Announcement of Research Projects

The National Cooperative Highway Research Program (NCHRP) is supported on a continuing basis by funds from participating member departments of the American Association of State Highway and Transportation Officials (AASHTO), with the cooperation and support of the Federal Highway Administration, U.S. Department of Transportation. The NCHRP is administered by the National Research Council’s Transportation Research Board (TRB). The NCHRP is an applied contract research program totally committed to providing timely solutions to operational problems facing highway and transportation practitioners and administrators.

Each year, AASHTO refers a research program to the TRB consisting of high-priority problems for which solutions are urgently required by the states. The AASHTO program for FY 2016 is expected to include 16 continuations and 44 new projects.

This announcement contains preliminary descriptions of only those new projects expected to be advertised for competitive proposals. Detailed Project Statements (i.e., Requests for Proposals) for these new projects will be developed beginning in August 2015.

Please note that NCHRP requests for proposals are available only on the TRB website. Those who have an interest in receiving RFPs can register on the website http://trb.org/nchrp.

Upon registration, you will receive an e-mail notification of every RFP posting and an e-mail notification of new anticipated projects in future years.

Because NCHRP projects seek practical remedies for operational problems, it is emphasized that proposals not evidencing strong capability gained through extensive successful experiences in the relevant problem area stand little chance of being selected. Consequently, any agency interested in submitting a proposal should first make a frank, thorough self-appraisal to determine whether it possesses the capability and experience necessary to ensure successful completion of the project. The specifications for preparing proposals are quite strict and are set forth in the brochure entitled Information and Instructions for Preparing Proposals. Proposals will be rejected if they are not prepared in strict conformance with the section entitled “Instructions for Preparing and Submitting Proposals.” The brochure is available on the Internet at the website referenced above.

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IMPORTANT NOTICE

Potential proposers should understand clearly that the research program described herein is tentative. The final program will depend on the level of funding available from the Federal-aid apportionments for FY 2016. Meanwhile, to ensure that research contracts can be executed as soon as possible after the beginning of the fiscal year, the NCHRP is proceeding with the customary sequence of events through the point of agency selection for all projects. The first round of detailed project statements will be available in August and September 2015; proposals will be due in October and November 2015, and agency selections will be made in November and December 2015. This places the risk of incurring proposal costs at the election of the research agencies. Beyond the point of selecting agencies, all activity relative to the FY 2016 program will cease until the funding authorization is known. These circumstances of uncertainty are beyond NCHRP control and are covered here so that potential proposers will be aware of the risk inherent in electing to propose on tentative projects.

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SUMMARY OF APPROVED RESEARCH PROJECTS

♦ Project 03-121
*Transit, Freight, and Emergency Services Integration in Integrated Corridor Management Using SHRP2 Business Process Tools*

Research Field: Traffic
Source: Federal Highway Administration
Allocation: $400,000
NCHRP Staff: William C. Rogers

Integrated corridor management (ICM) is a relatively new congestion management approach that has been gaining interest for its potential to mitigate congestion with few changes to the existing transportation infrastructure. The primary objective of any ICM system is to coordinate the assets and expertise of multiple transportation agencies rather than have each agency respond to related issues independently. By integrating the management and operations of the transportation system, the complete transportation infrastructure may be better utilized, thus resulting in improved travel conditions in the target network.

The goal is to maximize infrastructure investment. Available capacity and utilization of the transportation network space is critical. Each mode, transit, highway and freight networks may or may not have available capacity. ICM techniques support efficient utilization to maximize the supply of available capacity as well as reduce the demand on that supply in time.

In an effort to support the development of ICM strategies the Federal Highway Administration (FHWA) sponsored a multi-phase ICM research initiative. Phase I resulted in development of ICM Concept of Operations (such as MCPST, 2008A) and System Requirements (such as MCPST, 2008B) at eight pioneer sites. Of these sites, three (Dallas, TX, San Diego, CA and Minneapolis, MN) were selected for ICM Analysis, Modeling, and Simulation (AMS) tests of potential ICM methods under several traffic scenarios. Finally, the results from the ICM AMS efforts were used in a demonstration phase in Dallas and San Diego.

The results from these demonstration sites lead to several publications such as the use and response to travel time information study by Petrella et al. (2014) and study by Marcuson (2013) that investigated the integration of ICM with active traffic management. In additional to pilot sites in Dallas and San Diego, states such as Virginia and Florida have pursued the development of ICM programs.

In addition, under the Strategic Highway Research Program 2 (SHRP2) Reliability Area, Projects L01 and L06, much research has been done to develop and advance the need to address and develop business processes for improved reliability and operational efficiency of the transportation systems. The research showed that improved reliability and operational efficiency is associated with good business processes rather than just the introduction of a technology project. The key aspects of the business processes that are addressed in the research include Planning and Budgeting, Systems and Technology development, Performance Management, Institutional Culture, Organization and Workforce Development, and Collaboration.

The objective of this research is to develop business process guidance for the key stakeholder communities engaged in an ICM program in order to accomplish improved operational efficiency and reliability in a corridor. To do so, this research will make use of the existing FHWA work and the SHRP2 work—blending both as needed. The research will investigate business processes of the stakeholder communities for ICM projects in Dallas and San Diego, freight projects in Dallas, Kansas City, Los Angeles, and Miami, as well as other related projects to identify effects and lessons learned. Based upon this investigation, and results of the SHRP2 L01 and L06 Reliability Projects, an expanded ICM Operational concept will be developed using the unique operational objectives, needs, and requirements. It is expected that this research will also develop model performance measures as well as model standard operational procedures and/or agreements that the ICM stakeholder communities can use to collect and share real-time data. Ultimately, this work will contribute to the development of a desk reference that will provide the ICM stakeholder communities (freeway, arterial, transit, freight, and emergency services) with guidance on how to improve their business processes to realize and sustain integrated corridor management.
Project 03-122
Performance-Based Management of Traffic Signal Operations

Research Field: Traffic
Source: Indiana
Allocation: $600,000 (Additional $150,000 from Federal Highway Administration)
NCHRP Staff: B. Ray Derr

With over 400,000 traffic signals deployed throughout the US, traffic signal operations have a profound impact on the performance of urban streets. Poor signal timing is one of the primary causes of recurring congestion. Ideally, traffic signals should be retimed on a need basis, but because signal retiming projects are quite labor intensive, there is a tendency for such projects to be deferred or placed on an arbitrary schedule on the scale of years. Consequently, many agencies rely primarily on user complaints to identify problems. However, user complaints are often difficult to substantiate, and as such, do not always lead to a resolution.

The operational and maintenance issues that cause poor signal operations could be substantially improved by introducing a performance-based approach to automatically identify and report problems to the engineering staff, before they generate user complaints. There have been numerous innovations in the development of automated traffic signal performance measures that can assist in this task. However, adoption of these methodologies has so far been limited to a few large agencies with the ability to employ technical staff such as computer programmers to build systems for converting the data into useful information. There is currently very little guidance for agencies without such resources on how to implement traffic signal performance measures. Task 4. Develop a tiered set of recommendations for agencies of different sizes to make effective use of the performance measures. Task 5. Implement recommendations developed in prior tasks to assess their effectiveness in identifying the operational deficiencies related to agency objectives. Agencies selected for inclusion in this study should reflect a variety of roadway network configurations, traffic scenarios, and operational management structures. Tune recommendations based upon the results of these implementations. Task 6. Develop a set of recommendations scoped for assisting agencies across a spectrum of budget constraints and personnel capabilities to implement and utilize signal performance measures.

Project 03-123
Innovative Methods for Identifying and Delineating Dynamic Lane Use Control

Research Field: Traffic
Source: Iowa
Allocation: $350,000
NCHRP Staff: B. Ray Derr

Proactively managing recurrent and non-recurrent traffic congestion on freeway systems has introduced a number of innovative strategies under the frame of Active Traffic Management (ATM). ATM has also introduced a new family of traffic control devices necessary to support the dynamic practic-
es of these innovative systems management and operational strategies. Most of the traffic control devices currently used to support ATM strategies are not supported in the Manual on Uniform Traffic Control Devices (MUTCD) or by research prior to their development, installation and use. Furthermore, human factors, especially driver comprehension of dynamic traffic control devices used to support ATM, are not well understood. Inefficiencies in traffic control lead to reductions in safety and operational efficiency, precisely what ATM is intended to improve.

Consider one of the commonly used ATM strategies—dynamic lane use control. FHWA defines dynamic lane use control to be dynamically closing or opening individual traffic lanes as warranted and providing advance warning of the closure(s) (typically through dynamic lane control signs), in order to safely merge traffic into adjoining lanes. Dynamic lane use control continuously monitors the roadway system to dynamically manage the operations of travel lanes and temporary use of shoulder lanes. It monitors traffic demand and determines when and how the current lane configurations of the roadway should be reconfigured to improve capacity and reduce congestion. Real-time incident and congestion data is used to control the lane use ahead of the lane closure(s) and dynamically manage the vicinity of the closure(s) to reduce rear-end and other secondary crashes. Note that a number of other dynamic lane control strategies exist with similar challenges to dynamic lane use control; namely, dynamic lane reversal, dynamic shoulder lanes, dynamic lane access control, and dynamic merge control.

Drivers are required to identify and understand the appropriate lane usage, while traveling at freeway speeds, when dynamic lane use control is implemented. In many existing applications, acceptable travel lanes are identified by text-based or graphical overhead signage such as a green arrow or a dynamic speed limit sign. Closed travel lanes are most often identified by an overhead red ‘X’. In some locations, ground mounted signing is also used to communicate lane use to drivers. For example, Seattle, WA uses shoulder or barrier mounted manual flip signs that reads either SHOULDER OPEN TO TRAFFIC or SHOULDER CLOSED. Other locations use signs to support the type of traffic mode acceptable for the controlled lane, often time designated to bus traffic. Various forms of static pavement marking are used to support the specific freeway operational program in place. There is little consistency and limited guidance in the methods used for communicating dynamic lane use control to drivers via pavement marking, nor are changes in lane uses effectively communicated through pavement markings, static or dynamic signing, other delineation devices, or in-vehicle displays.

Research is needed to explore the array of methods currently being used to identify active lanes with dynamic lane use control. Additionally, research is needed to explore and develop innovative techniques for supporting the transition from static to dynamic lane changes with appropriate traffic control and delineation methods that can be uniformly applied and effectively communicated with road users. The most effective traffic control devices should be recommended for inclusion in the MUTCD to support safety, uniformity and positive guidance. Best practices will also be provided to transportation agencies and present standard methods for optimizing traffic control. Note that this research differs from currently proposed FHWA research focused on better understand traveler strategic decision making, better understand driver tactical decision making, understand the motivation(s) behind traveler behaviors and decisions, and develop approaches to overcome resistance to change related to dynamic ATM systems.

The objective of this research is to identify and produce the most effective traffic control devices to support dynamic lane use control. Specific objectives include the following: (1) Produce a comprehensive synthesis report on existing traffic control devices and methods used to communicate dynamic lane use control. (2) Recommend and conduct research to assess the effectiveness of currently used traffic control devices supporting dynamic lane use control. Innovative and transformative traffic control devices not currently being used, including both static and dynamic signs, markings, signals, and in-vehicle displays should be considered. (3) Recommend traffic control devices to standardize methods of communicating with drivers that maximizes driver recognition and minimizes driver error. (4) Recommend changes to the MUTCD to support the results of the research.

This research will require the following tasks to meet the stated objectives: Task 1. Conduct a comprehensive synthesis (literature review, surveys, interviews, etc.) of existing studies and data on traffic control devices used to support dynamic lane use control. Task 2. Develop a comprehensive research plan.
for assessing the effectiveness of existing and proposed traffic control devices used with dynamic lane use control. Task 3. Present the plan to the research project panel. Task 4. Perform research plan developed in Task 2. Task 5. Develop and submit a final report documenting the entire research effort, identifying recommended changes and additions to the MUTCD and best practices and new innovative methods for traffic control devices supporting dynamic lane use control.

♦ Project 03-124

*User Information Needs and Workload Issues Associated with Active Traffic Management Strategies*

Research Field: Traffic  
Source: Iowa  
Allocation: $750,000  
NCHRP Staff: B. Ray Derr

Persistent congestion and safety concerns continue to challenge transportation professionals in the United States and around the world. Ever increasing recurring and non-recurring congestion is responsible for longer delays, higher fuel consumption, and increased risk of accidents. Recognizing the inability to quickly and cost-effectively add capacity to their systems, agencies have relied on systems operations and maintenance strategies to mitigate their mobility and reliability impacts. Over the past two decades, there have been several success stories and advances in freeway management, arterial management, and regional coordination. Today, most agencies have levels of detection and operational capability that would have been unimaginable two decades ago, which can be leveraged for a wide variety of approaches to improve mobility and safety. However, changing travel patterns, growing demand, traveler behavior changes, and increasing expectations are all requiring agencies to ask the question of “what is the next generation of systems operations and management strategies that can address their new challenges?” Active traffic management (ATM) has emerged in the evolutionary advancement of systems management and operational strategies bringing together operational strategies and a management philosophy to manage highway network conditions to improve efficiency and reduce system congestion.

ATM is the ability to dynamically and proactively manage recurrent and non-recurrent congestion on an entire facility based on real-time traffic conditions. Focusing on trip reliability, ATM strategies maximize the effectiveness and efficiency of existing facility capacity while increasing throughput and enhancing safety. ATM strategies rely on the use of integrated systems with new technology—including comprehensive sensor systems, real-time data collection and analysis, and automated dynamic deployment—to optimize system performance quickly and without the delay that occurs when operators must deploy operational strategies manually. When various ATM strategies are implemented in combination, they can work to fully optimize the existing infrastructure and provide measurable benefits to the transportation network and the motoring public. One of the benefits of these new systems is that they allow for the “dynamic” or real-time automated operation of traffic management strategies that more quickly respond to changing conditions as they occur. These strategies include but are not limited to adaptive ramp metering, adaptive traffic signal control, dynamic junction control, dynamic lane reversal/contraflow lane reversal, dynamic lane use control, dynamic merge control, dynamic shoulder lanes, dynamic speed limits, queue warning, and transit signal priority.

Deployment of ATM strategies has led to the creation of new graphical and text-based user information displays to deliver dynamic traveler information. These information displays are designed to garner travelers’ attention quickly to allow sufficient opportunity to make and carry out decisions in a safe and timely manner. The presence of new signage and information displays along with the need to make quick decisions has the potential to significantly increase the driving task and lead to driver error. This may be compounded when drivers have to interpret and respond to multiple user information displays that are used when combinations of ATM strategies are deployed on a facility.

Safety is one of the primary objectives of ATM strategies, and further research on the user information needs and driver workload issues is needed to understand their impact on the safety of ATM strategies. To date, there is a lack of consistency and standardization as it relates to the design and deployment of ATM user interfaces. There is also limited understanding of how drivers interpret and react to the design of such interfaces. To gain the maximum
benefit from ATM strategies, agencies need to better understand the following questions: (1) How does the design and placement of ATM user interfaces impact the ability of drivers to make timely decisions and execute safe movements? and (2) Is there a combination of strategies that require complex user interfaces that would present challenges to driver workload and could negatively impact driver safety?

It is important to note with all of the traffic control device (TCD)-related research within the ATM context is that no research has been conducted to specifically assess user information needs within the overall context of their trip as well as the additional workload these signs, alone or in combination, cause for the driver. Particularly, at what point does the driver begin to shed information within the complex environment and what do they shed first.

The objective of this research is to produce an overall framework for understanding the human factors and user information needs in complex driving environments to optimize driver response and reduce driver error in support of the planning, design, and deployment of ATM strategies. Desirable future outcomes from this research are enhancement of guidance provided in pending ATM-related documents as well as potential specific information needs requiring research and validation for inclusion in the MUTCD.

