National Cooperative Highway Research Program

Fiscal Year 2020 **May 2019**

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 Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. The NCHRP is an applied contract research program that provides practical and timely solutions to 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 required by the states. The NCHRP program for FY 2020 is expected to include 13 continuations and 56 new projects.

This announcement contains preliminary descriptions of only those new projects expected to be advertised for competitive proposals. **Detailed Requests for Proposals for these new projects will be developed beginning in August 2019.**

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, proposals should demonstrate strong capability gained through extensive successful experiences in the relevant problem area. Consequently, any agency interested in submitting a proposal should first make a 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 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.

Address inquiries to:
Lori L. Sundstrom
Manager
National Cooperative Highway Research Program
Transportation Research Board
lsundstrom@nas.edu

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 2020. 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 research agency selection for all projects. The first round of detailed Requests for Proposals will be available starting in August 2019; proposals will be due beginning in September 2019, and research agency selections will be made beginning in November 2019. 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 2020 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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National Cooperative Highway Research Program
Projects in the Fiscal Year 2020 Program
(Titles are HOTLINKS)

Project 03-138
Experimental Implementation of Big Data Analytics for Traffic Incident Management

Research Field: Traffic
Source: AASHTO Committee on Transportation System Operations
Allocation: $500,000
NCHRP Staff: William C. Rogers

There is much talk about Big Data these days within the field of transportation; however, many groups and organizations do not fully understand or appreciate the scale of the data, the concepts, and the paradigm shift that is necessary to move from traditional data collection, storage, and analytics to the implementation of Big Data. This shift is not simply a linear one; rather, it requires completely new approaches to data collection, storage and management, and procurement of IT services, as well as skill sets that lacking in most agencies and which are difficult to acquire. Furthermore, there are few ready to use Big Data data sets that can be used to demonstrate the benefits of this approach, particularly for traffic incident management.

The recently completed project NCHRP Report 904, *Leveraging Big Data to Improve Traffic Incident Management (TIM)*, begins to address these issues. Products in the report include a list of Big Data Opportunities, Big Data guidelines for transportation agencies and TIM programs, and Outreach Materials. One of the most significant findings of NCHRP Report 904 is that in order to gain the most benefits from Big Data approaches and analytics, a large-scale, multi-state implementation is essential. In addition, three barriers to implementation were identified: organizational culture, organizational capabilities, and access to large amounts of varied data. These significant technical and non-technical barriers would be difficult for any agency to overcome and are best addressed through continued national-level research into implementation.

The objective of this research is to demonstrate the feasibility and practical value of the Big Data approach to improve TIM. The project will demonstrate the scale and variety of the data needed, the data sources that can be leveraged, the Big Data concepts (e.g., cloud data storage, open data, data management), and the Big Data analytics techniques through real-world data, examples, and case studies. Proposed tasks include:

1. Establish a data environment in which data can be stored and analyzed:
    a. Integrate multiple, diverse datasets into a data analytics environment.
    b. Document openness of data, as well as challenges with gaining access to the data.
    c. Provide a description of the data environment.
    d. Establish the costs of the data environment.
    e. Describe the data management (storage, data structure, accessibility, security, etc.).
2. Develop use cases for improving TIM–based on the data collected, explore the data and identify possible analyses that would help to improve TIM.
3. Apply Big Data analytics techniques to produce real-world examples.
4. Document and share outcomes–share trends, models, visualizations, and outliers.
5. Develop lessons learned and case studies–document lessons learned throughout the process and develop case studies to enhance the NCHRP Report 904 guide-

lines to further support adoption and implementation. The case studies will look at using local, regional, state, and national data sets to develop the proof of concept. In addition, the case studies will aim to show how the use of the Big Data approach can support tracking national TIM performance measures: roadway clearance time, incident clearance time, and number of secondary crashes, as well as other measures.

Project 03-139
Next Generation of the USLIMITS2 Speed Limit Setting Expert System

Research Field: Traffic
Source: Federal Highway Administration
Allocation: $350,000
(Additional $100,000 from Federal Highway Administration)
NCHRP Staff: Camille Crichton-Sumners

Per NHTSA, in 2016, 18% of drivers involved in fatal crashes were speeding at the time of the crash and 27% of those killed were in a crash involving at least one speeding driver. Setting safe speed limits is one strategy and foundation of speed management to reduce speeding–related crashes and fatalities. USLIMITS2 is the only tool available for setting appropriate speed limits with the consideration of all prevalent factors impacting speed limits setting.

NCHRP 3-67 Expert System for Recommending Speed Limits in Speed Zones was completed in 2006, resulting in the deployment of the USLIMITS2 Speed Limit Setting Expert System. The system was developed based on results from previous research, responses from practitioners to hypothetical case studies as part of two web-based surveys, input from experts from three panel meetings, and lessons learned from an earlier version of the USLIMITS program developed by the Australian Road Research Board for FHWA. The system and documents related to decision rules can be found at https://safety.fhwa.dot.gov/uslimits/.

USLIMITS2 employs a decision algorithm to advise the user of the speed limit for the specific road section of interest. The algorithm focuses primarily on operating speeds, 85^{th} percentile speed, and 50^{th} percentile speed to determine the recommended speed limit based on other variables inputted by the user. While minor updates were made to USLMITS2 in early 2018 to improve usability, the decision algorithm has not been updated since 2006. New research is needed to refine the decision rules of the algorithm.

The objective of this research is to (1) use current literature, interviews with State and local agencies, discussions with experts, and feedback on the current USLIMITS2 system to determine what updates are needed for the USLIMITS2 decision algorithm and (2) to implement the findings by updating the algorithm, conducting user testing of the revised system, and deploying the updates. The research will make use of the findings from other NCHRP projects such as 17-76 -- Guidance for the Setting of Speed Limits, 17-79 Safety Effects of Raising Speed Limits to 75 mph and Higher, and 20-05; Topic 49-08 Pedestrian Safety Relative to Traffic Speed Management to ensure that USLIMITS2 is consistent with recommendations from other NCHRP projects.

Project 03-140
Applications of RFID and Wireless Technologies for Highway Construction

Research Field:	Traffic
Source:	South Dakota
Allocation:	$400,000
NCHRP Staff:	Waseem Dekelbab

Advancement in sensing and transmitting technologies such as radio-frequency identification (RFID), barcodes, e-ticketing, global positioning systems, and other associated wireless technologies has significantly improved wireless transmission. Projects where such devices were used reported beneficial outcomes through improved resource and quality management. But, due to some reasons, the beneficial outcomes could not attract the highway construction industry to adopt it to its fullest potential and as a result there exists a lag in terms of reaping the benefits of technological advancements. The wireless transmission technology enables sensing, counting, measuring, documenting, identifying, locating, tracking, and transmitting information in real time. These features can help project managers to manage time, money, quality, and safety of any project effectively. However, a significant difference exists between wireless technologies' acceptance versus the expected acceptance and efficient use.

The objective of this research is to bridge the gap between the existing technology buy-in, efficient use of technologies, and the beneficial applications of advanced wireless technologies to the highway construction industry.

Some of the benefits realized while using these techniques are: reduced time for locating and tracking materials/pieces; hassle–free documentation of operations, maintenance, repair history and warranty claims; availability of onsite operational support through availability of personnel data, timekeeping, fleet management and progress status; instant and easy data availability to decision makers and administrative staff, reduced paper work and related hassles; and convenient digital data storage, analysis and transfer.

