of recommended best management practices, based on comparative case studies throughout the country. Recommendations would answer as many as possible of the specific issues listed above.

The **third objective** in this proposal is the establishment of a forum to facilitate ongoing dialogue between state transportation agencies, as adaptive practice evolves nationally in response to the economy and combined societal pressures. This project would include efforts to communicate and discuss the issues with the larger national audience. Webinar discussions would be conducted to collect initial information and data and provide periodic input on analysis and recommendations. An ongoing peer-exchange working group would be established in conjunction with the project to work participate in information gathering efforts, facilitate the national discussion, and continue the discussion upon completion of the project.

## **URGENCY AND POTENTIAL BENEFITS**

It is likely that poverty levels in our nations urban areas will increase in the years ahead and this issue will continue expand geographically and grow in magnitude. This is a liability to state and local transportation agencies in terms of potential legal action around social equity. This project would bring to light any local solutions from ongoing case study around the country and throughout North America.

The presence of encampments on transportation rights of way continues to grow, and many of the emerging challenges to operations and maintenance are unprecedented. Therefore, there is a limited amount of existing research on this topic and many unanswered questions. However, the synthesis study NCHRP 20-05/Topic 49-06 (Landscape Development and Management for Urban Freeway Roadsides) gathered and considered existing published research on this topic. This research proposal is based, in part, on the analysis and recommendations of the synthesis study.

## **IMPLEMENTATION CONSIDERATIONS**

Research expectations:

- Work with the TRB Project Manager and project advisory panel to coordinate with AASHTO and state transportation agencies to recruit and appoint the project working group, from any states willing and able to participate.
- Work with TRB to assemble and conduct a national webinar explaining the project and the issue and encouraging all states to join in the discussion.
- Refine and organize the list of specific issues and collect and analyze information from the working group on current practice and impacts with regard to each issue.
- Produce final report including a point by point analysis of information gathered and recommendations for best management practices as agreed upon by the working group.
- Work with TRB to assemble and conduct a second national webinar to report out on findings and recommendations and to encourage ongoing dialogue around the issues.

Research on this topic is being coordinated through the TRB standing committee on Roadside Maintenance Operations (AKR20). This committee includes a network of over 150 roadside management professionals and academics from throughout the continent, and this group would be used to disseminate information to all states and industry stakeholders. This issue impacts all phases of highway planning, design, construction, and maintenance, and this project will naturally attract the attention of the concerned AASHTO committees and working groups. The AKR20 research team will be responsible for coordinating this effort and its findings with all other relevant TRB and AASHTO committees.

**Recommended Funding:** \$350,000

**Research Period:** 24 Months

**Problem Statement submitted by the Author:**

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Washington State Department of Transportation/Maintenance Operations  
AKR20 Committee Research Coordinator

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## **NCHRP Review of SP-01**

Reviewed By: Amir N. Hanna [ahanna@nas.edu](mailto:ahanna@nas.edu)

Comments: A. The problem is solvable through multi-disciplinary research that should address associated social, legal, security, safety issues as part of the impacts on highway and bridge operations, maintenance, and construction. B. The topic of research should be of interest to the majority, if not all, state DOTs. C. The objective, as stated in the problem statement, appears to focus on developing recommended management practices. D. The scope, as stated in the problem statement, identifies more than 25 issues for consideration in developing a recommended management practices. The research should place emphasis on identifying, evaluating, and recommending actions to alleviate the problem. E. The estimated duration of 24 months seems adequate. F. The estimated budget of \$350,000 seems adequate. G. The problem statement notes availability of eight related publications, and cites NCHRP Synthesis 539, Landscape Development and Management Practices for Urban Freeway Roadsides, but further literature review, surveys, and other information gathering should be performed as part of this research. Note: This problem statement is one of 3 problem statements submitted by the AASHTO Committee on Maintenance; it was ranked first (highest priority) by the committee.

Review Date: 12/14/2020

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## **FHWA Evaluation of SP-01**

Reviewed By: HEPR/Lindsey Svendsen

Comments:

The issue of how to deal with encampments of homeless populations in public ROW often comes up when these populations must be relocated as a result of a pending highway project. It would be beneficial to have documented case studies of best practices and effective strategies for addressing these situations.

Review Date:  
12/18/2020

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## **AASHTO Committee Evaluation for SP-01**

**Submitted By:**

Casey Soneira

AASHTO Staff

Committee on Right of Way, Utilities, and Outdoor Advertising Control

**Priority #:** N/A

**Comments:** The Committee on Right of Way, Utilities, and Outdoor Advertising Controls is supportive of this project and is interested in the results of this study.

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## **Submitter Response for 2022-SP-01**

**From:** [email: kathy.ahlenius@wyo.gov; WillarR@wsdot.wa.gov]

**Comments:** Based on the comments submitted by FHWA and NCHRP, changes were made to the problem statement. *[Submitter provided an updated problem statement but that has not been included since it has not gone through the review process.]*

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