This research will require the following tasks:

**Task 1.** Conduct a comprehensive synthesis (literature review, surveys, interviews, etc.) of existing studies and data on user information needs and driver workload issues associated with complex driving environments (e.g., a facility with frequent interchanges and/or lane drops, dense signing, etc.), driving conditions, and TCDs that may relate to the ATM operational strategies, both internationally and within the U.S. Special attention should be given to how ATM user interfaces (graphical, symbolic, text-based), when deployed individually or in combination, influence driver recognition, comprehension, and behavior.

**Task 2.** Develop a comprehensive research plan for assessing the user information needs, driver workload and human factors issues that impact driver recognition, comprehension, response, and errors related to ATM operational strategies when deployed individually or in combination. The research plan should, at a minimum, review the following issues:

- Information required by drivers for each ATM strategy,
- Methods of providing that information to drivers,
- Human factors guidelines for each of the dissemination methods,
- Driver workload related to information provision for each ATM strategy,
- Driver workload issues for combinations of ATM strategies and user interfaces and determination if any combinations create unacceptable loading, and
- Options to reduce workload in situations where the workload is too high.

**Task 3.** Perform research plan developed in Task 2. Results will be documented in a form suitable to proceed with Task 4.

**Task 4.** Develop a framework that associates user information needs and human factors issues with ATM user interfaces, when deployed individually or in combination. Identify best practices in presenting user information via ATM user interfaces and provide recommendations for standardizing these user interfaces to improve driver recognition and reduce driver error.

**Task 5.** Develop and submit a final report documenting the entire research effort and recommendations.

Note: Consideration should be given to incorporating aspects of NCHRP Problem Statement 2016-G-10, “Optimizing Road User Compliance by Effective Communication Methodologies in Dynamic Freeway Management.”

**♦ Project 03-125**

**Evaluation of Change and Clearance Intervals Prior to the Flashing Yellow Arrow Permissive Left-Turn Indication**

Research Field: Traffic
Source: AASHTO Highway Subcommittee on Traffic Engineering
Allocation: $300,000
NCHRP Staff: B. Ray Derr

The flashing yellow arrow has been the focus of many research efforts over the past 20 years. Those efforts culminated with the inclusion of the flashing
yellow arrow (FYA) as a permissive left-turn and right-turn indication in the 2009 Manual on Uniform Traffic Control Devices (MUTCD). As such, implementation of FYA indication operations across the country has rapidly increased. As an example, Washington County, Oregon, added the FYA permissive left-turn indication to over 300 signalized intersections in a single year. Other cities and states have also installed hundreds of FYA indications. One of the issues with the implementation of the FYA indication that has not been effectively addressed by research is the indication sequence prior to and immediately after the FYA indication that most effectively communicates the desired action to road users. For example, many jurisdictions who have implemented the FYA permissive left-turn indication, following a green arrow protected left-turn indication, use both the yellow arrow change indication and the red arrow clearance indication prior to initiating the FYA indication. Although not currently required by the MUTCD, some traffic engineers believe that the solid red arrow is needed to effectively communicate to drivers that the left-turn movement has switch from protected to permissive. Other traffic engineers allow the solid yellow arrow change interval following the protected left-turn movement to immediately change to the FYA indication, without the use of the solid red arrow clearance indication. The need for the red arrow clearance indication, its effectiveness when used, and the appropriate duration for its use have not been explored. Traffic engineers lack the necessary guidance in using the solid red arrow prior to the FYA indication. Research is needed to determine the need and best methods of using the solid red arrow clearance indication when the FYA indication is used.

The objective of this research is to better understand the safety and efficiency implications of the use of solid yellow arrow change and solid red arrow clearance intervals after a leading solid green arrow transitioning to a permissive FYA or after a permissive FYA transitioning to a lagging solid green arrow. Specifically, there is a need to understand what intersection characteristics result in a value proposition that supports the use of both the solid yellow arrow change and solid red arrow clearance intervals. Additionally, there is a need to determine the appropriate duration of the red clearance interval when it is used. The influence of opposing bicycle, pedestrian and vehicle volumes and gaps, left turning demand, approach speeds, and lane configurations will all be considered. Ultimately, recommendations for the inclusion of change and clearance intervals and their correct durations will be drafted in a form as to be considered for inclusion in updates to documents such as the MUTCD or the Traffic Signal Timing Manual.

♦ Project 08-103
Test and Demonstrate the Implementation of NCHRP Project 08-91, Cross-Asset Allocation

Research Field: Transportation Planning
Source: AASHTO Standing Committee on Planning
Allocation: $400,000
NCHRP Staff: William C. Rogers

Performance management is being increasingly applied in the transportation industry as state DOTs, metropolitan planning organizations, transit agencies, and other local/regional transportation planning and service providers strive to invest in projects that achieve performance targets across the multimodal transportation system. While the concepts of performance management and performance measures are generally understood, deciding how to best allocate inevitably limited resources across various types of investments to provide acceptable transportation system performance poses a persistent and difficult challenge for agency managers, elected officials, and the public.

NCHRP Project 08-91 provides a Framework and Tool Prototype for cross-asset resource allocation and demonstrates that a performance-based cross-asset investment approach can be achieved. The 08-91 Framework and Tool Prototype testing demonstrates that senior DOT managers can use a cross-allocation approach to analyze and communicate the likely system performance impact of investment decisions across multiple types of transportation assets. The research also provides recommendations for implementation and full deployment of a cross-investment approach within an agency.

While 08-91 research provides an implementable methodology that was tested for the research, it does not include a full deployment of the cross-asset resource allocation approach within a transportation agency. A full test deployment of a capital cross-asset investment approach is needed.
The objective of this research is to evaluate the practicality of implementing the NCHRP Project 08-91 research, by testing the process within one or more transportation agencies. To complete this work, the 08-91 Framework will be implemented in a fully functioning tool that can be applied within an agency to: (1) set strategic and long-range goals; (2) select performance measures; (3) analyze project-level data to support predictive analyses needed for the 08-91 Framework (to include both quantitative and qualitative data); (4) conduct multi-objective decision-making and tradeoff analysis; and (5) develop/optimize a capital transportation program at both the programmatic (“top down”) and project (“bottom up”) levels. The deployment should provide a fully functioning solution that can be utilized in agency strategic planning, long-range planning, asset management planning, and project selection using these five Framework steps.

Implementation will require the ability to take post-processed outputs from existing data management systems, whether from quantitative or qualitative sources, to ensure a comprehensive set of measures to include in the decision making. It is important to note that the 08-91 research identified the availability and validity of data to support a cross-asset allocation approach as an implementation challenge. The selected team should be prepared to identify and assess current management systems and predictive models and apply outputs for a cross-asset investment approach and make recommendations for any additional data needed (both quantitative and qualitative, because the 08-91 research recommends the incorporation of qualitative data to support decision making to meet stakeholder priorities). Where qualitative data are recommended, the selected research team should make recommendations regarding how and where these data may be collected, the organization of the data set (binary “yes/no” or other), and the methodology for vetting qualitative data. Additionally, the selected research team should be prepared to address risk in all components of the 08-91 Framework and show how implementation supports MAP-21 requirements.

Project 08-104
A Guidebook for Post-award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods

Research Field: Transportation Planning
Source: AASHTO Highway Subcommittee on Construction
Allocation: $500,000
NCHRP Staff: Edward T. Harrigan

There has been much research and writing completed in the past decade regarding project delivery using alternative contracting methods (ACM) such as design-build (DB), construction manager-at-risk (CMR), construction manager as general contractor (CM/GC), alternative technical concepts (ATC) and other nontraditional delivery methods. However, the bulk of the work has been accomplished with a keen focus on the pre-award procurement and project delivery method decision process. The literature is fundamentally devoid of research focused on best practices for administering ACM contracts after they have been awarded. The FHWA’s Every Day Counts (EDC) Program has increased the need for guidance on administering ACM contracts by increasing the visibility of DB, CMGC, and ATCs specifically in a series of nationwide summits in 2010 and 2012. Additionally, Section 1304 of the MAP 21 legislation provides an increased federal share for innovative techniques to help deliver projects more efficiently. The combined effect of the two programs has been a large increase in the use of ACMs by DOTs which have not used them before. Therefore the timeliness of this research is high to fulfill an urgent need for guidance on how to execute ACM contracts after award.

The proposed research should address the following questions:

- What are the best practices for post-award contract administration for ACM projects?
- How do the roles and responsibilities of ACM project personnel vary during post-award administration in comparison to traditional project delivery methods?
- What should be contained in ACM preconstruction services contract?
- How should the design contract be modified to support ACM project delivery?
- What are the advantages and disadvantages of current post-award ACM contract administration approaches?
• What training do in-house design and construction assets need to effectively administer ACM design and construction project delivery?

The objective of this research is to benchmark the state-of-the-practice in ACM contract administration practices, critically analyze DOT experiences including the costs and benefits associated with various contract administration approaches, and produce a guidebook which contains the information necessary to fill the current void in the body of knowledge on ACM contracting.

Specific tasks to accomplish the objective include: (1) Define the state-of-the-practice in ACM contract administration through a comprehensive literature review, the collection and analysis of relevant procurement documents, ACM design and construction contracts, review of enabling legislation and barriers to ACM contract administration implementation; (2) Select a representative set of case study projects from public transportation agencies with ACM contracting experience that can be studied in depth to identify both best practices and lessons learned; (3) prepare a research work plan that describes the details of the research methodology and methods for identifying ACM contract administration best practices and developing conclusions; (4) Execute the research work plan and prepare an interim research report that articulates the data collection and analysis as well as emerging conclusions, best practices, lessons learned, and a proposed outline for the guidebook; (5) prepare the draft guidebook for ACM contract administration, incorporate review comments as required, and validate the guidebook’s efficacy on actual ACM projects; (6) submit the final guidebook and a final research report that details the full results of the research; and (7) develop training and workshop packages to support adoption or exploration of ACM contract administration by interested DOTs.

Note: The AASHTO Standing Committee on Research directed that this project coordinate its efforts with those of NCHRP Projects 15-46, “Design-Management Guide for Design-Build and Construction Manager/General Contractor Projects,” and 15-51, “Pre-construction Services Cost Estimating Guidebook.”

♦ Project 08-105
Measuring the Effectiveness of Public Involvement in Transportation

Research Field: Transportation Planning
Source: Arizona
Allocation: $350,000
NCHRP Staff: Lori L. Sundstrom

Public involvement is fundamental to the development of most transportation projects. Information derived from outreach efforts provides the perspective of those who are impacted by, use, and pay for highway improvements—the public.

Transportation professionals have yet to define successful public involvement or develop commonly accepted methods for evaluating the effectiveness of public involvement. Practitioners are frequently in the position of not being able to sufficiently explain or quantify the benefits of their public involvement efforts, especially to those who question the financial investment typically needed for “good” public involvement. A survey conducted by the TRB Committee on Public Involvement in 2012 revealed that 70% of respondents, which comprised public involvement specialists, planners, and transportation executives, believe the development of performance measures for public involvement is a pressing need. This need was also reported by respondents in a similar survey distributed by the committee in 2009 to transit agency professionals.

The emphasis on performance measurement has grown in tandem with demand by the public and elected officials for increased accountability in the decision-making process. Performance measures are now a familiar concept to transportation agencies—in particular, state departments of transportation and metropolitan planning organizations—as MAP-21 mandates them to implement measures to assess the performance of their highway and transit systems. While public involvement has not yet been included among the required measures, which presently focus on safety, system condition, and congestion, agencies will benefit from clear guidance to inform the best allocation of resources for public involvement.

This research project will provide transportation agencies and public involvement professionals with examples of successful practices/case studies from transportation and other fields, a menu of tested measures for assessing the effectiveness of their pub-
lic involvement efforts, and methods for establishing such targets (i.e., defining success).

The major tasks of this study are:

- Through an evidence-based literature review, survey, interviews, and/or other appropriate methods, identify and document practices used within and outside the transportation industry to define and measure public involvement effectiveness. Fields outside of transportation may include utilities, health, and education, both domestic and international. Analyze findings to identify successful practices, as well as gaps to be addressed.

- Develop a framework for assessing the effectiveness of public involvement tools, techniques, and strategies.

- Develop a draft set of measures that consider not only agency effort (e.g., budget, number of meetings, variety of techniques, compliance with the National Environmental Policy Act), but immediate effects (e.g., number of public meeting attendees, number of comments received) and the outcomes of such efforts (e.g., the public’s satisfaction with the process, how well the influence of public input was communicated to them, the degree to which input influenced decisions). Both quantitative and qualitative measures should be considered.

- Identify appropriate urban and rural locations, and conduct a pilot test of measures at various stages of the project development process.

- Develop a menu of measures, with recommendations on the application of measures for specific purposes and under varying scenarios.

- Include techniques for determining target levels for each recommended measure of effectiveness.

♦ Project 08-106

*Getting Innovations in Metropolitan Freight Implemented*

Research Field: Transportation Planning  
Source: Minnesota  
Allocation: $375,000  
NCHRP Staff: William C. Rogers

Recent U.S. Census and commodity flow data indicate that more than 80% of people in the U.S. live or work in metropolitan areas, and 65 percent of American goods originate or terminate in such areas. As a result, how well goods move in metropolitan areas—of whatever sizes—has significant economic and social implications. To meet this challenge, freight professionals frequently scan for innovative practices or technologies developed elsewhere that could address top priority freight issues in their home areas. Except for a small minority of “early adopters,” most freight professionals want assurance that implementing these innovative practices and technologies will likely get the intended results and not waste scarce resources.

When addressing complex metropolitan transportation problems (e.g., safety, capacity, economic development), freight professionals from state DOTs, regional authorities (e.g., MPOs, COGs, ports), and cities not only grapple with scarce resources, they also often need to orchestrate an exceptionally diverse community of stakeholders (e.g., private-sector shippers and carriers, public policy makers, residents, academics, planners, and engineers at other levels of government) to identify and get traction for workable innovative solutions. Each type of stakeholder has different reward systems, views of the world, and goals that can block coalitions from forming and getting the job done. While resistance to innovation or any new ways of doing business is normal and expected, it can also derail an otherwise well-designed plan.

Although information about innovations or “best practices” in metropolitan freight is now widely available, research has not sufficiently addressed the question of why some of these succeed and others do not. Armed with such research results, freight professionals could much better tailor innovations to the specific circumstances they find in their home areas. Such tailoring not only increases the chances that genuinely new approaches and technologies applied to metropolitan freight issues will actually be implemented, but it will also result in significantly greater tangible benefits (e.g., improved reliability, travel time, safety, or lower costs as well as community and environmental impact) sooner than would otherwise have happened.

Because web-accessible catalogs of metropolitan freight-related best practices are relatively new, it is also not yet clear the roles these play when freight professionals evaluate the use of innovations or implement them once commitments are made. Sample
questions requiring research for practical implementation include:

- How does particular content or ways of delivering catalogs of innovative ideas make a difference in getting freight-related innovations from one area repeated in another?
- How do other mechanisms (e.g., peer support, pilot studies, forums for information exchange and problem solving) build confidence and resolve to try something new in a metropolitan area?
- How can government agencies at the federal, state, and metropolitan levels best help accelerate the adoption of innovative freight-related practices?
- What types of federal, state, and local technical assistance most effectively support successful implementation of freight innovations at the metropolitan scale? What modes of delivery have the greatest chances of moving such innovations from concept to reality?

Concern with effective translation of innovations in freight from one place to another is obviously not limited to metropolitan areas. As a result, lessons learned in designing and conducting this research could provide a starting place for exploring at other scales of freight issues (e.g., interstate commerce, international trade) in later, separate studies.