Project 08-127
Emerging Issues: Impact of New Disruptive Technologies on the Performance of DOTs

Research Field:	Transportation Planning
Source:	AASHTO Committee on Performance-Based Management
Allocation:	$250,000
NCHRP Staff:	Lawrence D. Goldstein

The transportation of people and goods is one of the most important components of our everyday lives. The arrival of the 4th Industrial Revolution and the rapid development and fusion of multiple disruptive and innovative technologies, such as artificial intelligence, big data and digitization, the Internet of Things (IoT), fifth (and even sixth) generation wireless technologies (5G/6G), connected and autonomous vehicle (CAV) technologies, on-demand ride-sharing services, Mobility as a Service (MaaS), 3D printing, the sharing economy, and others are changing not only the behavior but also the expectations of both customers and stakeholders.

The fusion of these technologies is bringing a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation is moving at a pace beyond which many governmental entities are equipped to respond. Mobility as we know it, is also transforming as new technologies disrupt traditional ways people and goods move throughout our transportation systems. The rapid introduction of mobile internet is upending the traditional approaches with new customer-centric business models based on the sharing economy such as online car hailing, bike sharing, time sharing, customized shuttle bus, parking sharing, etc. And while the new business models bring more convenience and efficiency to the users and to the national and local economies, they have also created new problems, needs, and challenges that we must face as decision makers. Today during the 4th Industrial Revolution as technology previously foreign to transportation rapidly enters old ways of doing business – e.g., solely road infrastructure related – performance is affected across all modes and aspects of transportation agencies' responsibilities. Institutional processes may be knocked down to make room for updated or more effective methods to improve performance outcomes. Unfortunately, all agencies lag behind to at least some extent as they struggle to define meaningful measures, manage data collection, maintain accountability, and streamline reporting.

Disruptive technologies are forcing global changes that are capturing the attention of transportation agency leaders within AASHTO as well as transportation researchers worldwide, including the World Road Association (PIARC) that has recently announced a call for papers on the "Impact of Disruptive Technologies to the Performance of Transport Administrations" as part of the World Road Congress in Abu Dhabi in 2019.

The objective of this research is to advance our understanding of the potential impacts that innovative and disruptive technologies, including the sharing economy, will have on the overall performance of DOTs and MPOs. The research will seek to identify leading performance indicators that transportation agencies can use to improve their understanding of the possible impacts of these evolving technologies and how these changes might affect strategic planning and service delivery.

Agencies that adopt new processes and methodologies developed through this research project will benefit by: 1) understanding the impacts of technology on the DOTs/MPOs performance; 2) having a defensible framework for defining performance measures tied to goals of the agency; 3) identifying the workforce skills needed for performance management capable of responding to advances in technology; 4) being proactive in adapting business models and processes that respond to changes in transporting people and goods; and 5) improving access, mobility, confidence in new technology, and safety for all users, including underserved populations.

Project 08-129
Incorporating Resilience Concepts and Strategies in Transportation Planning Efforts

Research Field:	Transportation Planning
Source:	AASHTO Committee on Transportation System Security and Resilience
Allocation:	$300,000
NCHRP Staff:	Lawrence D. Goldstein

This problem statement reflects research gaps identified as part of the NCHRP 20-117 project as well as findings from the RISE Summit held in October 2018. Most resilience efforts on the part of state departments of transportation (DOTs) are found in emergency response and to some extent in project design (for example, design exceptions when the context makes a different design appropriate). However, several presentations at the RISE Summit showed the importance of considering resilience efforts in planning efforts in order to set the overall direction of how resilience can be considered throughout the project development process. Corridor studies from Oregon, Colorado and Utah illustrated how corridor-based resilience planning provided direction to potential designs, operations and maintenance. In addition, other state DOTs, such as the Michigan DOT, are examining how resilience concepts could be included in statewide transportation planning. And yet a few others, such as Caltrans, are conducting resilience studies through its planning division. The purpose of this research is to provide more in-depth research on the topic of resilience and transportation planning that can be included in the Resilience Guidebook that is being produced by the NCHRP 20-117 project under way.

As an important contribution to this process, the FHWA has sponsored several efforts that examine the relationship between resilience and transportation planning. These efforts have been at a very high level and not specific enough to include in the Resilience Guidebook. There is a need to provide very detailed and specific advice to state DOTs on how resilience can be integrated into different aspects of transportation planning.

The objective of this project is to develop specific guidance on how resilience concepts can be incorporated into transportation planning efforts at all scales of application. The intent is to integrate the research results into the Resilience Guidebook being developed by the NCHRP 20-117 project. It is expected that the research will look at different types of state DOT planning efforts, such as statewide planning, modal planning and corridor planning, and how resilience could be integrated into such efforts.

Project 08-130
Best Practices in Coordination of Public Transit and Ride Sharing

Research Field:	Transportation Planning
Source:	AASHTO Council on Public Transportation
Allocation:	$250,000
NCHRP Staff:	Velvet Basemera-Fitzpatrick

Public transportation has long been the mobility alternative to single occupancy vehicles, offering a consistent and reliable method of ridesharing. However with the rise of private sector ridesharing companies and multimodal transportation options increasing, the interplay between traditional models and innovative approaches is critical to research, address, and engage with, in order to create a seamless transportation network that meets the mobility needs for all riders.

Online and phone mobility apps are becoming increasingly available in small urban and rural communities to help people find the best commuting option to shopping, appointments, recreation, employment, and other destinations. These apps make it easy to find the best transit route, locate a park and ride lot, map your trip, or even find a commuting partner based on your work schedule or neighborhood. However, many small urban and rural communities lack these online tools, leaving commuters, especially those without automobiles, to navigate the complexities of the transit systems in these areas, highlighting the needs to research solutions to the existing gap in transportation coordination amongst the growing options

The objective of this research is to document the available online apps to help ease commuter access to public transit and allow for improved mobility in their communities. In order to advance this area of transportation knowledge, it is important to identify what existing resources are currently available and if/ how the private industry is interacting and partnering with the public sector in coordinating mobility services.

As one of the Idaho Transportation Department's (ITD's) core mission statements, "Your Mobility", researching and understanding the opportunities to coordinate public transportation with other ridesharing mobility options directly ties back to the focus areas in this state. As the mobility needs are changing, and the gap in design between rural transportation and urban transportation increasing, we are at a critical juncture in need to innovative solutions. The outcomes that this project will offer will be able to be implemented in the form of marketing efforts, outreach strategies, and provide data and analysis to bring together multiple stakeholders with a common goal.

Project 08-131
Access to Jobs, Economic Opportunities, and Education in Rural Areas

Research Field:	Transportation Planning
Source:	AASHTO Council on Public Transportation
Allocation:	$250,000
NCHRP Staff:	Lawrence D. Goldstein

Populations across the country are shifting, creating a need for stronger connections to rural areas. These connections might be rural-to-rural or rural-to-urban. Population shifts have created challenges for employers in rural areas and their ability to expand and recruit additional employees. Moreover, jobs in our urban areas are not paying adequately, and increasing access for populations in rural areas to jobs in rural communities is important to their success. Transit plays a necessary role in traditional and non-traditional models in helping to solve this employment shortage.