The objectives of this research are to (1) identify critical success factors that appear important to getting innovative ideas in metropolitan freight fully implemented; and (2) identify methods, models, and environments that accelerate the adoption of innovative practices and technologies in metropolitan freight.

♦ Project 08-107

*A Guidebook for Emergency Contracting Procedures for Administration of a Regional Emergency*

Research Field: Transportation Planning  
Source: Washington  
Allocation: $250,000  
NCHRP Staff: S. A. Parker

Many state highway agencies (SHAs) have established procedures related to how to address an emergency project. Recent events in Colorado, involving multiple emergency projects across several geographic areas have identified the need for SHA’s to have a plan for prioritizing and managing several concurrent emergency projects across multiple routes.

*NCHRP Legal Research Digest 49* provided a good legal analysis for emergency contracting utilizing federal funds. However, many SHAs emergency contracting procedures are centered on a single emergency. When multiple infrastructure assets are compromised, SHAs do not have a consistent best-practice guideline related to how to bring an overall system back online. The domestic scan on Best Practices in Accelerated Construction Techniques, NCHRP Project 20-68A (07-02), developed case studies on seven emergency projects. It summarized operational techniques and made recommendations at the project level. However, it did not provide recommendations for a programmatic approach to facilitate the emergency contracting process. *NCHRP Synthesis 438: Expedited Procurement Procedures for Emergency Construction Services* identified this issue as a gap in the body of knowledge and recommended that research be undertaken to provide the necessary guidance to SHAs. The synthesis also identified the need to coordinate SHA plans with the plans in place with other state, federal, and local agencies in advance of a series of emergencies. Lastly it recommended that the research investigate alternative contracting methods like indefinite delivery/indefinite quantity (IDIQ) contracts as potential sources for on-call emergency design and construction services as is done in New York and Florida.

There is an emerging need for a guidebook that focuses on both the current available emergency procedures and also on how a SHA should react to and recover from a regional emergency.

The proposed research should address the following questions:

- What are the best practices for developing a contracting approach to an emergency project(s)?
- How do roles and responsibilities in the field shift depending on who is the lead agency?
- How are multiple corridors prioritized related to materials, contractor, route availability, and fabricator prioritization?
- What role to communities, and community outreach, play in emergency planning?
• How can routine design, construction, and maintenance IDIQ contracts be modified to provide a source of emergency capabilities when required?

Therefore the objective of this research is to identify best practices currently in SHAs emergency response plans and to create a guidebook on how to develop an emergency contracting plan for multiple projects. Washington State Department of Transportation’s best practices manual on Emergency Relief Procedures is an example of SHA best practices.

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

• **Task 1** – Define the state-of-the-practice in emergency contracting plans through a comprehensive literature review;

• **Task 2** – Select a representative set of case study plans from public transportation agencies with well-developed Emergency Contracting Plans or SHAs who have recently dealt with multiple emergency contracts concurrently;

• **Task 3** – Prepare a research work plan that describes the details of the research methodology and methods for identifying emergency contracting best practices and developing conclusions;

• **Task 4** – Execute the research work plan and prepare an interim research report that articulates the data collection and analysis as well as emerging conclusions, best practices, lessons learned, and a proposed outline for the guidebook;

• **Task 5** – Prepare the draft guidebook for emergency contracting procedures, incorporate review comments as required, and validate the guidebook’s effectiveness against recent emergency recovery efforts;

• **Task 6** – Publish the final guidebook and a final research report that details the full results of the research.

The intent of this project is to furnish a uniform set of guidelines for emergency contracting procedures at a time when major environmental events are on the rise. This guidance on emergency contracting for regional emergencies is needed immediately to help SHAs react to the new challenges being presented. The payoff of this research is likely to be significant through better contract administration and the provision of tools to benefit from the experiences of other DOTs.

♦ **Project 09-60**

*The Impacts on Pavement Performance from Changes in Asphalt Production*

- **Research Field:** Materials and Construction
- **Source:** Maine
- **Allocation:** $1,000,000
- **NCHRP Staff:** Edward T. Harrigan

Since implementation of the Performance-Graded Asphalt Binder specification developed by the Strategic Highway Research Program (SHRP), petroleum refining processes have changed considerably. Increased global demand for fuels and plastics has led refiners to develop improved refining techniques which allow them to extract increased amounts of the higher value light products from crude oil. Additionally, a wider variety of crude oil sources are being used to produce asphalt than was the case when the performance-graded (PG) grading system was first developed. Other changes include processes required for production of low sulfur fuel, expanded use of polyphosphoric acid and petroleum distillates, and addition of recycled materials such as re-refined engine oil bottoms (REOB), paraffinic base oils, bio binders, and ground tire rubber.

Expanded use of recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) is also driving the use of softer binder grades, which are often produced by modification of stiff binders with various additives. Although today’s asphalt binders typically continue to meet the requirements of the PG specification, several highway agencies in the United States and Canada are experiencing early failures of newly constructed pavements despite general compliance with the existing and proven pavement and mix design standards, construction methods, and materials specifications. These early failures are being described as atypical raveling whereby the surface exhibits asphalt matrix loss, aggregate loss, low-temperature cracking, and instances of total surface course loss within five years. One explanation that could be contributing to these early failures is the observed decrease in quality of asphalts. Anecdotal evidence from agency and contractor personnel suggests the asphalt does not adhere to the equipment as it did...
in the past. Simply put, the asphalts are not as sticky as they used to be. Given that there has been and continues to be significant change in the production and formulation of asphalt binders, it is a challenge for materials specifications to remain current. Accepted terms such as “neat” asphalt and “modifier” apparently have evolved as well with little understanding by the DOTs as to the implications.

Initial success with the SHRP model and the overall evolution of asphalt binder suggests that current asphalt binder properties and binder specifications are worthy of comprehensive review. The nationwide investment in pavements is in the billions of dollars. Some agencies are experiencing reductions in expected pavement life of fifty percent or more, requiring earlier application of pavement preservation or rehabilitation treatments. Considering the reduced funding levels for highway agencies, coupled with increased costs of asphalt pavements, these reductions in pavement life will make it extremely challenging to meet the performance measures required under MAP-21. Current research efforts are focused on binder testing and mix designs, with a view towards complementing the original SHRP model with its iterative improvements. Binder tests such as the bending beam rheometer with extended conditioning and notched tension testing are being evaluated as potential tools to evaluate binder performance. This research is focused on the risk assessment of the existing PG binder specification to fully assess performance characteristics of new asphalt binders prior to use in pavement construction. The results of this study will have an immediate impact on the ability of highway agencies to achieve expected pavement life.

The objective of this research is to identify potential shortcomings in the current PG asphalt binder specifications that are leading to incidents of premature failure of asphalt pavements and propose changes to improve these specifications. Specific tasks to accomplish this objective include: (1) identify changes in crude oil refining related to asphalt binder production that have occurred since 1996, including the use of additives such as REOB and paraffinic base oils; (2) investigate incidents of premature asphalt pavement failure occurring in several states and provinces since the mid-2000s and identify the principal failure mechanisms; (3) evaluate the correlation between major changes in oil refining and energy market demands and occurrences of premature pavement failure; (4) compare the physical and chemical properties of current asphalt binders with binders from different periods, such as samples analyzed by the Asphalt Research Consortium, or through recovery from field samples or from stockpiled reference samples such as those collected by the FHWA Materials Reference Library or Long Term Pavement Performance program; (5) identify gaps in the existing PG binder specification that may be leading to use of binders that contribute to early pavement failure; (6) evaluate current and proposed asphalt binder tests to determine how well their results correlate with actual pavement performance and develop proposed changes to the AASHTO PG binder specification and test methods, with emphasis on tests for low-temperature performance and asphalt adhesion quality.

Note: The AASHTO Standing Committee on Research directed that problem statement 2016-D-10, “Enhancing Low-Temperature Performance of Performance-Graded Asphalt,” be incorporated into the scope of this project.

♦ Project 10-98
Development of Standards and Quality Assurance Procedures for the Collection of Network Level Macro-Texture Measures

Research Field: Materials and Construction
Source: AASHTO Highway Subcommittee on Materials
Allocation: $500,000
NCHRP Staff: Amir N. Hanna

Adequate macro-texture of a pavement surface is essential for preventing wet weather accidents. The sand patch test (ASTM Standard E 965) has been historically used to determine the mean texture depth (MTD) on a pavement surface. Quality of the results of this test procedure is dependent on the skill of the technician. The Circular Track Meter (CT Meter) (ASTM E 2157) can be used to determine the mean profile depth (MPD) and the root mean square (RMS) values of the macro-texture. The MPD is useful in predicting the speed constant (gradient) of wet pavement friction. Measurement of surface macro-texture using the sand patch test or the CT Meter is time consuming and requires lane closures to collect data that disrupt traffic and expose personnel to risk. In addi-
tion, the sand patch test or the CT Meter provides macro-texture properties at a single location, and many tests have to be done to evaluate variations in macro-texture properties along a roadway.

High frequency single point lasers mounted on vehicles are currently being used to collect macro-texture data at highway speeds. ASTM Standard E 1845 describes the method to compute the MPD from data collected by a single point laser along a longitudinal path. This standard also provides a theoretical formula to convert MPD to MTD. Procedures for computing the MTD by simulating a digital sand patch test on three-dimensional data (3D data) collected on a pavement surface by vehicles travelling at highway speeds have also been developed recently. Correlations to estimate the MTD from MPD have been developed. In the United States, the MTD and/or the MPD is used to characterize pavement macro-texture. Other countries have used RMS of texture data to characterize macro-texture.

With increased emphasis being placed on providing adequate macro-texture on pavements to reduce/eliminate crashes, there is increased interest in measuring pavement macro-texture at highway speeds and for using that data to compute macro-texture indices. However, a standard procedure for verifying the accuracy of data collected by equipment that collect macro-texture data at highway speeds is not currently available in the United States. In order to check the accuracy of equipment that collects macro-texture data, a method to compare ground truth measurements with data collected by such equipment needs to be developed.

The objective of this research is to develop a recommended AASHTO standard for network level macro-texture measurement, including the necessary QA/QC protocol and equipment specifications, for use by both states and/or vendors. The tasks identified to address the objectives stated are: (1) Perform a literature review to identify macrotexture parameters, collection equipment, and review studies on the correlation between macrotexture indices with pavement surface characteristics. (2) Perform a survey of both domestic and international highway agencies to identify agencies that currently collect automated network-level macro-texture data. Identify the macrotexture parameter(s) computed from the macrotexture data. Identify how macro-texture parameters are applied to agency standard operating procedures, polices, or practices. (3) Identify factors that can affect the quality of the macro-texture data. Consideration should be given to both stationary and high speed devices. Develop procedures and guidelines that can be used for collection. (4) Identify and develop procedures to verify the accuracy of the collected data. Perform a field evaluation to evaluate the accuracy of network-level macro-texture data compared to ground truth measurements. (5) Recommend the best macro-texture parameters that can be used for pavements in the United States. Identify improvements to existing standards and provide recommendations for the development of new standards. Provide draft revisions and proposed new standards to AASHTO Subcommittee on Materials. (6) Prepare a final report documenting the entire research effort.

♦ Project 12-106

Development of Guidelines for Performance-Based Seismic Design

Research Field: Design
Source: AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $350,000
NCHRP Staff: Waseem Dekelbab

Currently, the AASHTO Guide Specifications for LRFD Seismic Bridge Design do not address performance-based seismic design (PBSD) nor do they provide guidance for bridges that are deemed Critical or Essential. Furthermore, there is essentially no guidance in the specifications to assist owners and designers who wish to consider seismic risk mitigation beyond the single, minimum level provided by the current specifications. Yet, it is clear that transportation facilities have different operational requirements, depending on the post-earthquake functions expected of such facilities by local emergency responders, and in the longer-term, by the regional economy.

NCHRP Synthesis 440: Performance-Based Seismic Bridge Design serves as the literature review for this research problem statement. In fact, this problem statement will address some of the knowledge gaps that were identified in this synthesis.

The objective of this research is to provide clear, consistent, and nationally accepted guidance for the use of PBSD concepts.
The work proposed herein would significantly enhance current practice and provide consistency that is lacking today. The work directly addresses a gap in the Guide Specifications for LRFD Seismic Bridge Design whereby Critical and Essential bridge criteria are not included. Inclusion of PBSD and addressing Critical and Essential bridges in that document would bridge an existing gap in criteria. The seismic guide specifications are a desirable place to address these topics, because the displacement-based methodology in that document can clearly and directly accommodate the PBSD concept. The LRFD Bridge Design Specifications, with their “R-Factor” approach to seismic design, on the other hand, are not as well suited for this purpose because expected performance is not directly checked. Additionally, all the building industries are moving toward more rational seismic design methods such as PBSD. This work will keep the AASHTO seismic design provisions in step with advancement in other building and infrastructure industries.

♦ Project 12-107

Development of Guidelines for Full and Hybrid Use of Stainless Steel for Bridge Girders

Research Field: Design
Source: AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $400,000
NCHRP Staff: Waseem Dekelbab

Whether to use corrosion protection of steel bridges is one of the largest decisions that can be made during design because it will ultimately affect the life-cycle cost due to various maintenance actions throughout the life of the bridge. However, the various protection schemes of zinc coatings (i.e., galvanizing, metalizing, and zinc primers) all have variable lives, which are challenging to predict, based on the macro- and micro-environments of a bridge. In marine and heavy industrial locations, even the best 3-coat, zinc-rich paint, or galvanizing can break down and require maintenance every 25 to 30 years. With a push to increase service lives of bridges out to 100 years and beyond, in severe environments, between two and five substantial maintenance actions could be required to attain the design lives. Many attempts have been made through research to develop more corrosion resistant alloys (i.e., weathering steels) or coatings for bridge applications. However, historical performance has shown that despite these attempts, areas beneath joints and/or in severe environments still result in corrosion of the steel and require continual maintenance.

The only steel alloys that will actually remain corrosion-free for a 100-year service life in any macro- and micro-environment are stainless steels. While these alloys are typically four to six times the cost of A709 Grade 50W, the ability to remain truly maintenance-free for a lifetime makes the alloy competitive in a life-cycle cost analysis. In less severe environments, there may be an advantage to using just stainless alloys in targeted locations (i.e., near joints and abutments) and creating a hybrid girder of A709 and stainless steel. Besides the issue of first cost, the other major obstacle to using stainless steel for bridges is a general unfamiliarity with the material in design, fabrication, and construction that is not addressed in any AASHTO specification.

The objective of the research project is to develop guidelines and/or specifications to help designers and fabricators use stainless steel in the superstructure of highway bridges. This would be considered a supplemental document to work alongside the AASHTO LRFD Bridge Design Specifications and the AASHTO LRFD Bridge Construction Specifications.

This needs statement satisfies the objectives of the 2013 AASHTO Highway Subcommittee on Bridges and Structures in the areas of Extending Bridge Service Life and Maintain and Enhance the AASHTO Specifications.

♦ Project 12-108

Development of Guidelines for Uniform Service Life Design for Bridges

Research Field: Design
Source: AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $300,000
NCHRP Staff: Waseem Dekelbab

There is limited experience in the state DOTs with rational design for service life. A few notable large signature bridges have been designed for specific service life criteria. But, most agencies rely on sub-
jective evaluation of perceived successful practices for identification and assessment of design alternatives to improve service life. The Strategic Highway Research Program 2 (SHRP2) has developed a Guide for Service Life under the project “Bridges for 100 Year Service.”

The AASHTO Highway Subcommittee on Bridges and Structures maintains the Load and Resistance Factor Design (LRFD) Specifications for Bridges as part of its responsibility to design and manage the nation’s highway infrastructure. The LRFD Specifications contain requirements for strength design and some serviceability checks. However, there are no comprehensive guidelines for design for service life.

A research project has just been completed by SHRP2 titled, R-19A, or “Bridges for 100 Year Service Life.” That effort lays the groundwork for establishing recommendations for extending service life and could be useful in developing a process for assuring uniform service life of various bridge components and elements. However, there are some elements of a comprehensive process for service life design that were not included in the SHRP2 project, such as a computerized tool for comparing life-cycle costs of life-extending materials and detailing practices, life-extension technologies for post-tensioned concrete structures, and nationally recognized life-cycle cost parameters for the three major environmental categories: severely corrosive (coastal), moderately corrosive (deicing applications), or mild (dry areas).

The research objective is to develop draft guidelines in AASHTO format for Uniform Service Life Design for bridges.

There is an urgent need to develop and improve the current methods of bridge service life design. These improved methodologies will increase the reliability and effectiveness of highway bridges, leading to improved durability, safety, and more effective management of bridges in state and local inventories. The results of this research will provide guidelines suitable for implementation by state DOTs.

Source: AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $600,000
NCHRP Staff: Waseem Dekelbab

Long-span bridges are often used in environmentally sensitive terrains, water crossings, and in locations with traffic and geometrical restrictions. Bridges with long-span precast pretensioned girders are advantageous due to their ease and speed of construction, lower cost, and long-term durability. The applicability of current bridge design and construction specifications for longer span prestressed girders is uncertain. Introducing the 0.7” strands will help bridge designers extend the spans of the current beam shapes as well as any future development. This larger strand helps by increasing the possible area of prestressing steel and by lowering the centroid of the prestressing force, which enhances the eccentricity of the force and effectiveness of the prestressing steel.

Research is needed to examine the applicability of the AASHTO LRFD Bridge Design and Construction Specifications for long-span precast pretensioned girders. This research shall thoroughly address design issues, fabrication, shipping, and handling of long-span precast pretensioned girders. To incorporate the 0.7” strand in the AASHTO LRFD Bridge Design Specifications, research is needed to determine the transfer length, the development length, the strands spacing, and the minimum concrete release strength.

The objective of this research is to summarize the current practice and augment the AASHTO LRFD Bridge Design Specifications (BDS) on the use of long-span precast pretensioned girders. The objective also includes developing specifications to incorporate the 0.7” strands in the BDS. This research should include instrumenting long-span precast pretensioned girders during all phases of fabrication and construction and comparing the measured strain at the end zones, prestress losses, deflections, and cambers with the calculated values.

This research addresses issues in several of the areas identified as program objectives in the 2013 Strategic Plan for Bridges and Structures developed by the AASHTO Highway Subcommittee on Bridges and Structures. The objectives addressed in this research are: Accelerate Bridge Delivery, Optimizing Structural Systems, and Maintaining and Advancing the AASHTO Specifications.
Increasing the spanning capabilities of precast girders is expected to have a large impact on reducing the bidding cost of current superstructure options for long-span bridges as it will provide a competitive alternative to steel solutions.

♦ Project 12-110
Development of Live Load Distribution and Impact Factors for the Analysis of Implements of Husbandry Vehicles on Bridges

Research Field: Design
Source: Wisconsin
Allocation: $650,000
NCHRP Staff: Waseem Dekelbab

The size, geometry, and weight of farm equipment known as implements of husbandry (IoH) have increased and changed significantly to meet the needs of the modern agricultural industry. While intended primarily for use on the farm or in the field, there are inevitably occasions where IoH will travel on public roads and over public bridges. Through a review of the history of bridge design vehicles as well as the evolution of truck size and weight legislation, it is clear that the growth of IoH has far out-paced typical commercial vehicles. The result is that a portion of the IoH now in existence creates force effects on roads and bridges that exceed original design capacities. State DOTs and other bridge owners are faced with ensuring public safety and preservation of their bridge assets. Therefore, an envelope vehicle or vehicles is needed to represent the practical physical aspects and limits of a series of IoH vehicles. The envelope vehicle would allow a systematic and system-wide analysis to evaluate infrastructure inventory in a proactive, consistent, and effective manner. Also, the nature of the load transfer between the IoH vehicles and the supporting driving surface and structural members lacks definition for the purpose of structural analysis. Further, dynamic load impact factors that are specific to IoH vehicles are a critical research need.

The objectives of this research are to define (1) a manageable set of “envelope” or “notional” vehicles that represent the fleet of husbandry-type vehicles and (2) live load and dynamic impact analysis factors for the distribution IoH-type vehicles to bridges and structures.

♦ Project 12-111
Incorporating Use of Effective Vibration Mitigation Devices for Traffic, Sign, and Lighting Structures in the Existing AASHTO Specifications

Research Field: Design
Source: AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $400,000
NCHRP Staff: Amir N. Hanna

Traffic, sign, and lighting structures are typically characterized by high flexibility and extremely low damping, which makes them prone to wind-induced vibration and susceptible to fatigue and structural failure. The AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals suggests the use of effective vibration mitigation devices for both new and existing traffic signal structures. The specification does not cover vibration mitigation devices for lighting and sign structures, even though such devices are available. The application of vibration mitigation devices for these structures for both design and retrofit is not explicitly identified in the specifications, and as a result mitigation devices are often not considered. An effective quantified vibration mitigation device would reduce the daily vibration stress range and thus would increase the fatigue life of the structure. The appropriate use of vibration mitigation devices will improve safety to the traveling public, reduce the costs of new structures, extend the life of new and existing structures, and lower maintenance, inspection, and repair cost, which results in more efficient traffic, sign, and lighting structures that use fewer resources.

Traffic, sign, and lighting structures are present in various forms throughout the United States. These structures are typically characterized by their high flexibility and extremely low damping which make them particularly susceptible to wind induced vibration (NCHRP Report 469). Various types of wind loading, including galloping, vortex shedding, natural wind gusts, and truck-induced gusts, can result in vibration of these structures. The large amplitude and cyclical response from the various wind-induced vibration result in repeated live load stress variations, which can significantly reduce the fatigue life of these structures. Reducing the effective stress range, the
difference between the maximum and minimum stress in a cycle, by reducing the amplitude of the vibration, as an effective vibration mitigation device would, can significantly increase the fatigue life of that structure.

There are two approaches to reduce vibrations: reduce the exciting load on the structure or modify the dynamic properties of the structure. Reducing the excitation on the structure has primarily focused on modifying the aerodynamic properties of attachments to the structure (i.e., mast arm). This approach, while effective, may limit performance to one type of wind excitation. For example, the proposed airfoil approach, whereby a sign blank is mounted horizontally near the tip of the mast arm to serve as an aerodynamic damper, can potentially provide an effective energy dissipating mechanism for galloping but may not provide any benefit for truck-induced gusts (NCHRP Report 412). As a second approach, changing the mass, stiffness, or damping of the structure can be considered. At the design stage, signal support vibration is commonly addressed by increasing the strength and stiffness of the structure. This results in larger poles and mast arms as well as overbuilt connection details. An alternative is the application of dampers to effectively modify the dynamic characteristics of the structure. Both modifying aerodynamic properties and applying dampers fall under the general classification of vibration mitigation devices.

According to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (Fifth Edition, 2009, Chapter 13), various traffic structures should be designed for fatigue, considering galloping, vortex shedding, natural wind gust, and truck-induced gust loading. Further, when a structure exhibits vibration in the field, a vibration mitigation device can be considered. For some traffic structures, the AASHTO specifications specify that in lieu of designing for galloping and vortex shedding forces, an effective vibration mitigation device may be used to reduce vertical deflections when approved by the owner. A number of mitigation devices have been proposed for traffic, sign, and lighting structures with varying degrees of complexity and performance. Various methods of testing, from free vibration tests to eccentric mass shakers to actual wind conditions, and various measures of effectiveness, from reduced displacements and accelerations to increased effective damping, have been reported.

While many different mitigation devices have been proposed, few have been adopted by traffic, sign, and lighting structure owners. This is mainly due to the difficulty for owners to reliably define if a particular mitigation device is effective and an absence in the specifications for how exactly effective vibration mitigation devices can be used in the design. Proposed is a study to provide methods and measures to quantify the performance of vibration mitigation devices, criteria to identify which mitigation devices are effective for specific structures, and explicit methods to incorporate the vibration mitigation device performance into the structural design of traffic, sign, and lighting structures.

The expected product of this research will be a test procedure that can be followed by traffic, sign, and lighting structure owners to qualify particular mitigation devices as effective for specific structures and an accompanying set of design procedures to incorporate the added performance of the vibration mitigation device into the design of the structure. The research is expected to include 3 phases comprising 7 tasks. Phase I, Quantifying Performance of Vibration Mitigation Devices: (1) Review and summarize literature related to vibration mitigation devices for traffic, sign, and lighting structures, identifying methods used to test the devices and measures used to quantify the performance of the mitigation devices. (2) Define specific performance measures for various traffic, sign, and lighting structure vibration mitigation devices. Phase II, Identifying Test Procedures to Qualify Mitigation Devices: (3) Review and summarize literature related to qualification testing of devices in general in the transportation field and mitigation devices in particular in other areas of engineering. (4) Prescribe testing procedures to qualify effective vibration mitigation devices for traffic, sign, and lighting structures and to quantify the performance of the mitigation devices. Phase III, Incorporate Effective Vibration Mitigation Devices into Specifications: (5) Identify procedures that directly incorporate specific vibration mitigation devices into the design of new structures. (6) Identify procedures that directly incorporate specific vibration mitigation devices into the retrofit of existing structures. (7) Develop recommendations for the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
Project 14-37

Guide Construction Specifications for Pavement Preservation Treatments: Chip Seal and Microsurfacing

Research Field: Maintenance
Source: Rhode Island
Allocation: $300,000
NCHRP Staff: Amir N. Hanna

Pavement preservation is becoming an important activity for DOTs in maintaining and enhancing the conditions of their highways. With the enactment of MAP-21 wherein DOTs have to show improved performance in the conditions of their highways, the use of pavement preservation treatments will be crucial to meet the performance goals. Pavement preservation treatments are treatments that do not improve the structural capacity of a pavement, but delay pavement deterioration by sealing cracks, preventing pavement oxidation, or rejuvenating the existing pavement surface layers.

Preservation treatments that utilize asphalt emulsions as the binder have almost always been considered secondary to the hot mix asphalt (HMA) technologies and as such are not well understood. Furthermore, these technologies have not been upgraded or researched as much as HMA. However, over the last 5 years the FHWA Pavement Preservation Expert Task Group has made a concerted effort to (1) improve the state of the science in emulsion technology and (2) create consistent performance-based standards (specifications, test methods, design practices, etc.) that are sponsored by FHWA and/or AASHTO and not vendor specific. The Emulsion Task Force has also drafted several standards for consideration by the AASHTO Highway Subcommittee on Materials. The rationale for creating AASHTO standards for the pavement preservation treatments was to provide credence and more importantly buy-in by the DOTs. In order to implement any of these treatments, material and construction standards have to be created. Material standards (design specs and design practices) have already been created for chip seals and microsurfacing. However, construction specifications (or a guide) for these treatments are not available and need to be developed.

The objective of this project is to produce a recommended AASHTO Construction Guide Specifications for the application of chip seals and microsurfacing to assist highway agencies in tailoring their own specifications to the local conditions and environments and implement these treatments for their pavement preservation programs. The research to produce the recommended guide specifications should include a review of previous work in this area.

Note: The AASHTO Standing Committee on Research directed that this project must include both chip seals and microsurfacing.

Project 14-38

Triggers and Timings for the Placement of Pavement Preservation Treatments for Asphalt Pavements

Research Field: Maintenance
Source: AASHTO Highway Subcommittee on Maintenance
Allocation: $350,000
NCHRP Staff: Amir N. Hanna

Pavement preservation is an increasingly widespread practice among agencies interested in extending the lives of their pavements in a cost-effective manner. Commonly stated challenges to the success of this practice include identifying good candidate pavements, selecting the best preservation treatments for those pavements, and the related challenge of placing the treatments at the best time. This proposed research specifically addresses the last challenge—treatment triggers and timings—although its successful completion will also provide insights into improved project selection and treatment selection practices.

It is acknowledged that there are a number of different approaches that are followed to identifying when to apply preservation treatments to asphalt pavements. These include (1) condition-based, in which one or more distresses trigger a treatment; (2) rating-based, in which an overall rating or rating range (such as a rating between 70 and 85) triggers a preservation action (but not a specific treatment); and (3) timing-based, in which treatments are applied according to a predetermined cycle, such as every 2, 5, or 10 years. There is clearly an opportunity to improve pavement preservation practices on asphalt pavements by collecting information and document-
ing practices that will strengthen the link between various triggers that identify a pavement as a good candidate for preservation and the placement of appropriate treatments. It is believed that this will contribute to the improved performance of preservation treatments. As such, the objective of this study is to document the range of triggers that are used to successfully identify when an asphalt pavement is a good candidate for pavement preservation. A secondary objective is to demonstrate various uses of these triggers in pavement preservation programs.

The objective of this research is to develop a manual that identifies pavement condition based and non-condition based triggers for pavement preservation treatments. The study is envisioned to be conducted in two phases comprising seven tasks. Phase I: (1) Literature review, (2) Assessment of agency practices, (3) Draft and final report. Phase II: (4) Recommendations for case study agencies, (5) Conduct case studies, (6) Draft guidelines, (7) Draft and revised final report.

♦ Project 15-61

*Applying and Adapting Climate Models to Hydraulic Design Procedures*

Research Field: Design
Source: Maryland
Allocation: $750,000
NCHRP Staff: Edward T. Harrigan

Hydraulic engineers are being asked to account for global climate change within hydraulic design procedures. To provide hydraulics engineers with the tools needed to amend practice to account for climate change, output from climate models must be downscaled and modified to provide recommended changes to regional precipitation data for design events used by hydraulics engineers. Collaborative efforts between climate scientists, hydrologists, hydraulic engineers, and coastal engineers are essential to producing these design inputs that are needed to amend hydraulic designs.

Incorporating the results of climate models will have very large cost implications for future infrastructure. Overestimating the magnitude of peak flows suggested by climate models can result in costly over sizing of drainage infrastructure, while underestimating may leave infrastructure vulnerable and their resultant flooding impacts on surrounding lands and structures inadequately addressed.

The objectives of this research are to: (1) identify the needed levels of precision, accuracy, and confidence for climate models to be compatible with that of the data used in current hydrologic/hydraulic analysis and design techniques, identify downscaling strategies to move climate models closer towards these levels of precision, accuracy, and confidence, and develop science-based strategies and methodologies to advance engineering in extending climate predictions when the limits of downscaling of climate models are reached; (2) identify and quantify resiliency in existing hydraulic design practices due to current safety factors and conservative assumptions/techniques; and (3) identify cost-effective adaptation solutions that extend existing infrastructure to continue to function to the end of its service life despite not having been designed for climate change. An outcome of this research will be a guidance document with a list of available and achievable hydraulic resiliency in design for retrofits.

♦ Project 15-62

*Access Management and Design Guidelines for Truck Routes*

Research Field: Design
Source: Florida, Kansas, Minnesota, New York, Utah, and Virginia
Allocation: $500,000
NCHRP Staff: William C. Rogers

Little or no research has been conducted on access management and design considerations for freight routes and sites that serve large trucks. Guidelines are lacking on the design and operation of truck routes through developed areas, as well as intersection and driveway design guidelines specific to larger trucks, such as the WB 67. In addition, agency design guidelines and warrants for turn lanes typically do not consider high volumes of large trucks.

Driveway and site circulation issues that impact trucks include inadequate throat length and other on-site conflicts that cause spillback into the roadway and impede efficient truck operations. Different safety and operational problems may occur in relation to ingress versus egress, requiring different solutions. From an operational perspective, there seems to be a
Critical point at which a small increase in trucks can create a major failure in operations. Research is needed to provide state transportation agencies and local governments with state-of-the-art access management and design strategies for freight routes and such issues as turn-lane design, access location, access spacing, and driveway and site circulation design.