The objective of this research is to identify specific needs in rural communities, including employment, education and transportation, and explore the range of new relationships and partnerships needed to improve access, not only to jobs and education, but also to other necessary community services. While many jobs, education institutions and medical facilities will be located in metropolitan regions, major employers supporting economic prosperity will also be located in suburban and rural areas. Commuting patterns will become increasingly regional, requiring transit agencies to develop new services to connect employees across jurisdictional boundaries. New local routes, regional commuter services and rural routes facilitating access to employment will support sustainability and growth to regional and statewide economies. This process represents a paradigm shift away from looking at jurisdictional–based planning, looking instead at larger geographic area needs or travel sheds to meet those needs.

Project 08-132

Accessing America's Great Outdoors: Understanding Recreational Travel Patterns, Demand, and Future Investment Needs for Transportation Systems.

Research Field:	Transportation Planning
Source:	AASHTO Special Committee on Research and Innovation/Committee on Planning/Tennessee
Allocation:	$450,000
NCHRP Staff:	Lawrence D. Goldstein

Each year, there are an estimated 870 million visits to federal lands (Leggit et al. 2017). This recreational and tourism travel, driven by demand for access to parks and public lands, continues to increase in urban and rural areas throughout the country, placing new and changing demands (traffic congestion, air pollution, etc.) on transportation systems. Managing this travel demand has been increasingly challenging and has added congestion and operational stresses on not only the public lands themselves, but also on the gateway communities that provide access to them. For example, many National Parks have seen substantial and rapid changes in visitation rates over the last five years (as high as 40% and 60% at some units) and looking ahead, the growth rate for international visitation to the US is higher than the forecast growth for domestic travel (according to the US Travel Association). This growth in visitation has resulted in congested roads, intersections, and entry gates for many parks as well as gateway communities (c.f. Yellowstone Transportation and Visitor Mobility Study 2016; Acadia Transportation Plan / DEIS 2017).

In many places we are seeing tourism expand at record breaking numbers. For example, tourism to Utah grew 12 percent from 2011 to 2015, with visitors spending a record of nearly $8.2 billion and generating approximately $1.15 billion in total state and local tax revenue. This visitation expansion is happening both in total visitation numbers, but also in traditionally low use seas seasons. For example, NPS visitation grew 9% in September 2018 when compared to the same month last year. Outdoor recreation contributed $373.7 billion to the US economy (or 2%) in 2016, exceeding the economic contributions of other industries that access similar lands (e.g., mining, oil, and gas extraction at 1.4% of total GDP) (BEA ORSA). The outdoor recreation economy grew 3.8 percent in 2016, compared with the overall U.S. economy's 2.8 percent growth that year. Many local communities in rural areas are largely dependent on the recreation travel economy.

As a result, there is a real need for increased research in understanding recreational travel demand, patterns and demographics. Changing consumer preferences and evolving travel decision-making will affect tourism in the future. Without information to help understand and predict these trends, land managers, states and gateway communities are limited in their ability to make equitable transportation investment decisions about access, quality and asset management within a single jurisdiction, and especially within multiple jurisdictions. A goal among several federal departments to enhance the recreation and tourism (e.g., DOI SO 3366, USDA Call to Action #5) means that agencies at all levels need to collaborate and find sustainable solutions to managing recreational travel demand generated by public land visitation. Proactive and strategic investment in the assessment and planning for visitor use management along recreational travel routes is needed to support both federal and state efforts to successfully manage changing visitation, connect visitors to public spaces, protect resources, support local economies and provide for high quality travel experiences; however, most (if not all) travel demand models use tools and assumptions that do not account for the unique needs, uses and patterns of recreation-based travel.

To address this need, this study has three primary objectives: 1) to document and describe recreational and tourism travel demand and the related data gap within key states of interest (focus states TBD); 2) to identify and begin to explore which factors (economic, demographic, geographical, etc.) drive recreational travel volumes and patterns (both within and between public lands); and 3) to develop a model to project recreational travel demand on state and country roads to allow those jurisdictions to make better informed decisions about investments in economic development, transportation and other issues that may affect quality of life for residents and experience for visitors.

Project 08-133
Development and Implementation of the National Intercity Bus Atlas (NIBA)

Research Field: Transportation Planning
Source: AASHTO Special Committee on Research and Innovation
Allocation: $600,000
NCHRP Staff: Stephan A. Parker

The purpose of this research project is to develop a national atlas of intercity bus services that utilizes General Transit Feed Specification (GTFS) data, is publicly available, can be maintained to a high level of currency, and is complementary to the National Transit Map.

Although the network of intercity bus services represents the most comprehensive national coverage provided by any of the intercity modes, there has not been any comprehensive, complete, and up-to-date inventory of these services until recently. Such an inventory has been needed by policy-makers, planners, operators of complementary services, and the industry itself to understand and depict the current state of the intercity bus network, its role, its connections with local transit, and its role with regard to Amtrak and commercial air service.

This mode has gone unrecognized for its critical role in connecting America's rural areas, small and large cities—in part because of lack of information about the national network it provides, and in part because most of this network is operated without federal or state subsidies. At a number of times in the past such a tool would have been extremely useful for policy analysis, for research, and for planning for improved connectivity. For example, it could have been used to determine the impacts on service levels, connectivity and mobility of such events as the Greyhound restructuring of 2004-2005, or the growth of curbside services such as (Megabus, Flixbus, etc.) that have developed over the past decade.

The major federal program of assistance for intercity bus service has been the Section 5311(f) program, providing federal funding to support intercity bus services serving rural areas. This program provides for a 15% set-aside of each state's allocation of Section 5311 funding, unless the state certifies that there are no unmet rural intercity needs. The 15% set-aside amounts to nearly $100 million per year, yet there is no map that can be used to help evaluate unmet needs, or to show which routes are funded by this program. Decisions are being made regarding Amtrak services, and there is no publicly-available national map that shows how intercity bus services relate to Amtrak, whether as part of the Amtrak network (Amtrak Thruway), complementary connecting service, or even directly competitive service. Policy issues regarding the Essential Air Service program could also benefit from the existence of a current atlas in intercity bus services that would show how rural areas are connected to the national airline system.

By using GTFS, which includes not only the routes (assigned to the highway network), but exact latitude and longitude of stops and terminals, and the schedules/frequency of service, this network can be linked to other data such as the National Transit Map to assess connectivity and to Census or health data, allowing assessments of the degree to which mobility and access exist from rural areas. The ability to know exactly where the stops are located allows for assessment of connections to transit, as it will be possible to finally know the proximity of intercity bus and transit stops. If such a tool exists and is maintained, by saving each update it will be possible to monitor trends in coverage or service levels over time. Finally, a major potential benefit is that by promoting the development of GTFS data for inclusion in this map, the industry may also see that this data can be used for trip-planning purposes if made available to information providers such as Google Transit—allowing potential travelers to know the all the connecting services needed to make multi-modal trips.

Potential users of this tool include state DOTs, state, regional and local planning agencies; policy researchers; the academic community; trade associations; and the industry itself.