The objective of this research is to provide state transportation agencies and local governments with model access management guidelines, policies, and strategies for truck routes, including guidance relative to the local designation of freight routes and the design of access and circulation for sites that serve high volumes of trucks and other large vehicles.

The following tasks are expected: (1) document and compare typical methods and criteria used by local governments to designate truck routes in local plans; (2) identify access-related issues and problems encountered by drivers of large trucks through surveys and interviews, and conduct field observations of traffic operations at interchanges and other sites where there is a substantial volume of large trucks to identify and evaluate the nature and frequency of traffic conflicts; (3) identify and obtain photographs and sketches of examples of good practices and problem situations, including site plans and photographs of good and poor location and design of access to truck stops and other major traffic generators of large trucks; (4) identify and evaluate techniques that might be applied to improve traffic operations and safety on truck routes; (5) prepare model network designation/classification, access management, and design guidelines for truck routes, including suggested criteria for the items noted above and case studies illustrating the potential application of these strategies and retrofit opportunities, and explore land use planning best practices to support the proposed strategies and reduce adverse impacts of freight movement on urban centers; (6) and recommend enhancements to state access management regulations and/or design standards, as appropriate, with regard to truck routes and site access and circulation.

♦ Project 15-63

*Design Options to Reduce Turning Motor Vehicle Conflicts with Bicyclists and Pedestrians at Intersections*

Research Field: Design

Source: AASHTO Technical Committee on Non-motorized Transportation

Allocation: $500,000

NCHRP Staff: William C. Rogers

More than 4,000 pedestrians and 700 bicyclists were killed in collisions with motor vehicles in the United States in 2012. Each year, many more pedestrians and bicyclists have their jobs, financial security, and physical capabilities changed permanently as a result of non-fatal crashes. The most common location for these collisions is at intersections. By way of example, a nine-year analysis of bicycle crash types in Cambridge, MA showed that over 60% of bicycle/motor vehicle crashes occurred at intersections. In addition, 56% of pedestrian crashes in Alameda County, CA occurred at or within 50 feet of an intersection. Signalized intersections are particularly important locations for safety improvements: an extensive pedestrian safety analysis in New York City found that nearly half (47%) of pedestrian fatalities and severe injuries occurred at signalized intersections.

Improving bicycle facilities at intersections is clearly a critical safety topic, and several common types of bicycle crashes have been identified in previous studies. Of particular concern for bicyclist safety at intersections is the conflict between bicyclists traveling straight and automobiles from the opposite direction turning left across the path of bicyclists. In addition, there are often conflicts between bicyclists traveling straight and automobiles from the same direction turning right across the path of bicyclists. A third common type of bicycle crash involves motorists emerging from side streets and driveways (which are a kind of minor intersection) and not yielding to through-moving cyclists.

There are also several common types of pedestrian crashes. These often occur at intersections that involve automobiles turning left and striking pedestrians in the far crosswalk and automobiles turning right and striking pedestrians in the near or far crosswalk. This includes situations where drivers are allowed to make a right turn on red.

Despite the widespread acknowledgement of these problems, transportation engineers and planners still lack definitive guidance on which types of designs have the greatest safety benefits. For example, current design practices commonly drop bicycle pavement markings and signs at intersections, provid-
ing little or no positioning guidance for motorists or bicyclists. Meanwhile, some more recent guidance suggests options such as dashing or coloring through the intersection. Some intersections fail to provide crosswalks or pedestrian signals, leaving motorists and pedestrians to rely on their best guess as to what the other user will do. In addition to these ambiguous situations, there are a number of design choices that may directly impact pedestrian or bicycle safety: pedestrian signal phases may be shortened to their minimum required length, turning radii may be increased, or right-turn-on-red may be allowed in order to allow more automobiles to pass through the intersection, making it more difficult to cross the street as a pedestrian. These changes are often made without the most effective consideration of pedestrian safety.

There is no comprehensive approach to indicate what designs provide the most effective approach or the most appropriate situation in which each should be applied. The primary guidance documents for practitioners, including the AASHTO Guide for the Development of Bicycle Facilities (2012), AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities (2004), NACTO Urban Bikeway Design Guide (2011), Highway Capacity Manual (2010), Highway Safety Manual (2010), and Manual on Uniform Traffic Control Devices (2009), do not provide sufficient information about the strategies that are most effective in specific circumstances. Engineering judgment will still be needed in many cases, but better guidance for applying typical and innovative intersection design treatments will help improve pedestrian and bicycle safety.

The objective of this research is to develop guidance for intersection design that minimizes the risk of motor-vehicle turning conflicts with pedestrians and bicyclists. The following tasks are expected: (1) identify typical and innovative design treatments to improve the safety of bicyclists and pedestrians at signalized intersections; (2) identify prevalent motor vehicle/bicycle and motor vehicle/pedestrian crash types at signalized intersections and identify specific differences in different settings (urban, suburban, rural); (3) conduct conflict studies at intersection approaches with and without the following design elements: for bicycles, standard bicycle lanes; marked/dashed bike lane/bike travel path through intersections; colored pavement for bike travel paths through intersections; bike boxes; bicycle signal-phasing; physical separation of bicycle facilities; and exclusive right-turn lanes for automobiles; for pedestrians, pedestrian signals with and without leading pedestrian intervals; curb extensions; reduced curb radius; prohibit right-turn-on-red; and pedestrian crossing islands; (4) document safety impacts of various design treatments observed; and (5) a practitioner’s reference for effective accommodation of bicycles and pedestrians at intersections. This reference will synthesize existing information in the common manuals mentioned above and add relevant results from research providing practitioners with documentation to improve designs of intersections for multiple users.

A key outcome of this research is the ability to determine those intersection designs that provide the most effective means of improving bicycle safety for specific situations and environments. Note that the conflict studies will not be expected to produce crash modification factors (CMFs) since it is unlikely that there will be sufficient data to draw strong conclusions. However, the conflict studies will provide a basis for future data collection and more rigorous studies that produce CMFs.

♦ Project 15-64
Unsignalized Median Openings in Close Proximity to Signalized Intersections

Research Field: Design
Source: Florida, Iowa, Kansas, New York, Utah, and Virginia
Allocation: $325,000
NCHRP Staff: David A. Reynaud

Closely spaced full median openings result in a complex pattern of overlapping conflicts. Provision of full access intersections is often provided yet unjustified—leading to high crash rates and reduced mainline capacity—each resulting in poor traffic operations. Restricting access in most cases is the best solution; however, there is little guidance on what parameters for full versus restricted access should be considered.

There are obvious safety and operational benefits to restricting access. For instance, closing a full median opening and making an intersection right-in/right-out eliminates all left-turn and crossing maneuvers. This reduces the number of conflict points
from thirty-two to four. Converting a full median opening to a directional opening for left turns from the major roadway eliminates left turns from the intersecting connection onto the major roadway and crossing maneuvers. Conflict points are reduced from thirty-two to eight (ten if u-turns from both directions are permitted) in this scenario. In some cases an unsignalized median opening may improve operations of a signalized intersection, but only if designed correctly.

Based on current research, the operational and safety problems resulting from unsignalized full median openings— as compared to unsignalized directional median openings—need further investigation. For example, Florida DOT has a policy of closing or converting unsignalized full median openings to directional openings whenever possible (left turn from the main roadway only). Other examples also exist that need to be analyzed.

The objective of the research will be to develop guidelines for closing an existing median opening or converting an existing full median opening to a directional opening. The proposed research should answer the following questions:

1. Using a before-after crash analysis, what are the differences in crash rates at unsignalized full median openings compared to the crash rates at unsignalized directional median openings;
2. Using supplemental conflict analysis methods, what are the frequency and severity of conflicts at unsignalized full median openings compared to unsignalized directional openings as a function of speed, traffic volume, or other attributes; and
3. What is the effect of full median and directional median openings on capacity as a function of the movements at a median opening and volume of these movements, the number of traffic lanes, roadway volume, and the speed at which the vehicle(s) on the roadway was traveling when the conflict occurred, etc. The above data collection and analysis will include the distance from signalized intersection to the unsignalized median opening and the design of the left-turn bay where one is present.

Many state and local agencies are reconstructing undivided roadways with a nontraversable median or replacing a continuous two-way left-turn lane with a nontraversable median. These reconstruction actions frequently result in opposition by owners of abutting businesses and request for unsignalized median openings. Rationale based on safety, traffic operations, and effect on business as to when and where an unsignalized median opening may be advantageous (as well as where one should be avoided) will assist state DOTs and local governments in gaining acceptance of limiting unsignalized median openings near a signalized intersection. Guidelines for evaluating the safety and operational effects of the proposed location and design of an unsignalized median opening will assist in implementation by state and local agencies.

♦ Project 17-74
Developing Crash Modification Factors for Corridor Access Management

Research Field: Traffic
Source: Florida, Kansas, New York, Utah, and Virginia
Allocation: $450,000
NCHRP Staff: Mark S. Bush

“Part D—Introduction and Applications Guidance” of the *Highway Safety Manual* (HSM) presents information regarding the effects of various safety treatments (i.e., countermeasures) on the roadway network. The information presented in Part D is used to estimate the effect of a specific countermeasure on safety. These effects are then used to develop a crash modification factor (CMF) for the specific countermeasure. In addition to the CMFs developed and recorded in the HSM, FHWA has also funded the CMF Clearinghouse to provide a venue for transportation professionals to identify the most appropriate countermeasures for their safety needs.

The HSM notes that corridor access management is one of the most critical elements in roadway planning and design and that access management is effective in helping to manage roadway access, while simultaneously preserving the safety, capacity, and speed on the surrounding roadway network. This helps to address the problems associated with congestion, capacity loss, and safety on the nation’s roadways. Corridor access management is also identified as one of nine general proven safety countermeasures as part of the FHWA’s proven safety countermeasures initiative. Even though corridor access management is considered to be effective in helping to manage the
roadways across the nation and to preserve safety, Part D of the HSM includes only three CMFs associated with corridor access management, specifically the potential crash effects of reducing access point density. The CMF Clearinghouse helps add to the number of CMFs related to corridor access management where as of January 2014 there were more than 250 CMFs related in some way to corridor access management. These CMFs cover a wide range of topics and associated benefits related to corridor access management.

Although the CMF Clearinghouse provides a large number of CMFs related to corridor access management, this large number in many ways complicates the benefit to the practitioner in trying to determine how best to apply CMFs to specific situations. There is a need to better understand the existing CMFs related to corridor access management by identifying ways to group and organize the CMFs with respect to various aspects of roadway type, geography, and other identifying conditions or features. In addition, corridor access management improvements generally include a combination of factors, which necessitates the documentation and determination of the cumulative/interactive effects of corridor access management features and the tradeoffs associated with various corridor access management features. NCHRP Project 17-63, “Guidance for the Development and Application of Crash Modification Factors,” is setting the foundation for this process in a general sense, but this needs to be built upon for corridor access management-specific CMFs.

The available CMFs are also concentrated on corridor improvements that may be made during design for reconstruction. Frequently, however, practitioners are confronted with questions about how adding or removing a particular access point will impact roadway safety. Providing micro-level CMFs would greatly aid highway operations and permitting personnel with making and documenting access decisions. This information would also be useful to municipal planning personnel in reviewing proposed access points as part of site plan approval for new development/redevelopment. Finally, there is also a need to develop corridor access-management related CMFs for all modes (e.g., bicycle, freight, pedestrian) and for specific conflict types and severity. This would benefit all agencies that regularly assess corridor access management and would ultimately improve the application of corridor access management across the nation.

The objective of this research are to identify ways to group and organize corridor access management related CMFs with respect to various aspects of roadway geometry, geography, land use context, and other identifying conditions or features; document cumulative/interactive effects of corridor access management features and the tradeoffs associated with various corridor access management features; provide micro-level CMFs tied to corridor improvements that may be made during design for reconstruction to aid highway operations and permitting personnel with making and documenting access decisions; develop corridor access management-related CMFs for all modes (e.g., bicycle, freight, pedestrian) and for specific conflict types and severity; and quantify safety performance of access management features both in terms of predictive methods (Safety Performance Functions) and CMFs.

Corridor access management has been identified as one of the proven safety countermeasures for corridor management outlined by the FHWA. The research outlined in this statement will provide practitioners and decision makers with tools to evaluate impacts of corridor access management alternatives to help them select the best alternatives. Additionally, the research will aid practitioners and decision makers with ways to better document safety benefits of corridor access management in order to help them justify access management decisions to stakeholders.

Currently, highway access design and operation decisions are made every day using guidance from the HSM and the available CMFs. When these decisions involve multiple corridor access management techniques or individual driveways, practitioners and decision makers are faced with uncertainty about how to apply current CMFs. This research will provide guidance in applying CMFs for multiple related corridor access management techniques and applying CMFs to decisions about individual access points. The research results will increase the accuracy and efficiency of design and operations decisions affecting millions of access points each year. While this research will help to improve best practices related to the use of CMFs, the ultimate payoff from the research will be to improve roadway safety.

Products of this research will result in application guidance for the use of corridor access management-related CMFs from the HSM and the CMF
Clearinghouse as well as additional CMFs for inclusion in the CMF Clearinghouse.

♦ Project 17-75

**Leveraging Big Data to Improve Traffic Incident Management**

Research Field: Traffic  
Source: Iowa  
Allocation: $275,000  
NCHRP Staff: William C. Rogers

Recent advancements in transportation data collection technology have significantly increased data quantity and improved data quality; however, traffic incident management (TIM) professionals have not yet harnessed the full potential of the data. As we enter the era of “Big Data” there are even more data sources to draw from to evaluate and improve TIM programs. Big Data is not just “a lot of data,” it is a fundamental change in how to collect, analyze and use data to uncover trends and relationships that can significantly change how TIM programs are managed and evaluated.

Big Data offers opportunities to bring multiple, comprehensive datasets together to derive information and relationships that can be used to improve TIM programs and protocols. The ability to mine information on unanticipated or unrealized trends can provide significant opportunities for improving protocols, resource management, scene management, and real-time data sharing. Current and future sources of data include traffic operations centers, responder dispatch centers, weather stations, connected vehicles, connected infrastructure, crowd sourcing, private providers, and other emerging technologies.

The opportunity and challenge is how to bring datasets together to uncover relationships and trends that may occur outside the more traditional evaluation processes, and to create platforms for developing Big Data analyses of traffic and response-related data.

Investments in TIM programs have been on the rise due to the potential for improved safety, reduced congestion, and improved environmental considerations. Many agencies have conducted formal evaluations of their TIM programs and are looking at TIM performance measures to track their success. Big Data provides a powerful new tool for leveraging the greatest return on investment in TIM resources.

The objective of this study is to determine current and emerging sources of data that can be accessed and mined in support of TIM program planning and operations, and to develop guidance on applications and analyses of the datasets to identify embedded and previously unseen relationships and trends. This project will create initial platforms for analyzing Big Data to provide enhanced insights into the relationships between traffic, response, resource, and existing conditions data. It will consider trends, relationships, and dependencies associated with both TIM program planning and real-time operations and response. It will also address the challenges faced with multi-agency data sharing, including security, propriety, interoperability, and other institutional challenges. The final report will describe and address the challenges of accessing and analyzing large datasets from multiple sources. This effort may require collaboration with multidisciplinary stakeholders experienced in TIM program evaluation.

♦ Project 17-76

**Understanding the Relationship between Operating, Posted, and Design Speeds and Safety in the Setting of Speed Limits**

Research Field: Traffic  
Source: Michigan  
Allocation: $500,000  
NCHRP Staff: Mark S. Bush

Studies have shown that speed is among the major causes of crashes. Inappropriate speed limits are more likely to cause larger speed variability and larger mean difference from the posted speed based on the observed population of drivers. It is desirable to achieve balance for safety between the three types of speed: operating, posted, and design.

Ideally, the design speed will exceed or match the posted speed and operating speed, but that is not always the case. While the design speed for an existing roadway is based on geometric features, the posted speed limits have historically been established based on state statute or an engineering study. Engineering studies often consider the 85th percentile speed during free-flow conditions when determining the posted speed. These studies often result in 85th percentile speeds above the design speed. In these situations the engineer is faced with the dilemma of set-
ting a posted speed above the design speed without fully knowing the safety risk. For highly-congested urban highways free-flow conditions rarely occur. For this situation the question raised is should the posted speed limit be based on operating speeds for conditions that occur for the majority of a time period.

NCHRP Report 504 identifies general relationships between design speed, operating speed, and posted speed limit. Setting safer speed limit requires a clear understanding of specific relationships between posted speed limit and operating speeds for the local driving population. However, the posted speed limit also needs to be related to design speed in order to minimize safety risk. It is important to identify the relationship between the three types of speed for different roadway sections and their influence on safety in terms of crashes when setting speed limits.

The objective of the research will (a) identify roadway inventory data such as geometric, cross-sectional, and access density, as well as traffic volume characteristics that may impact operating speed; (b) collect nationwide data sources for roadway inventory data, particularly the geometric, cross-sectional, and access density, as well as traffic volume characteristics; (c) develop prediction models for determining crash type, crash severity with respect to operating speed, roadway characteristics (roadway inventory data, and traffic volume characteristics); and (d) develop prediction models for operating speed that may be utilized by DOTs to determine the appropriate speed limit for a roadway or effective roadway design features for managing operating speeds with minimal safety risk.

This research will assist roadway agencies with making informed decisions related to establishing speed limits on their roadways. The development of prediction models for operating speed in relation to posted and design speeds will assist roadway agencies with setting speed limits based on risk and will provide knowledge on the impact that various roadway design features have on operating speeds. The research will focus on urban and rural freeways and rural non-freeways with posted speeds of 55 mph or higher.

Source: AASHTO Standing Committee on Highway Traffic Safety
Allocation: $300,000
NCHRP Staff: Dianne S. Schwager

The systemic approach to safety is a method of safety management that involves typically lower (unit) cost safety improvements that are widely implemented based on high-risk roadway features. This approach has been gaining favor with practitioners in recent years, whereas the more traditional approach has focused on identifying high crash locations and constructing larger projects to address predominant concerns at each site. The systemic approach is not meant to replace other analysis methods, but has shown to be more efficient than traditional spot improvements for reducing systemwide targeted crash types and meeting safety performance targets. However, the systemic approach is not presented in the first edition of the Highway Safety Manual (HSM), and there are limited tools available to agencies implementing these types of projects that seek to use quantitative safety analysis to drive management decisions.

The three most widely referenced tools capable of assisting agencies with planning and implementing systemic projects are the FHWA Systemic Safety Project Selection Tool (FHWA Tool), United States Road Assessment Program (usRAP Tools), and AASHTOWare Safety Analyst™. Recent research has presented a comparison of the FHWA Tool and usRAP Tools, while the Safety Analyst software has not yet been evaluated in the same context. A notable conclusion of this previous research is that the methodologies used in the FHWA Tool and usRAP Tools presume that crash data may not be available or is of poor quality.

Furthermore there is a need for efficient methods to perform effectiveness evaluation of large systemic projects. This proposed research is intended to address the urgent need for guidance and recommendations for agencies seeking to integrate quantitative analysis methodologies into existing safety management processes with respect to systemic safety. The proposed research results support the AASHTO SCOHTS’ Strategic Plan (June 2011) by addressing Goal 2, related to institutionalization and further development of the HSM, and Goal 4, Strategy 4, by developing tools that can better quantify changes in safety performance.
The value of the systemic approach to safety is well documented in literature, and the approach is being widely adopted because it is relatively easy to administer, effective, and flexible. However, research to date has primarily consisted of studies regarding the impacts of systemic projects and expanded implementation of the most widely used methods to specific roadway and crash types. In contrast, this proposed research will promote the use of science-based methods in systemic safety analysis by exploring quantitative approaches consistent with other state-of-the-art methodologies such as those in the HSM that are capable of adequately considering safety performance and other highly influential risk factors, such as crash frequency and exposure. This could include adapting existing quantitative analysis methods for use in the systemic approach and/or development of new methodologies.

The proposed research will build on tools and methods currently available to agencies by focusing on quantitative approaches that can improve safety management processes, promote better decision making, support policy changes, and enhance agencies’ ability to measure safety performance.

There are a number of other projects that are beginning or ongoing at this time related to systemic safety analysis, including NCHRP Projects 17-71 and 17-73. The FHWA Office of Safety is undertaking a project that will provide guidance on which risk factors should be used in the FHWA Tool when certain focus crash and roadway types are selected. While this research problem statement is of a different nature and addresses more broadly the need for improvement of quantitative analysis approaches, it will be important that this research be cognizant of the progress in these related research projects.

The primary objective of this research is to develop means for state DOTs, MPOs, and local agencies to effectively plan, implement, and evaluate systemic safety improvement projects using quantitative analysis approaches. The research should present recommended methodologies that agencies may implement with software tools using available databases and analysis tools, such as safety performance functions.

This research may:

a. Review published engineering literature regarding the systemic approach to safety.

b. Investigate methodologies used by widely available and commonly used tools, such as the FHWA Tool, usRAP Tools, and AASHTOWare Safety Analyst, to conduct systemic safety analysis and perform effectiveness evaluations. Identification of other guidebooks, tools, and software with similar capabilities is recommended.

c. Provide a standardized critique and capabilities assessment of these tools that agencies could use to decide which, if any, may be beneficial. Include examples of how each can be applied in the context of systemic analysis, data requirements, quantitative effectiveness, as well as expertise and resources required to support implementation.

d. Identify potential revisions to methodologies used by the reviewed approaches and software tools that would increase their effectiveness or support their implementation.

e. Present best practices for quantitatively considering risk factors such as crash frequency, exposure, and high-risk roadway features in the context of systemic safety analysis, as well as methodologies for efficiently evaluating the effectiveness of systemic safety projects.

f. Provide guidance for agencies regarding when it is appropriate and effective to implement systematic (implemented everywhere) projects as opposed to systemic projects (risk-based implementation). Review tradeoffs and expected impact on safety program effectiveness with respect to countermeasure type, nominal or substantive safety improvement type, and extent of implementation area.

g. Develop implementation guide and training materials to assist agencies in adopting or transitioning to quantitative approaches for systemic safety analysis in safety management and project development processes. Discuss findings from the capabilities assessment including data needs, tradeoffs of qualitative versus quantitative approaches, and recommend best practices. These materials may be incorporated in a future edition of the AASHTO HSM.
♦ Project 17-78
Understanding and Communicating Reliability of Crash Prediction Models

Research Field: Traffic
Source: AASHTO Standing Committee on Highway Traffic Safety
Allocation: $300,000
NCHRP Staff: Mark S. Bush

Credibility is essential to any form of analysis being performed for the public welfare. During initial implementation of the *Highway Safety Manual* (HSM) model, results have been generated and utilized to make major capital improvement decisions without understanding the accuracy of the model results, which can erode the credibility of this new and rapidly growing field. The state of the art of safety analysis has progressed and more has been learned about the impact on accuracy of assumptions made during the development of crash prediction models using HSM procedures. It also appears that practitioners are struggling to understand and communicate the reliability of crash prediction models. This reliability includes the general model accuracy in addition to when models are executed at or outside the appropriate thresholds (i.e., $e = 8\%$, very low AADT values, etc.). Case studies presented at various conferences, including the TRB Annual Meeting, and through other initiatives demonstrate that practitioners are utilizing the models in ways not recommended and also displaying crash prediction results without properly understanding the model reliability. Understanding and communicating consistently reliable crash prediction results is critical to credible analysis and a barrier for some transportation authorities to utilizing these models.

This topic was among the top ranked research needs identified at the 2013 Safety Effects of Geometric Design Decision Workshop, which was a joint meeting of TRB committees that focus on design, operational effects of design, safety performance, safety data, asset management (AHB65, AFB10, ANB25, AHB70 and ANB20), and the AASHTO Technical Committee on Geometric Design. In addition to being of interest to both practitioners and researchers, a better understanding of the reliability of individual models and the general concepts of crash prediction reliability will support the AASHTO SCOHTS' Strategic Plan (June 2011) by addressing Goal 2, related to the institutionalization and further development of the HSM, and Goal 4, Strategy 4 by developing tools that can better quantify changes in safety performance.

The objective of the research is to develop guidelines for estimating, calculating, and reporting reliability of crash prediction models including crash modification factors/functions, safety performance functions, calibrations, and combinations thereof. In development of the guidelines, consideration will be given to the balance between improved model reliability and user friendliness.

The guidelines developed with this research will be able to be applied to existing crash prediction models and will serve to improve all future models and model elements. This could impact a range of documents including the HSM and all supporting documents that provide guidance on model development.

♦ Project 17-79
Safety Effects of Raising Speed Limits to 75 mph and Higher

Research Field: Traffic
Source: AASHTO Standing Committee on Highway Traffic Safety
Allocation: $500,000
NCHRP Staff: Mark S. Bush

Over the past decade, there has been a trend toward higher speed limits, especially on Interstates/freeways. Twelve states have increased speed limits to 75 mph, some as high as 85 mph on freeways and 75 mph on other roads. A number of states have increased regulatory speed limits up to 65-70 mph on 2-lane rural roads. In some cases these higher posted speed limits exceed design speeds. The impacts of these recent speed limit increases on safety, specifically the interactions of vehicles and drivers with the roadway environment, have not been thoroughly studied. For example, roadside hardware is tested at lower speeds, and it is not well understood how various devices perform on roadways with higher speed limits.

Previous studies on this topic examined only short-term effects and did not address speed limits 75 mph and higher. TRB’s 1998 *Special Report 254* critically reviewed studies on the effects of increasing speed limits up to 65 mph on rural Interstates. Many
of the studies examined reported statistically significant increases in fatalities on the affected highways. However, most of the studies did not examine the broader issue of network effects—the limited number of studies that attempted to look at such system effects reported mixed results. NCHRP Research Results Digest 303 summarizes research on the effects of increasing speed limits up to 70 mph. However, the findings were largely based only on short-term impacts in a single state.

The objective of this research will be to evaluate the safety impacts of increasing speed limits on high-speed highways and examine how specific geometric and roadside design elements perform with higher speed limits. Although the primary focus should be on limits increased to 75 mph and above, the long-term impact of other speed limit increases (e.g., 65-70 mph on freeways and non-freeways) should be examined. The product of the research is intended support decisions on whether to increase speed limits and to help identify engineering, enforcement, educational, or other strategies to counteract potential negative safety impacts.

Speeding is one of the most common factors contributing to fatal crashes, and while raising speed limits may lower traffic violations, there are concerns about the increased crash severity resulting from higher speeds. As safety professionals work on multidisciplinary approaches to reduce and even eliminate fatalities and meet performance targets, the results of this research will help consider whether to raise speed limits and how to do so appropriately, understanding potential infrastructure and behavioral countermeasure limitations and resource needs.

The results of this project will help transportation agencies make more informed decisions about raising speed limits and better respond to legislative proposals across the US to increase allowable speed limits. The research will also help practitioners implementing higher speed limits balance the design, operational, and human performance factors with the potential economic or other advantages of increased speeds, and consider potential impacts across the network. Objective evidence of the safety effects of high speed limits will be a useful tool for practitioners communicating with interested stakeholders, and will assist decision makers in making tradeoffs on speed-related issues that constantly arise at the state level.

♦ Project 17-80

**Expansion of Human Factors Guidelines for Road Systems, Second Edition**

| Research Field: | Traffic |
| Source: | AASHTO Standing Committee on Highway Traffic Safety |
| Allocation: | $500,000 |
| NCHRP Staff: | Mark S. Bush |

The first complete release of *NCHRP Report 600: Human Factors Guidelines for Road Systems, Second Edition* (HFG) was published in 2012. It has 21 guideline chapters with a total of 90 guidelines. The HFG assists safety practitioners and designers in developing a greater understanding of road users’ capabilities and limitations and how these issues could be incorporated into day-to-day safety decision making. About 25 percent of highway fatalities are associated with a combination of road and road user factors, and this proposed research would further assist practitioners in addressing these crashes.

At inception, it was envisioned that the HFG would be a living document where new guidelines would be developed as new human factors needs are identified for enhancing road users’ safety and as new research studies and data become available to serve as the source of guideline materials. It was recognized that some topics could not be developed in the initial HFG publication. For example, *NCHRP Report 600* does not have chapters for bicycle, motorcycles, roundabouts, or incorporation of user constraints into road safety audits, and only some limited guidelines for pedestrians. This material is frequently requested by practitioners using the HFG, however. The Transportation Research Board Joint Subcommittee on Human Factors Road Design Guides, AND10(2), with the assistance of numerous other TRB Committees, has compiled a list of about 20 suggested additional guidelines that are being assessed for development. Since the development of the 90 guidelines in the current HFG, additional research has been completed that will permit the addition of guidelines that could not be included initially because of the lack of reliable published research.

Pilot tests were performed by the state departments of transportation in Arizona, Nevada, Idaho, Wisconsin, and Delaware. The tests were well received and were used in areas such as road safety audits, design, and diagnostic assessment of safety...
concerns. FHWA initiated a contract to develop an HFG training course to be delivered by the National Highway Institute to state and local transportation departments and other organizations. NCHRP is also planning to develop a primer for using the HFG and the Highway Safety Manual (HSM) together. Both the HFG and HSM when used together greatly enhance the efforts of highway engineers, traffic engineers and planners to account for the road users’ needs in the design, operation, and control roadways.

The objective of this research is to review existing published highway-related human factor road-users research literature, update as needed existing guidelines in HFG, Second Edition, and develop new technical chapters with guidelines for inclusion in HFG, Third Edition. All new guidelines will use the format as published in NCHRP Report 600: Human Factors Guidelines for Road Systems, Second Edition. The HFG is a living document for use by highway designers, planners, and traffic and safety engineers.

♦ Project 19-12
Development of Financial Plans and Performance Measures for Transportation Asset Management

Research Field: Administration
Source: AASHTO Standing Committee on Planning
Allocation: $350,000
NCHRP Staff: Andrew C. Lemer

Transportation agencies face significant and continuing challenges in securing resources needed for preserving and improving the nation’s transportation network, and in planning future expenditures considering investment needs, public expectations, asset deterioration, expected revenue streams, risk, uncertainty, and other factors. In addition, federal transportation legislation—Moving Ahead for Progress in the 21st Century (MAP-21)—requires states to develop financial plans for managing their National Highway System assets.

Transportation asset management provides a framework for making resource allocation decisions about how best to preserve infrastructure assets, such as roads, bridges, and traffic and safety assets, and well as other asset types. Asset management emphasizes optimizing investment decisions to be cost-effective, improve performance, and control asset lifecycle costs. Much work has been performed nationally and internationally over time to develop asset management concepts and tools, such as those detailed in Volumes I and II of the AASHTO Transportation Asset Management Guide. However, available asset management guidance lacks details on how to develop financial plans for transportation assets, and what specific financial measures to use in characterizing asset performance. The Government Accounting Standards Board has provided guidance for development of asset valuation estimates though its Statement Number 34 (GASB 34), but in practice the existing measures of asset valuation, though important for accounting, have proven to be of limited value for developing future plans and characterizing performance over time.