Prior to deregulation of the intercity bus industry by the Bus Regulatory Reform Act (BRRA) of 1982, the Interstate Commerce Commission (ICC) and state regulatory agencies controlled the routes and fares of virtually all carriers. Although these agencies had this information, it was not publicly available, though the overwhelming majority of intercity bus carriers made their schedules and routes known through a publicly available, industry-wide schedule book, the National Motorcoach Guide, published by Russell's (commonly known as Russell's Guide or just Russell's). This monthly publication was not generally used by individuals, but was in the hands of virtually every ticket agent in the country, and could be used by knowledgeable researchers to analyze services and monitor changes. However, it was not easy, because the Guide was not searchable, had no comprehensive maps, and was constructed of individual timetables for each company. Since deregulation there has been a lack of information about this mode and its role, with occasional and sporadic efforts to develop a map for industry promotion, or to attempt to address the impact of deregulation and industry changes. This includes two studies of rural access by the U.S. DOT's Bureau of Transportation Statistics (BTS), the last of which took place nearly a decade ago.

However, Michael Buiting, an individual interested in providing the public information that could be used to plan trips that involved multiple carriers voluntarily developed a national intercity bus map. The independent and unbiased map is available from the American Intercity Bus Riders Association's (AIBRA) website (http://www.kfhgroup.com/aibra/pdf/usmap.pdf). He keeps the map up to date through his carefully developed network of industry contacts and by constantly reviewing published timetables. The AIBRA map is in a CAD (computer aided drafting) format, and stops are shown as cities with no identification of terminal addresses. Despite these limitations, this map slowly became recognized as the only consistent, comprehensive and up-to-date depiction of the national intercity bus network. The industry and planners use the map to identify gaps in service and potential connections.

This project is intended to support the development and implementation of the NIBA as an ongoing, comprehensive and publicly available inventory of intercity bus services. While BTS has developed the structure and platform to house and maintain the NIBA, research is needed to populate the NIBA with GTFS data. The research team will need to work closely with BTS and its working group to accomplish this project. Key task elements of this research project include:

- Development of standards for inclusion—whether based on service type (fixed-route, fixed-schedule), minimum frequency, route length, connectivity or other factors. This effort will need to consider such aspects as the degree to which transit commuter routes are included, how to include services that are marketed as parts of several networks (many Amtrak Thruway bus routes are operated by intercity carriers who also sell seats on the same bus), etc.

- Identification of the universe of firms that should be included and contacting them to elicit participation.
- Clarification of the difference between provision of data for this research tool, as compared to potential issues with carrier provision of GTFS to trip-planning developers, etc.
- Activities to promote the need to develop and supply GTFS data to the industry itself, including coordination with industry trade associations including the American Bus Association (ABA) and the United Motorcoach Association (UMA). The goal is to have carriers sign the MOU, agree to provide data (generally easily developed by their ticketing system) on an ongoing basis.
- Identify and work with ticketing firms to make GTFS data generation a routine part of ticketing system updates.
- Development of potential applications for NIBA data, such as defining routes funded with Section 5311(f), routes funded with other sources, the Amtrak Thruway network, routes operated without subsidy, mobility analysis, equity analysis, service gaps and unmet needs. This effort includes identification of additional data to be joined with the NIBA, as well as potential analyses.
- Identification of potential additional layers for inclusion such as airport ground transportation providers, or bus companies serving particular ethnic communities that are open to public, etc.
- Work with industry efforts to develop and include GTFS Flex data so that the many rural transit operations that are demand-response can be included (both as part of NIBA and the National Transit Map), showing their potential role in a connected national network.
- Identify a permanent method for maintaining the NIBA map and associated timetables, such a public agency, industry group, or open source community.
- This effort may include initial conversion of timetable data into GTFS to demonstrate to carriers and their ticketing contractors what this entails, and to encourage them to sign the MOU and commit to maintenance of their data. Any GTFS data developed or collected will be provided to BTS for inclusion in the NIBA.

The end product of this research will be the populated and functioning NIBA, and a technical report addressing the activities, results, issues and future directions of this effort. It will include a base map of the national intercity bus network—as defined in this process, current as of the conclusion of this inventory—a functioning process for maintaining the map, and potential additional uses and research that can be conducted using this tool. It will also include a plan for future development of the NIBA, and the resources needed to maintain and improve it.

USDOT Office of Science Technology and Research (OST-R) is expected to host the atlas. Consideration should be given to including the USDOT Federal Motor Carrier Services Administration (FMCSA) ratings of carriers.

Project 08-134
Integrating Freight Movement into 21st Century Communities' Land Use, Design, and Transportation Systems

Research Field:	Transportation Planning
Source:	AASHTO Committee on Urban Freight Committee/Minnesota
Allocation:	$500,000
NCHRP Staff:	William C. Rogers

Each day, about 60 million tons of freight valued at $40 billion moves through the US transportation system. Communities rely on efficient and reliable freight systems. As cities and communities seek to encourage and implement mixed-use and human-scale development, it is important to consider the needs for commercial and residential goods movement, access, and mobility. Not doing so may lead to delivery trucks double-parking, blocking bike lanes, mounting curbs and sidewalks while driving, and other high-risk behavior when serving businesses and homes. Cities and suburbs will also need street design and parking regulations that ensure trucks can efficiently access dense pick-up and delivery locations without creating roadway safety or maintenance concerns; incurring costly parking fines; or interfering with local vehicle, bike, transit, and pedestrian traffic. The same applies to the noise and other environmental impacts trucks deliver at a higher relative rate than smaller vehicles.

Research continues to underscore the significant disconnect between land use decision-making and the freight movement-related traffic associated with various land uses. Planners and policy-makers at the local, metropolitan, and state levels often make decisions on transportation system development, management, and investment with only a limited grasp of how, where, and why freight moves on that system, both currently and what future forecasts indicate. At least two dynamics drive this disconnect. First, freight movement is mainly a private-sector activity with significantly different planning timeframes and objectives than the public sector, resulting in difficulties achieving useful public-private communication and collaboration. Second, useful commodity flow and volume information and data can be very difficult and costly for the public sector to acquire and apply in planning activities, resulting in transportation system plans and priorities that can under- or overestimate freight movement demand. State, regional, and local decision-making based on incomplete information and comprehension can lead to land use, economic development, and transportation plans, policies, project priorities, and funding choices that do not address long-term mobility needs for people and freight.

The objective of this research is to develop a guidebook for transportation planners and policy-makers that provides a clear description of the myriad interactions between land use policy, development regulations, environmental preservation, planning, and freight movement, and how and why economically vital and sustainable communities need to integrate freight movement considerations into their development visions and plans. Building on prior research and planning products, the research effort to meet this objective would include:

1. An overview of how freight shipments support community economic and livability needs, and how those shipments in community visioning and equity efforts should be considered.

2. An overview of freight movement behavior, decision-making and operations and the importance of such factors as travel time reliability, differences in how and why time of day of travel differs from general traffic, and the identification and description of special freight movement issues and considerations in the urban environment.
3. Descriptions of the challenges in forecasting freight movement and applying forecasts at the state, regional, and local level.
4. Identification of key stakeholders and partners (including those not normally engaged in freight outreach efforts) and their relationships to freight facility planning.
5. An overview of different freight vehicle types, technologies, and infrastructure (current, emerging, future), such as the operating space required around different freight vehicles (e.g., operating space buffers for loading/unloading), building code opportunities, including parcel receiving rooms, and accommodation of on-street loading and unloading.
6. Case studies of noteworthy practices ("success stories") in coordinated land use planning and freight trip management/forecasting that summarize key findings for planners and policy-makers.
7. Guidelines and model freight friendly plans/approaches for planners, engineers and architects.