Research is needed to strengthen the financial management aspects of transportation asset management and to develop guidance for how to prepare financial plans for transportation assets and networks that comprise those assets. The research should draw on previous work in the United States and other countries to supplement existing AASHTO and GASB documents with step-by-step details for preparing financial plans as elements of transportation asset management plans. The research should address issues such as projecting available expenditures given uncertain revenue streams, reporting projected investment levels, inflation, selecting maintenance activities based on net present value analysis, understanding opportunity costs, and comparing projects for different assets using comparable financial metrics. The research should also describe specific measures for characterizing financial performance of transportation system assets and asset portfolios. The research should produce guidance for transportation agencies to use as they develop their asset management plans and will help foster increased emphasis on making investment decisions supported by consideration of financial concerns.

Research tasks might include review of the current literature and ongoing research, characterization of the state of practice in financial planning for infrastructure in public and private sectors, review of federal and state regulations influencing financial management of transportation system assets, and analysis of what particular guidance materials would be most helpful to state transportation agencies for financial planning as an element of transportation asset management planning. Guidance materials to be
developed might be tested and refined to ensure they are responsive to the needs and interests of agency officials and other potential users. The research may also include development of plans for further work to extend the performance measures and financial planning guidance developed in this research effort.

♦ Project 19-13

**Value Capture Toolkit for State Transportation Agencies**

Research Field: Administration  
Source: South Dakota  
Allocation: $350,000  
NCHRP Staff: Andrew C. Lemer

Value capture (VC) is a mechanism for generating revenue to pay for transportation infrastructure by collecting fees or taxes on the value of land served by that infrastructure. Investments in new or enhanced facilities such as highway interchanges and transit stations improve access and generate commercial traffic that boosts property values; capturing a portion of that increased value can be an instrumental component of the financing needed to undertake the project. As a public-sector financing tool, VC mechanisms accelerate project delivery. Many local and regional agencies use VC mechanisms regularly, but for state departments of transportation (DOTs) the practice has been relatively rare.

*NCHRP Synthesis 459: Using the Economic Value Created by Transportation to Fund Transportation* described nine VC mechanisms being used to fund transportation by agencies across the United States. The synthesis highlighted the need for decision tools to aid implementation. A considerable body of literature has developed describing VC and analyzing specific applications in transportation.

Implementing VC mechanisms equitably and legally depends on agency preparation to determine the area of benefit, the magnitude of the benefits, and the timing of the benefits. A VC toolkit could assist DOTs in (a) choosing appropriate VC mechanisms, (b) estimating stakeholder involvement costs and administrative costs, and (c) identifying VC practices that may be effective in a particular situation. Research is needed to expand DOTs’ understanding of VC concepts, practical applications of those concepts, examples of VC usage in situations typical of DOT practice; and provide practical guidance for how to identify opportunities for VC and take advantage of those opportunities. The objective of this research would be to develop guidance for DOTs on use of VC in project development and a toolkit for VC analysis and applications.

♦ Project 20-107

**Construction Project Staffing Strategies for Effective Program Oversight**

Research Field: Special Projects  
Source: Michigan  
Allocation: $500,000  
NCHRP Staff: William C. Rogers

State DOTs continue to struggle with constrained resources resulting from staff reductions. These same departments are challenged to ensure that legal, environmental, and federal requirements are met and documented for all federal and state funded construction projects. As such, many agencies have decided to hire full or part time consultants, create limited term positions, and recruit co-ops or similar staff to supplement their work force.

Currently, a national need exists to analyze DOT staffing practices, their use of supplemental resources, and review of the state-of-the-practice of the types of work being outsourced. Such an analysis will help to determine the optimal staffing levels to ensure proper inspection and documentation of federal aid contract work. The results are needed by DOTs to help guide central office, regional, district, and local construction field offices in optimal staffing levels for construction projects.

This research is vitally important to all DOTs to help guide them as they balance the requirements for construction inspection and oversight with new technologies and efficiencies. All agencies will benefit with more unified and efficient use of resources. Research is needed to determine the optimal types of projects for consultant oversight for better utilization of staff as well as developing procedures, protocols, and tools for resource acquisition and allocation.

The objective of this research is to develop guidance to help DOTs determine how to effectively and efficiently balance program oversight responsibilities using agency staff and outsourced contractors. The guidance should identify best practices as deter-
mined by state DOT agencies, and include a workforce planning toolkit with various optional inputs for project size/cost, geography, available staffing, complexity, and technologies.

♦ Project 20-108
**Effective Practices for Creating and Maintaining an Innovation-Delivery Culture within Departments of Transportation**

Research Field: Special Projects  
Source: California  
Allocation: $300,000  
NCHRP Staff: Andrew C. Lemer

Innovation can be defined as developing ways to improve existing products, processes, or services to better serve customers. Industry and government organizations, in the US and worldwide, increasingly consider innovation to be the key to maintaining competitiveness, achieving business success, and socioeconomic advance. Leaders of state DOTs are recognizing that it is no longer adequate or acceptable for the DOT to focus only on solving problems. DOTs need to become highly innovative, to be on the leading edge in technology and management to meet the demands of a sophisticated customer base.

There has been much research and advice published on innovation in transportation, but much of the work has focused on innovating in specific domains, applications, or technologies (for example, transit, pavement materials, or structures). Some work has primarily considered a single phase of the work that DOTs conduct to deliver a safe, effective, and environmentally responsible transportation system (for example, planning, design, or asset management). Some work presents case studies describing how introduction of particular process or product improvements were introduced, received in the marketplace, and judged to have succeeded or failed (for example, outsourcing, electronic design and bid documents, or fiber-reinforced bridge components). Relatively little work has been done to address comprehensively the practices of innovation within a DOT or among DOTs, the factors influencing success or failure, and the ways that DOT leaders can enhance their organization’s readiness to accept innovation.

Some work has sought to take a broader view of innovation at the organizational level. For example, *NCHRP Report 768: Guide to Accelerating New Technology Adoption through Directed Technology Transfer* presents a framework and guidance on how to use technology transfer to accelerate innovation within a DOT or other such agency, but is focused on one particular mechanism for encouraging innovation. To be successful, an organization’s strategic objectives and business models should align with and support innovation delivery generally, and generate quantifiable benefits to the organization. Research is needed to identify organizational and management practices that create and foster an innovation-delivery corporate culture and to analyze their use and efficacy for DOTs—the challenges, opportunities, incentives, and roadblocks to their effective implementation. Research is needed also to identify performance measures for evaluating how effectively innovation is adopted and delivered by the DOT for the benefit of the agency’s stakeholders.

The research may include activities such as describing precisely what is meant by a “culture of innovation” and the value of having such a culture, identifying organizations widely recognized as having a culture of innovation that could be models for DOTs and characterizing the features critical to their maintenance of the culture, describing the characteristics of DOTs and their business environment that discourage or encourage a culture of innovation, describing DOTs that have been more successful in benefiting from having a culture of innovation, and describing a framework and process for developing a culture of innovation delivery within a particular DOT.

The objective of this research will be to develop a guide for DOT leaders presenting a clear explanation of what is an organizational culture of innovation delivery, the value of having such a culture, the ways to measure an organization’s culture of innovation delivery, and ways that leaders can create and foster such a culture. The guide should include description of effective practices from DOTs and other organizations that leaders may be able to adapt to their own situation.
Project 20-109
Improvements to the Transportation Research Thesaurus

Research Field: Special Projects
Source: Montana
Allocation: $350,000
NCHRP Staff: Andrew C. Lemer

In 2001 TRB published *NCHRP Report 450: Transportation Research Thesaurus and User’s Guide*. The primary purpose of the Transportation Research Thesaurus (TRT) is to provide a common vocabulary for producers and users of TRB’s TRIS database. Indexers can describe documents in a consistent way, and TRIS users can successfully retrieve TRIS records in their areas of interest by searching the thesaurus terms. In FY2006 NCHRP Project 20-70 funded the development of web access to the TRT on the TRB website as well as improvements to the technology that supports use of the TRT by TRIS indexers. Both tasks were successfully completed and implemented. In FY 2008 NCHRP Project 20-79 funded the addition of a limited number of definitions to the TRT.

Although the progress made under previous projects has been significant, additional upgrades will allow for improved functionality. A more robust search engine on both the public and data entry sites would suggest and provide links to preferred terms, based on a partial word. A new taxonomy management system could support a number of tasks. More definitions would be useful to indexers and searchers alike. Thesauri, in the limited sense, do not include definitions, just scope notes to allow the user to distinguish between terms that have more than one definition, for example cranes (birds) and cranes (equipment). Providing more information to those who assign terms to reports would promote more consistent use of vocabulary across repositories and thus improved access to like information. Additional definitions in the TRT on the web would support the searcher who is working outside his or her specialization, allowing him or her to improve the search strategy.

Research is needed to accomplish a number of tasks, including deprecation of terms that have never been used, review of “uncontrolled terms” to merge similar terms or recommend terms for addition to the TRT, structural changes in the thesaurus to enhance its utility, fixing a structural problem in one facet, preparing additional definitions and analyses to support migrating to a new software platform, and others.

The objective of this research will be generally to enhance the TRT’s functionality through accomplishing such tasks as consultation with TRIS indexers, the TRB Subcommittee for the TRT, and the others in the research community; review of the facet structure; recommendation of new terms (for example in areas of information management and technology) and terms for deprecation or deletion; recommendation of maintenance processes for accommodating future additions, deprecations, and deletions; review of metadata standards; and recommendation of a taxonomy management system for TRB and steps for the system’s adoption.

Note: Funds may be reserved from the research budget for purchase of software and migration of the TRT to a new platform.

Project 20-110
Best Practices for Increasing Access to the Results of Federally Funded Scientific Research

Research Field: Special Projects
Source: Washington
Allocation: $250,000
NCHRP Staff: S. A. Parker

In February, 2013, the White House Office of Science and Technology Policy (OSTP) released a memo titled, “Increasing Access to the Results of Federally Funded Scientific Research.” The goal of the new policy is to ensure that, as stated in the memo, “to the greatest extent and with the fewest constraints possible and consistent with law and the objectives set out below, the direct results of federally funded scientific research are made available to and useful for the public, industry, and the scientific community. Such results include peer-reviewed publications and digital data.” The memo goes on to require that any research project utilizing federal funds, done by either intramural or extramural researchers, must include open access research data management and publication plans. Further, agencies and organizations receiving federal research monies must provide
for the long-term preservation and access of digital research data and resulting publications.

While the transportation sector has only recently begun to look at issues of long-term research data preservation and open access, there are a handful of transportation agencies and organizations that have experience with quite large research data sets. Further, other federal agencies and federally-funded organizations, especially in the hard sciences and medicine, have had data management requirements in place for several years, creating a pool of knowledge and experience the transportation research community can draw from.

This research should produce 1. A survey of current practice in providing open access to federally-funded research data; 2. Information and training materials designed to guide agencies and organizations towards compliance; and 3. A manual of best practices, case studies, sample policies, and potential state and federal synergies. The outputs of this project are expected to assist state DOTs and transportation research organizations to efficiently come into compliance with OSTP directives around “Increasing Access to the Results of Federally Funded Scientific Research.”

Note: Implications of federal and state laws should be examined and emerging practices documented and evaluated. Consideration should be given to producing a research roadmap covering the important issues.

♦ Project 21-11

Improving Processes for Characterizing Corrosion Potential of Soils and Fill Materials

Research Field: Soils and Geology
Source: Kansas, AASHTO Highway Subcommittee on Materials, and AASHTO Highway Subcommittee on Bridges and Structures
Allocation: $400,000
NCHRP Staff: Edward T. Harrigan

Electrochemical properties of soils and aggregates such as resistivity (conductivity), pH, salt (chlorides, sulfates, phosphates), and organics contents are used to characterize the potential for corrosion of buried/embedded metal elements that may include piles, drains, culverts, or soil reinforcements. These elements are often incorporated into transportation-related construction projects within earth embankments, bridge foundations, abutments, and approaches. Electrochemical properties are evaluated using current AASHTO test standards, adopted in the early 1990s, that were based upon preexisting test procedures applied to agronomy. These methods do not consider the vastly different characteristics of materials used in transportation-related construction, nor do they distinguish issues inherent to particular applications. For example, moisture contents of mechanically stabilized earth (MSE) fills during service cannot exceed the saturation limit, and often coarse sand, gravel, and aggregate types of fills are used, which current test standards fail to consider. Construction practices and our knowledge of underground corrosion have evolved since the 1990s, such that the limitations of the current AASHTO test standards must be recognized and suitable alternatives need to be evaluated and implemented. There are many projects for which this issue generates considerable conflict, and often results in use of more expensive sources of backfill. The needless use of more expensive sources of backfill from greater distances is not a wise use of available resources, does not contribute to proper asset management, and is inconsistent with sustainable design and construction practices.

Research is needed to address limitations of current AASHTO-specified test methods. These limitations are related to (1) particle sizes that may be included in the test specimen (must pass a #10 sieve), (2) identifying the proper end-point for the test, and (3) the small size of the specimen included in the measurement. These attributes limit the appropriateness of the test results to finer soil types, and do not consider practical limits on water contents that may be experienced in the field. The research will evaluate alternative test methods that may be more appropriate for particular applications (e.g., MSE walls) and will consider a wider range of fill types. Protocols for assessing corrosion potential for different applications, and recommendations for updating the current AASHTO standards for the design and construction of bridges will be developed based on the evaluation of test alternatives.

The research will address needed revisions and clarifications to existing standards, and the need to adopt new test methods. Results from this study will be a resource for highway and bridge engineers
and contractors who need to evaluate the corrosiveness of soils and fill materials for construction, and will be of great interest to the AASHTO Subcommittees on Materials and on Bridges and Structures who review standards for material testing and design and construction of transportation facilities.

The objective of this research is to review existing test procedures and evaluate alternatives that may enhance or extend our abilities to characterize the corrosiveness of earthen materials for a wider range of conditions and considering different applications compared to the current protocol.

Specific tasks include to (1) identify alternative test methods for measuring the resistivity of soil/aggregate. Review and recommend existing procedures for testing coarse aggregate that apply to materials that do not have a significant amount of material passing a #10 sieve; (2) document differences in test procedures including sample preparation, methods of measurement, and potential interferences. Indicate the range of application for each test in terms of soil types and function (e.g., culverts, piles, MSE, etc.). Assess the occurrences of materials with minimum resistivity at the slurry state, and the relevance (or irrelevance) of this to in-service conditions; (3) recommend alternative test techniques that apply to coarse sands, gravels and aggregates and evaluate the test methods by comparing results obtained with different test methods including AASHTO T 288. Document relationships between measurements, expected correlations, trends, and other means that may be useful to crosscheck and verify the veracity of laboratory measurements. Verify results of the laboratory study with field measurements of corrosion from sites where the corrosion potentials of the fills have been assessed using laboratory test methods; (4) propose alternative tests that may be useful to replace, improve, modify, or enhance current AASHTO test standards; (5) recommend an updated protocol to assess corrosion potential of different materials and for various applications. The protocol may cite several test standards for measurement of resistivity, or other electrochemical properties, and provide guidance on when the different tests should be applied. For example, establish a boundary to describe coarse soil and aggregates and the different tests that apply to coarser and finer materials. Sample size will also vary with respect to the coarseness of the material (i.e., maximum size); and (6) recommend updates to the current AASHTO standards that may include new test standards and protocols for design and construction. Outcomes from this research include updated protocols for evaluating the corrosiveness of soils and fill materials, which will distinguish between specific applications, e.g., MSE wall systems as opposed to culverts and steel piles.