Project 08-135
Reliability and Quality of Service Evaluation Methods for Rural Highways

Research Field:	Transportation Planning
Source:	Arkansas
Allocation:	$400,000
NCHRP Staff:	Stephan A. Parker

Rural roads are a major part of the highway system. According to FHWA (2016), rural roads are around 70% of all highway mileage; of which 98% correspond to two-lane and multi-lane highways. Often times, a rural highway goes through small communities with a variety of conditions, including adjacent land use context (e.g., agriculture farm land, light development), roadway characteristics (e.g., number of lanes, access point density, free flow speed, terrain), and traffic control (e.g., isolated signalized intersections, roundabouts). The same facility can serve multiple purposes, such as through movement or local traffic, and users, like motorists or bicyclists. The perception of quality of service of a rural highway can also vary, depending on the user and purpose. In this regard, providing a multimodal, facility-based evaluation methodology that currently does not exist is of interest to state DOTs.

A significant gap in the *Highway Capacity Manual* (HCM), Sixth Edition (Transportation Research Board, 2016), is the facility analysis of rural roads. The HCM contains procedural analysis techniques for uninterrupted flow two-lane and multilane segments, but it does not contain a technique to analyze the capacity and level of service for rural highways with different segment types at the facility–level. The HCM also contains facility analysis techniques for other roadway types (i.e., interrupted flow urban streets and freeways), but not for rural highway facilities. Work with two-lane highways should build upon the work completed in NCHRP 17-65, "Improved Analysis of Two-Lane Highway Capacity and Operational Performance". Currently, facility level analysis for rural highways in Germany is addressed in German HCM, however not in the United States. Given that the HCM is nationally accepted as the primary source on highway capacity and quality of service, not having a technical approach to address many of the nation's highways is a major limitation.

Another limitation of the current HCM methodology for rural highways is the analysis horizon, which is limited to a single study period. Recently, the HCM incorporated a methodology to evaluate travel time reliability for freeways and urban streets (Chapters 36 and 37), through the work of SHRP 2 Project L08, "Incorporating Travel Time Reliability into the Highway Capacity Manual". With this approach, the analysis horizon is expanded to an extended time horizon of several weeks or months to evaluate the variability and the quality of service the facility provides to its users. Using a distribution of level of service values mimics the variability of traffic conditions on the facility and provides a better understanding of the quality of service across time. By having more appropriate level of service measures for these types of facilities, states can better allocate their scarce resources.

In parallel, the AASHTO Policy on Geometric Design of Highways and Streets (commonly known as the Green Book), 7th Edition, has introduced the consideration of context classifications as an element of the geometric design process. The two new context classes supplement, but do not replace, the functional classification system. The rural class applies to roads in rural areas that are not within a developed community, while the rural town class applies to roads located in developed communities. The classification results from the NCHRP 855 Project, "An Expanded Functional Classification System for Highways and Streets". Given the known relationship between geometric design features and traffic operations, incorporating the Green Book's context classification into the HCM for highway capacity analyses and design is needed.

The objective of this research is to develop nationally accepted capacity and quality of service reliability techniques for rural road facilities accounting for the new context and functional classifications of the Green Book, 7th edition. The intent is that the research would lead to development of a new chapter in the HCM.

The following tasks are proposed in order to achieve this goal:

Task 1. General Work Plan. The objective of this task is to develop a general work plan that targets the objectives of the study and validates the project objectives, desired deliverables, and project schedule.

Task 2. Literature Review and Current Practice. The objective of this task is to review relevant literature, but not limited to the HCM, state procedures, Federal Highway Administration source materials, and international input.

Task 3. Draft Methodologies. The objective of this task is to develop draft methodologies on proposed analysis for rural facilities, describing the expected inputs, outputs, strengths and limitations. The most appropriate service measure(s) or a way of combining multiple service measures encompassing various segments (e.g., two-lane segment, multilane segment, signalized intersection influence area, roundabout) and their reliability will be determined. The AASHTO Green Book new functional and context classifications must be explicitly incorporated. Methodologies for calculating reliability in rural highways must be developed. Motorized and non-motorized modes must be included.

Task 4. Data Collection Plan. This task aims to develop plans to guide the collection of data for rural and rural town contexts. The research agency is expected to develop a comprehensive list of study locations in a manner that the data reflects different traffic scenarios throughout the country, as well as the key parameters to be collected and which approaches or sources will be adopted to collect data.

Task 5. Data Collection and Preliminary Results. The objective of this task is to implement the approved data collection plan developed in Task 4. The task also includes the preliminary analysis of the data against the proposed draft methodology from Task 3, indicating needs for method review, additional validation, as others.

Task 6. Validation and Methodology Refinement. The objective of this task is to comprehensively analyze and validate the data collected in Task 5, and perform any methodology refinement needs previously identified.

Task 7. Report. The Report shall summarize the work performed on the previous tasks, along with significant conclusions and recommendations for implementation. The report shall include a guide that addresses rural facilities and should be suitable for potential inclusion in a future update of the HCM.

In using existing uninterrupted flow two-lane highway segment techniques, states get poor or even failing level of service results in rural and rural town context. This often leads to costly roadway expansions and excessive highway widening in small communities in order to meet level of service standards, especially when the analysis is for a single time horizon and does not include reliability on the performance measure. By having more appropriate level of service measures for rural highways and their consideration as a whole facility, states can better allocate their scarce resources.

Additionally, HCM and Green Book provide different highway classifications. Updates to the HCM shall incorporate new Green Book's functional and context classifications for consistency between the two major references of designing and operating rural highways at national level.

The vision is that this research will lead to a new chapter in the HCM. Any changes or updates to the HCM will need to be formally adopted by the TRB Highway Capacity and Quality of Service (HCQS) Committee (AHB40).

Project 09-64
Developing Test Methods and Specification Limits to Evaluate Trackless Tack and Tack Coats for Different Paving Applications

Research Field:	Materials and Construction
Source:	AASHTO Committee on Materials and Pavements
Allocation:	$500,000
NCHRP Staff:	Edward T. Harrigan

Bonding of different layers within a pavement structure is critical to ensure its durability. The quality of this interfacial bond is dictated by the quality and durability of the tack coat used during pavement construction, maintenance or rehabilitation. Over the last few years, there have been several developments (some that are proprietary) in terms of both the equipment to apply the tack and the tack coat material itself. Specifically, the use of trackless tack has gained a lot of attention in the pavement industry. One of the main advantages of trackless tack is that it allows for the tack coat to remain in place on the surface even with construction traffic until the mix is placed on it. The ability to retain the desired amount of tack on the pavement surface is strongly tied to the overall durability of the bond and the pavement surface.

Several producers have developed some variation of a trackless tack coat and have approached different roadway agencies for product approval. Agencies and in some cases producers of these products have developed several different laboratory tests to evaluate the trackless character of the emulsion and its bond strength to qualify the use of this material. There is a need to revisit these methods that have been developed, particularly over the last decade, and develop a standard test method(s), relevant parameters that are indicative of the trackless character and bond strength derived from these method(s), and tentative specification limits based on field performance and/or criteria.

The objective of this research is to develop standard test methods, parameters and tentative specification limits to evaluate the durability of tack coats and the trackless characteristics of trackless tacks. The tests shall evaluate the tack coat material itself as a supplement to mixture specimen testing developed in previous research.

Accomplishment of this objective shall require the following tasks: (1) review existing literature for (i) available methods from NCHRP Project 09-40 and other studies to evaluate the quality of tack coats in the field and laboratory, and identify specific methods (field and/or lab) that can be used as the basis to validate the findings from this study, (ii) methods to evaluate the quality of the tack coats as a material including trackless tack using devices such as the DSR or pull-off tester, and (iii) methods to evaluate the trackless quality of a trackless tack; (2) develop and/or modify test methods to evaluate the performance-related characteristics (e.g. bond strength, ductility while considering factors such as temperature sensitivity and aging) of tack coats including trackless tacks, and trackless characteristics of a trackless tack, and identify and validate parameter(s) from such tests using performance of the tack coat in laboratory and/or field conditions; (3) analyze performance requirements for different pavement structure configurations (e.g. tack coat shear strength or bonding requirements will be different when used with an ultrathin overlay), and propose specification limits for the tack coat properties measured above for different pavement configurations; and (4) prepare draft AASHTO specifications for the methods developed in the previous task.

Project 10-105
Protocols for Traffic Speed Pavement Deflection Measuring Devices: Calibration and Structural Assessment

Research Field:	Materials and Construction
Source:	Louisiana
Allocation:	$600,000
NCHRP Staff:	Amir N. Hanna

State, federal, and, in some cases, local agencies, have recognized the value and need of better cost-effective treatments on their perspective roadways. Having a robust structural condition assessment method other than from visual distress surveys is certainly a significant step in that direction. There is now a wealth of published literature on the ability and feasibility of utilizing Traffic Speed Deflection Devices (TSDD). Some agencies have gone as far as establishing structural correlations between TSDDs and the Falling Weight Deflectometer (FWD); several have gone as far as developing indices that can be incorporated into the decision matrices of their Pavement Management System (PMS). Though there is a plethora of published literature on the utilization of TSDDs, no agency has gone as far as establishing standard practices or calibrations methods for TSDD. For example, there are ASTM standards for the FWD (ASTM D4694) and nationally recognized calibration centers as well. The same is true for other pavement assessment devices such as locked wheel friction testers (ASTM E274) and roadway surface profilers (ASTM E950). Ultimately, to ensure the accuracy of TSDDs, standards by some national organization or agency, whether it be ASTM, AASHTO, NCHRP or FHWA, need to be developed and implemented to ensure that TSDDs are properly calibrated and designed so that accurate readings are being taken. Furthermore, competition has a tendency to drive down assessment costs as well as allow different companies to manufacture TSDDs that are able to provide comparable results between devices. Having a nationally recognized organization produce such standards ensures that.

The objectives of this research are twofold: calibration and structural assessment. In the calibration portion, procedures will be established to calibrate the TSDDs to a reference such as the FWD. Standard deviations and bias for the deflections or deflection basin will be established. The second objective is to establish structural assessment guidelines for parameters obtained from TSDDs. These parameters include in-place structural number, layer moduli, base curvature index, surface curvature index, and structural health index. These objective will be accomplished by the following tasks: Phase I: (1) Conduct a literature review on the utilization of TSDDs; (2) Conduct surveys of US and state DOTs to assess the state of the practice for TSDDs, which include calibration and verification procedures; (3) Develop an experimental plan for assessing the accuracy of TSDDs, validating robust structural parameters based on TSDD measurements, and for developing a standard calibration procedure for TSDD devices; (4) Prepare an Interim report to present Phase 1 findings and clearly delineate the plan of work for Phase 2 of the project, Phase II: (5) Conduct the experimental plan approved in Phase 1; (6) Develop calibration procedures for TSDDs with the FWD as the reference device; (7) Provide structural assessment guidelines for TSDDs that include field testing procedures and equations for the calculation of in-place structural number, pavement layer moduli, base curvature index, surface curvature index, and structural health index; (8) Prepare a Manual of Practice on the calibration and structural assessment using TSDDs; and (9) Prepare a final report documenting all aspects of research.

Project 10-106
Improvement of Certification Method of Inertial Profiling Systems for Network Data Collection

Research Field:	Materials and Construction
Source:	AASHTO Committee on Materials and Pavements
Allocation:	$250,000
NCHRP Staff:	Amir N. Hanna

As one of the national performance metrics, International Roughness Index (IRI) is required to be collected and submitted annually to Federal Highway Administration (FHWA), per 23 CFR 490.309. IRI, along with other performance metrics, is also employed to determine performance measures, based upon which the 4-year performance targets are established. In order to collect reliable pavement data, state transportation agencies are required to develop Data Quality Management Programs (DQMPs). One of the critical elements of DQMP is the certification of data collection equipment. Most states certify their inertial profiling system, which is used to collect IRI, in accordance with AASHTO R 56 “Standard Practice for Certification of Inertial Profiling Systems”. However, the repeatability and accuracy requirements in R 56 are only employed for test sections less than 150 in./mi. As stated in R 56, “a lower agreement score may be accepted for the medium rough section that has an IRI greater than 150 in./mi.” Given that the threshold of poor section in terms of IRI is 170 in./mi., there is a gap of repeatability and accuracy requirements in R 56 for network IRI collection. Additionally, the agreement scores in R 56 are employed for construction quality control and acceptance at project-level. It is arguable that whether it is necessary to employ the same repeatability and accuracy requirements for network data collection, where the purpose of data collection is quite different from that of construction QC/QA testing. The purpose of this research is to fill the gap in AASHTO R 56 so that state transportation agencies and stakeholders will be able to utilize R 56 to certify inertial profiling systems for network IRI collection. This project will involve researching and documenting nationwide practices of certifying inertial profiling systems for network data collection; investigating the measurement variability of IRI for different types of test section; evaluating the influence of measurement variability on the performance measure related to pavement IRI. The final delivery of this research project will be able to assist transportation agencies to select requirements for equipment repeatability and accuracy based on their needs for network data collection. The outcome of this research will make recommendations for revision of AASHTO R 56.

The objectives of this research are to (1) investigate the influence of IRI variability on national performance measure at network-level data collection; (2) identify the range of roughness for test sections and the associated repeatability and accuracy requirements for certify inertial profiling systems for network data collection; and (3) develop and document recommendations for AASHTO Standard Practice that could be used by state transportation agencies to certify inertial profiling systems for network data collection.

Project 10-107
Performance Specifications Implementation Guide

Research Field:	Materials and Construction
Source:	AASHTO Committee on Materials and Pavements
Allocation:	$600,000
NCHRP Staff:	Edward T. Harrigan

Many public transportation agencies are in the process of implementing some type of performance specifications for asphalt mix and concrete. Reasons for doing so include a desire to improve long-term durability, encourage contractor innovation, better align design requirements with construction, and to have rational pay adjustments tied to predicted project life.

Ongoing initiatives such as Balanced Mix Designs for asphalt mixes and Performance Engineered Concrete Mixes lend themselves to a performance specification approach by introducing higher level test methods that are intended to be more directly related to material performance than current methods. Introduction of these test methods and mix design criteria will have a major impact on existing quality assurance programs. Agencies will need to make informed decisions regarding applicability of new tests to process control and quality assurance. Lot and sublot sizes may need to be adjusted to account for test time and complexity. Quantity of material obtained for testing may need to be increased. Technician training and certification programs will need to be addressed, as will laboratory qualification/accreditation programs. Independent Assurance procedures will need to be developed, and the impact on dispute resolution programs must be assessed. Precision and bias of the newer test methods will need to be determined, along with appropriate specification limits for various quality characteristics. New approaches to pay adjustments will need to be developed.