♦ Project 24-46

Development of an Implementation Manual for Geotechnical Asset Management for Transportation Agencies

Research Field: Soils and Geology
Source: AASHTO Planning Subcommittee on Asset Management
Allocation: $500,000
NCHRP Staff: David A. Reynaud

In the past decade considerable advancement has been made in Transportation Asset Management (TAM) to allow agencies to focus strategically on the long-term management of government-owned assets. Minimal guidance is available for developing TAM plans, but more detailed guidelines will soon be available for plan development. In the past few years, the application of asset management principles to geotechnical assets has followed the general TAM development pattern and has been tried by a few state departments of transportation and other agencies. However the results to date are mixed, with considerable differences in approaches and results. Early efforts have often focused on inventory and condition surveys, without continuing along the full TAM spectrum. As a result, the benefits of asset management have not been realized for geotechnical assets so far.

Recent efforts such as those by the FHWA Central Federal Lands Highway Division, Colorado Department of Transportation, and the Alaska Department of Transportation and Public Facilities to develop asset management plans for geotechnical assets have increased the awareness of the valuable contributions possible by geotechnical asset management (GAM). Various management practices that fall within the scope of GAM are also implemented in many other states, including Washington, Oregon, and Nevada. In fact, a recent informal survey of states found at least 38 are practicing or starting some type of geotechnical asset management (inventory, assessment,
and/or programming decision making) though many didn’t realize it as such.

The federal surface transportation bill, Moving Ahead with Progress for the 21st Century (MAP-21), specifies risk- and performance-based asset management for bridges and pavement and encourages state transportation agencies to develop and implement transportation asset management strategies for all assets within the right-of-way. It is time to move beyond the initial steps of GAM and focus on the development and incorporation of geotechnical assets into the transportation asset management arena.

The primary objectives of this research are as follows:

1. To define what geotechnical assets are and to provide a taxonomy of geotechnical assets.
2. To identify performance expectations, targets, and means of measurement.
3. To identify how to incorporate risk analysis principles and processes into asset management for geotechnical assets.
4. To develop a manual for creating and implementing geotechnical asset management plans.

This research provides an opportunity for a national coordination effort that can lead to consistent application of geotechnical asset management. Without the research, there is potential of a fragmented implementation approach that will vary from agency to agency. Similar to existing pavement and bridge management systems, a coordinated research effort is key to developing a system that can be used by many agencies and also can be used to efficiently recognize the benefits of more complete asset management throughout the country.

♦ Project 24-47

Clear-Water and Live-Bed Scour in Long Contractions

Research Field: Soils and Geology
Source: Tennessee
Allocation: $500,000
NCHRP Staff: David A. Reynaud

Current guidance in Hydraulic Engineering Circular No. 18 (HEC-18), “Evaluating Scour at Bridges,” (Arneson et al. 2012) provides equations for estimating contraction scour. Existing equations are based on sediment transport theory using approaches developed by Laursen (1960) (live-bed contraction scour) and Laursen (1963) (clear-water contraction scour). Both equations assume that the scour is due solely to the contraction effect and that local effects are negligible (i.e., that the contraction is hydraulically “long”), and both solve for the depth of flow, \( y_2 \), in the contracted section after scour has occurred. The depth of scour of the bed material, \( y_s \), is then calculated as Equation 1: \( y_s = y_2 - y_0 \), where \( y_0 \) is the depth of flow in the contracted section before scour occurs.

Depending on the ratio of the length of contraction, \( L \), to the approach channel width, \( b_1 \), channel contractions are designated as long or short. According to Komura (1966), a contraction becomes long when \( L/b_1 > 1 \), whereas Webby (1984) considered it as \( L/b_1 > 2 \). In a short contraction, local scour also occurs throughout the contracted section as a result of large-scale turbulent flow structures created at the entrance to the contraction, and the total scour is the result of both the contraction and local effects.

Analysis of existing laboratory data sets conducted under NCHRP Project 24-34, “Risk-Based Approach for Bridge Scour Prediction” revealed that the clear-water contraction scour equation does not envelope the observed data as a design equation. Rather, it is a predictive equation that is seen to underpredict observed scour relatively frequently compared to pier and abutment scour equations. No laboratory data sets of live-bed contraction scour were identified during the NCHRP 24-34 study; therefore, the live-bed contraction scour equation could not be assessed against observed data.

In addition, the NCHRP 24-34 study found that all of the previous studies suffered from a flaw in the experimental design, as none actually measured the depth of flow, \( y_0 \), in the contracted section before scour began to occur. Therefore, this value had to be estimated in order to determine the depth of scour using Equation 1. In addition, a number of laboratory studies did not directly measure the depth of scour using bed elevation measurements. Instead, the assumption was made that \( y_0 \) was equal to \( y_1 \) (the depth of flow in the approach section upstream of the contraction). This assumption ignores the hydraulic drawdown effect in the contraction that occurs during subcritical flow (particularly in a bridge reach).

Lastly, most of the existing laboratory data points were obtained from tests where the contraction
ratio \( W_2/W_1 \) created a “choked” condition at the entrance to the contraction (Wu and Molinas, 2004). This condition leads to energy losses between the approach and contracted sections, further compounding the difficulty in estimating \( y_0 \).

The objectives of this research are to 1) Develop a reliable data base of scour in long contractions under both clear-water and live-bed conditions, and 2) Develop live-bed and clear-water contraction scour equations suitable for use in bridge design, not simply a best-fit prediction. This research would identify, compile, and assess existing laboratory data sets to supplement the NCHRP 24-34 analyses. In addition, laboratory studies should be conducted under both live-bed and clear-water conditions where the physical model setup can be adjusted to examine contraction scour under a range of hydraulic conditions, contraction ratios, and bed material types.

Scour estimates at bridge foundations have been roundly criticized for decades as being overly conservative. The perception is that the equations almost always result in more costly bridge designs, at major expense to taxpayers. A long and ongoing concern has been expressed by bridge engineers regarding the perceived excessive conservatism in predicting bridge scour. This indicates that there is an urgent need to determine the most appropriate and reliable way to estimate the various components of bridge scour in order to estimate total scour for 1) assessing scour vulnerability of existing bridges, and 2) designing foundations for new bridges.

Research conducted under NCHRP Project 24-34 clearly indicates that of the three primary scour components (pier, contraction, and abutment), the contraction scour equations exhibit, by far, the least amount of reliability in terms of 1) the conditional probability that the contraction scour estimate will be exceeded during the design event, and 2) the unconditional probability that the contraction scour estimate will be exceeded during the life of the bridge. Thus there is a demonstrated and urgent need to decrease the uncertainty of contraction scour estimates so that greater reliability can be achieved.

The payoff potential to bridge owners is significant if bridges currently considered to be scour critical can be reclassified to a lower-risk status, or if foundations for new bridges can be designed for a lesser amount of total scour. Implementation of new guidance would be primarily oriented toward revisions of HEC-18 and the AASHTO Highway Drainage Guidelines.

♦ Project 25-53

**The Efficacy of Treating Highway Runoff to Meet Watershed TMDL Goals**

**Research Field:** Transportation Planning  
**Source:** Washington and AASHTO Standing Committee on the Environment  
**Allocation:** $200,000  
**NCHRP Staff:** Lori L. Sundstrom

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant (the “load”) that a water body can receive while still meeting water quality standards and an allocation of that load among the various sources of that pollutant. TMDLs are developed for water quality-impaired bodies pursuant to Section 303(d) of the federal Clean Water Act. State DOTs are being named as Designated Management Agencies in TMDL management plans. Such a designation often requires state DOTs to commit a substantial amount of staff time, conduct compliance reporting, and construct capital facilities for stormwater treatment at a high whole-life cost. The requirements outlined in TMDL reports are applied broadly to a number of land uses, are often based on assumption—rather than actual constituent load data on DOT stormwater discharges—and consider neither the relative nor the absolute contribution to the water quality problem.

Some TMDL implementation actions have been adopted as regulations, as is the case with requirements in the National Pollutant Discharge Elimination System’s municipal and construction stormwater permits, increasing the risk of third-party legal challenges for DOTs through these permits. The impacts related to transportation have been considered equal to those impacts from municipal, commercial, and industrial uses in some cases. While highways are a significant source of some pollutants, for others, highways may be only a minor contributor, or the pollutant of concern may have its origins outside the highway right-of-way, unrelated to the operation or maintenance of the roadway. For example, while highway runoff may have high bacteria concentrations, water body impairments are usually associated with inadequate on-site sewage treatment systems and
agricultural livestock operations. Consequently, under certain scenarios, it is likely more economical for entities other than the state DOT to control the pollutant at its source. The portion of the total pollutant load attributable to the DOT may be small compared to the total load reduction needed, resulting in only nominal improvement in the receiving water at a relatively higher cost than addressing the primary pollutant source. Treating all stakeholders equally for all pollutants does not result in the highest benefit for the environment, but does misallocate resources. As outlined in EPA’s Clean Water Act 303(d) Vision and Goal Statement (2013), effective integration of responsible parties and sources increases the likelihood of successful TMDL implementation, especially for TMDLs that include nonpoint source pollution. A U.S. Government Accounting Office publication states that “experts also reported that the TMDLs that do not diagnose and aim to treat the true causes of water body impairment are unlikely to lead to attainment of designated uses.”

Previous research has focused on how DOTs can respond to and meet TMDLs, and substantial effort has been put into characterizing highway runoff and identifying the sources of pollutants. This project will integrate existing information and develop strategies for determining appropriate and cost-effective TMDL requirements for DOTs. Also, this research would directly support the SCOE strategic plan mission to “provide policy and technical support to the AASHTO member departments to integrate environmental stewardship goals into all transportation decisions and activities;” the goal to “develop policy alternatives for integrating environmental considerations into all transportation decisions;” and the Natural Resources Subcommittee goals to “actively participate at the federal level in implementation of the Clean Water Act” and “target…the committee’s efforts to…operating activities and technologies…such as Storm Water Runoff and nonpoint source pollution.”

The first phase of this project will focus on conducting a general evaluation of the importance of the various highway runoff pollutant contributions in a TMDL context. This analysis will be based on the concentrations of pollutants in highway runoff, the sources of the pollutants in the runoff, and the relative and absolute contribution of the highway runoff pollutant to receiving waters (taking geographic and traffic variations into account). The objective is to provide watershed managers and regulatory agencies with guidance to determine if it is appropriate to name the DOT as a stakeholder in a TMDL, and provide factual data to assist in screening DOTs as potential TMDL stakeholders. Such guidance could ultimately result in a more clearly defined and appropriate set of requirements for highways.

In the second phase, the project will reference other NCHRP projects to develop a protocol for evaluating the cost effectiveness of implementing highway runoff treatment requirements to meet TMDL pollutant reduction goals. There are many excellent references available for computing a unit cost by best management practice (BMP) and by constituent. More efficient control strategies could be realized by both DOTs and regulatory agencies if unit costs by BMP and by constituent were considered when determining requirements within the highway environment. This phase two research has two intended outcomes. The first is that TMDL load allocations and implementation plans be based on appropriate information and accurately reflect DOT impacts and water quality mitigation capabilities. The second is to ensure that the responsibility placed on DOTs is commensurate with DOT contributions to the receiving water body impairments and actual watershed loads.

Also, innovative compliance strategies and alternatives to TMDLs, which have been utilized by some state DOTs will be compiled and summarized. Results from this investigation can be used by both DOTs and regulatory agencies in the development of TMDL management plans and/or alternative compliance strategies. Better guidance and data-based decisions will ensure that responsibilities and resources are allocated to maximally benefit the receiving waters and that the costs of compliance for the designated management agencies do not outweigh the benefit to the watershed.

It is expected that the research will include the following tasks:

Task 1 - Literature Review, Compilation of Data, and Survey of State Practices and Experience
Literature review and data compilation will focus on the following areas: highway runoff characterization data selected from a broad range of geographic conditions and traffic levels; source studies for the most common TMDL pollutants, both in highway runoff and watersheds as a whole; effectiveness of stormwater BMPs at removal of the most common TMDL
pollutants; costs associated with the stormwater BMPs constructed in the highway environment; a specific evaluation NCHRP Synthesis 20-05/Topic 43-06 that has information useful for this work, and NCHRP Projects 25-37 and 25-40; innovative compliance strategies (e.g., Caltrans, DelDOT, MnDOT) including alternative implementation approaches to numeric waste load allocations; and alternative approaches to TMDLs (e.g., NCDOT).

Task 2 - Evaluating Highway Runoff Contribution to TMDL Pollutant Loads

Using the information collected in Task 1, the project will evaluate when and under what circumstances TMDL pollutants are in highway runoff, and, if so, is runoff a substantial or primary source of the regionally significant TMDL pollutants. This evaluation would include the geographic variables such as land use, local soils and geology; traffic volumes; relative and absolute size of receiving waters compared to highway drainage area; and ultimate sources of the pollutants. A decision tree would be developed to help the DOT practitioner and regulatory agency assess if the DOT should participate as a stakeholder in a TMDL. The information from Tasks 1 and 2 can be used to help inform the DOTs if alternative approaches to TMDLs are viable, and also if innovative compliance strategies are beneficial. The decision tree could include paths for alternatives to TMDLs, and options for innovative compliance strategies.

Task 3 - Evaluating Cost Effectiveness of BMPs

Using the information from Tasks 1 and 2, the project will develop a protocol for evaluating the cost effectiveness of BMPs to meet overall pollutant reduction goals for a TMDL, using previously completed NCHRP research. This would include assessing the relative and absolute contribution of highway runoff to the watershed pollutant load, incremental costs associated with increasing BMP size, effectiveness and frequency, and local conditions. Unit cost data by BMP and by constituent would be used to assess TMDL compliance options, such as regional treatment or source control programs.

The protocol will also need to include assessment of the overall cost of a DOT meeting its TMDL goals within the target watershed. This calculation will need to include not only the direct BMP capital cost, but also the ratio of monetary and other costs incurred to implement the BMPs within a given watershed compared to the benefit for the watershed, to determine overall cost effectiveness. That is, for a given watershed, how much stormwater would have to be treated, how many BMPs would be required to do so, how practical is it to implement those BMPs, and how do those costs compare to the overall benefit for the watershed? This holistic watershed assessment may lead to options to meet TMDL goals such as stormwater banking, pollutant-trading, off-site mitigation, or other watershed approaches where DOTs might find it advantageous to direct funding to non-DOT mitigation that has more benefit than traditional approaches.

Note: The AASHTO Standing Committee on Research suggests that this project consider the results of related SHRP2 research.

♦ Project 25-54
Field Trials of BMP to Remove Dissolved Metals in Highway Runoff

Research Field: Transportation Planning
Source: Tennessee
Allocation: $400,000
NCHRP Staff: Lori L. Sundstrom

The recently published NCHRP Report 767: Measuring and Removing Dissolved Metals from Stormwater in Highly Urbanized Areas (NCHRP Project 25-32) developed a number of designs of facilities for the removal of dissolved metals in highway runoff in ultra-urban areas, as well as a laboratory protocol to evaluate the potential of various media to remove dissolved metals. That research did not include a field testing component to evaluate either the functionality of the designs or validate the laboratory protocol. The objectives of this project are to achieve both of those goals, so that DOTs can implement the designs with the sure knowledge of their cost effectiveness.

The purpose of the proposed field trials is to evaluate dissolved metal removal rates, assess operational functioning under actual highway conditions, and develop actual cost information, so that DOTs have reliable data to support implementation decisions.
Potential tasks include (1) selection of installation location, (2) construction of the treatment facility, (3) water quality monitoring for up to a year, (4) whole-life cost assessment and, (6) final report development.

Dissolved metals in highway runoff frequently exceed water quality standards; consequently, DOTs are under regulatory pressure in many areas to reduce the concentrations of these constituents. Without field testing the recommendations contained in *NCHRP Report 767*, the money and effort that went into that project will be largely lost. Consequently, the proposed work is a necessary follow up to that previous work.

Note: The AASHTO Standing Committee on Research suggests that the emphasis of this research be placed on deployment.