Agencies will benefit from a performance specification implementation guide for asphalt and concrete. The transition from current QA practices, which often rely on properties such as aggregate gradation or mixture volumetrics to performance-related criteria, will be challenging and will introduce new risks for DOTs and contractors. Understanding the impact of performance-related testing on the core elements of quality assurance will help this transition to occur in a controlled fashion and may help minimize risk to both parties during the implementation process.

The objective of this research is to develop a guide to assist public transportation agencies with implementation of performance specifications for asphalt and concrete materials. Accomplishment of this objective will require the following tasks: (1) perform a critical review of the literature on performance specifications and their impacts; (2) develop clear, consistent definitions of terms related to performance specifications; (3) identify existing test methods and mix design procedures that are likely to be included in performance specifications for asphalt and concrete, including those tests and procedures in SHRP2 R07 "Guide Performance Specifications;" (4) determine the impact of implementing these tests and procedures on DOT QA programs, including (i) technician training and certification, (ii) laboratory accreditation, (iii) lot and sublot sizes, (iv) material sample sizes, (v) turnaround time for test results, (vi) cost of testing, (vii) applicability of various tests for design approval, (viii) process control, quality control, acceptance, and

IA procedures, and (ix) the dispute resolution process; (5) develop guidance for agencies to use during implementation of performance specifications, which may include guidance on setting up pilot projects/shadow specifications, setting appropriate control and specification limits, and ways to gain buy-in from agency and industry personnel; and (6) prepare the final implementation guide as a draft AASHTO recommended practice.

Project 10-108
Manual for Incorporating NDT in Quality Assurance

Research Field:	Materials and Construction
Source:	AASHTO Committee on Materials and Construction
Allocation:	$250,000
NCHRP Staff:	Inam Jawed

State highway agencies (SHAs) routinely accept highway materials using quality assurance (QA) procedures based on certifications and material requirements, material specifications (method, end-result and performance requirements) and acceptance plans. In most cases, the QA requirements consider the federal regulations for construction QA procedures 23 CFR, Part 637B, as well as the recommendations of the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) for QA programs. However, one thing generally missing in these programs or plans is the utilization of nondestructive testing (NDT) methods in the QA process.

Several studies in recent years have identified the potential advantages of incorporating NDT methods into the QA process for highway materials. These methods are considered to provide an "added value" in the QA process since they enable (i) quickly assessing product uniformity in real-time as construction progresses; (ii) identifying potential defects during construction and thus allowing for timely corrective actions; (iii) inspecting/testing more frequently and replicating without the damaging effects of coring and other destructive testing; and (iv) reducing testing and inspection costs while improving construction quality and available data for SHAs to use in their acceptance process. For concrete, NDT methods can evaluate concrete properties, uniformity, honeycombing, segregation and cover depth as well as detect reinforcement location and characteristics. Similarly, in asphalt mixtures, NDT methods can identify thermal uniformity, density and stiffness. However, despite the high potential and usefulness of these methods, their transition from research and forensic investigation to QA has been rather limited, presumably because of their complexity or a lack of needed training of QA technicians and inspectors.

Develop a manual to assist SHAs with the development and implementation of Quality Assurance Plans incorporating NDT methods.

The work plan will include, but not limited to, the following tasks:

1. Perform a literature review that will comprise (i) an overview of existing QA procedures currently in use for concrete and asphalt materials for highway applications; and (ii) a discussion of the state of knowledge and practice of the NDT methods applicable to asphalt and concrete materials for highway applications.
2. Identify NDT methods considered to be good candidates for inclusion in quality control and acceptance testing for asphalt and concrete materials.
3. Recommend QA program(s) incorporating NDT methods for asphalt and concrete materials for various specific highway applications. The NDT methods could be considered for inclusion in a QA process during quality control testing by the contractor and for inspection, verification and acceptance test-

ing by SHA inspectors. Determine the impact of implementing these NDT methods and procedures on SHA QA programs. This impact would need to consider a variety of factors, including (i) technician training and certification; (ii) laboratory accreditation; (iii) lot and sublot size; (iv) material sample size; (v) turnaround time for test results; (vi) testing costs; (vii) applicability of various tests for process control, quality control, and acceptance; (viii) independent assurance (IA) procedures; (ix) dispute resolution process; and (x) cost/benefits analysis assessment.

4. Develop a guidance manual providing an overview of the current practice of NDT methods applicable to concrete and asphalt mixtures along with a brief description of their operating principles, detection capabilities, potential benefits, and limitations and drawbacks. The objective of the manual is not to recommend any specific NDT method to SHAs but rather to illustrate the features and capabilities of various NDT methods and their applicability to the QA process. The guidance for SHAs should include (i) development and implementation of NDT-based QA procedures; (ii) setting up of pilot QA procedures before full-scale implementation; and (iii) assessing appropriate control and specification limits. Ways to gain buy-in from highway agency and construction personnel should also be suggested.
5. Develop an implementation plan, prepare the final guide as an AASHTO recommended practice, and conduct workshops and webinars for SHA and FHWA personnel.

Implementation of the guide will be accomplished through presentations at the AASHTO committees relevant to materials, pavements and bridges, adoption as an AASHTO recommended practice, workshops and webinars to SHAs and FHWA personnel, and through presentations at various regional and national meetings and conferences, including the TRB Annual Meetings.

Project 12-119
Bridge Deck Overhangs with MASH-Compliant Railings

Research Field:	Design
Source:	AASTO Committee on Bridges and Structures
Allocation:	$500,000
NCHRP Staff:	Waseem Dekelbab

State highway agencies across the country are upgrading standards, policies, and processes to satisfy the 2016 AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (MASH). Many existing bridge deck overhangs were designed to accommodate a barrier with a 10-kip collision design load while the current TL-3 and TL-4 test railing call for a 54k-load. When a barrier upgrade is required, the bridge deck overhang must often be assumed to have adequate over-strength or retrofitted in order to accommodate the new requirements. The latter is costly and the traveling public is inconvenienced by the construction. In many cases, limitation of work space and strength of existing reinforced concrete make retrofit of overhang impractical to satisfy the new higher collision load requirements.

FHWA mandated use of the *AASHTO LRFD Bridge Design Specifications* (LRFD) in 2007. These Specifications include higher design loads than the previous *AASHTO Standard Specifications* for different test levels (TL) of bridge railings. The deck overhang design is specified in LRFD Section A13; three design load cases are given including the over-turning moment caused by the collision load and portion of the vehicle on the overhang. California, New Jersey, and other states have gone even further in requiring 20% additional strength in the overhang.

In 2009, *AASHTO Manual for Assessing Safety Hardware (MASH)*, 1st Edition, was published followed by the 2nd Edition in 2016. Crash-testing of various safety shapes for the new requirements has taken place, but the test surface to which the shape is anchored is often over-designed in order to verify performance of the barrier. Anecdotal evidence of crashes supports the premise that bridge deck overhangs perform well during collision events.

The primary objective of this research is to recommend changes to the current AASHTO LRFD bridge deck overhang design specifications for both solid and "see-through" post-beam barriers subjected to TL4 and TL5 collision loads.

The research is of urgent need to ensure public safety and satisfy the AASHTO MASH and LRFD requirements in cost-effective way. State DOTs across the country are striving to upgrade standards, policies, and processes to meet the 2016 AASHTO/FHWA Joint Implementation Agreement for MASH (MASH), where it is stated that for contracts on National Highway System with a letting date after December 31, 2019, only safety hardware evaluated using the 2016 edition of MASH criteria will be allowed for the new permanent installations and full replacements.

Project 12-120
Developing High Strength Corrosion Resistant Steel Strands for Prestressing

Research Field: Design
Source: AASHTO Committee on Bridges and Structures
Allocation: $750,000
NCHRP Staff: Waseem Dekelbab

Prestressed concrete elements such as beams, girders, piles, and decks are an essential part of the vast majority of bridges built in the US. Bridges built using prestressed concrete components use black steel strands that are susceptible to corrosion leading to structure deterioration. Corrosion is the first mode of deterioration for all bridges and the 7-wire strands are the most sensitive steel to corrosion. Delaying the onset of corrosion will reduce maintenance needs, extend the bridge service life and enhance the safety overall.

There is a need to develop corrosion resistant metallic strands. Georgia, Florida and Virginia have worked to develop and produce stainless strands meeting the requirements of ASTM A276, UNS S31803 or S32205 (Type 2205); however, these strands have a lower strength and lower elongation or ductility compared to black steel strands.

The objective of this research is to develop guidance and AASHTO specifications for the use of high strength stainless steel strands for prestressing concrete structures and components. This guidance and specifications should include all bridge structure applications including pre-tensioning, post-tensioning and cable stay applications.

This statement addresses a critical need to transition toward more corrosion resistant alloys for use in the infrastructure. Stainless steel offers a viable corrosion resistant material for prestressing strands which will extend the bridge service life, reduce potential maintenance and future rehabilitation work.

Project 14-43
Guide Construction Specifications for Cold In-place Recycling (CIR) and Cold Central Plant Recycling (CCPR)

Research Field:	Maintenance
Source:	AASHTO Committee on Maintenance
Allocation:	$250,000
NCHRP Staff:	Edward T. Harrigan

Pavement preservation is becoming an important activity for DOTs in maintaining and enhancing the condition of their highways. With the enactment of MAP 21 mandating that DOTs show improved performance in the condition of their highways, the use of pavement preservation treatments will be crucial to meet performance goals. Pavement preservation treatments are treatments that do not improve the structural capacity of a pavement but do delay pavement deterioration. Cold in-place recycling (CIR) and cold central plant recycling (CCPR) are considered minor rehabilitation pavement preservation treatments when the recycled layer is topped with a thin overlay. They can treat cracks of a higher severity than other preservation techniques can and topping the recycled layer with a thin overlay modifies the pavement structure to produce a more long-lasting system. CIR and CCPR treatments are part of a sustainable strategy for reducing the need for new aggregate and new asphalt while using lower energy and creating fewer emissions.

Preservation treatments using asphalt emulsion as the binder have almost always been considered secondary to hot mix asphalt (HMA) technologies and are therefore not as well understood. These technologies have not been upgraded or researched to the extent that HMA has. However, over the last five years the FHWA PPETG (Pavement Preservation Expert Task Group) and ETF (Emulsion Task Force) have 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 AASHTO and are not vendor specific.

The rationale for creating AASHTO standards for pavement preservation treatments is to provide credence, and more importantly, buy-in from the DOTs. In order to implement any of these treatments in construction projects, both material *and* construction standards must be first created, and in the case of CIR and CCPR, a mix design practice and material specifications have been developed and submitted to the AASHTO Subcommittee on Materials (SOM). However, as noted in *NCHRP Synthesis 421*, one of the barriers to greater use of these treatments is lack of specifications. Development of guide construction specifications accounting for the best practices by agencies and contractors will greatly assist in increased use of these treatments, especially by agencies with little experience with in-place recycling.

The objective of this research is to produce an AASHTO Construction Guide Specification for the application of CIR and CCPR. This guide specification will assist highway agencies to tailor their own specifications to the local conditions and environments and go far towards getting DOTs to implement such treatments in their pavement preservation programs. Accomplishment of this objective shall include a task to review (1) previous work in this area and (2) construction specifications and practices that are in use in several state DOTs already using CIR and CCPR.

Project 14-44
Construction Specifications for Pavement Treatments – Slurry Seals and Tack Coats

Research Field: Maintenance
Source: Rhode Island
Allocation: $250,000
NCHRP Staff: Amir N. Hanna

Pavement preservation is an important tool DOTs use to maintain and enhance the conditions of their highways. Pavement preservation treatments do not improve the structural capacity of a pavement; rather they delay pavement deterioration by sealing cracks, preventing pavement oxidation, and, in the case of surface seals, rejuvenating the exiting pavement surface layers. Preservation treatments utilizing asphalt emulsions as the binder have generally been considered secondary to hot mix asphalt (HMA) technologies. As such, these treatments have not been upgraded or researched to the same extent as HMA technologies. Over the last few years, however, the AASHTO Transportation System Preservation Technical Services Program (TSP·2) Emulsion Task Force (ETF) has made a concerted effort to improve the state of the science in emulsion technology and to create consistent, performance-based standards (specifications, test methods, design practices, etc.) that are sponsored by FHWA and/or AASHTO and are not vendor specific. The ETF has focused on creating and delivering materials standards to the AASHTO Committee on Materials and Pavements. A slurry seal is a homogenous mixture of emulsified asphalt, water, well-graded fine aggregate and mineral filler that is used to fill existing pavement surface defects as either a preparatory treatment for other maintenance treatments or as a wearing course. A tack coat is the application of an emulsified asphalt or performance-graded (PG) asphalt binder, followed by any applied surface layer. The tack coat is used to ensure a good bond between the existing asphalt or concrete pavement and an overlay, between the multiple lifts of a new structural pavement and at any vertical surfaces that the new layer will be placed adjacent to, such as curbs, gutters, utilities, and construction joints. Tack coats can be used in pavement maintenance activities or in new construction. Materials specifications and design guides exist for slurry seals and tack coats (AASHTO MP 32-17 Materials for Slurry Seal, AASHTO PP 87-17 Slurry Seal Design, AASHTO MP 36-18 Materials for Asphalt Tack Coat, AASHTO PP 93-18 Asphalt Tack Coat Design) but construction guidelines are less developed. Some agencies have developed construction specifications for local jurisdictions, but standardized nation-wide construction guide specifications do not exist. The creation of construction standards is now necessary in order to implement these treatments. This research seeks to develop construction guidelines for slurry seals and tack coats. Research in Slurry Seals and Tack Coats is available; however, a national Construction Guide Specification is not available.

The objective of this project is to produce AASHTO Construction Guide Specifications for the application of Slurry Seals and Tack Coats. This will assist highway agencies in tailoring their own specifications to the local conditions and environments and will aid DOTs in implementing these treatments in their pavement Transportation Asset Management Program (TAMP). The Construction Guide Specification will address the construction operations required, with possible adjustments for local materials and experience. The research will include a review of previous work in the area, including construction standards, construction specifications, and construction practices both national and internationally. Deliverable documents will be in conformance with AASHTO format.

Project 14-45
Model Procedures for Post-Event Bridge Damage Assessment and Engineering Evaluation

Research Field:	Maintenance
Source:	Alaska
Allocation:	$500,000
NCHRP Staff:	Amir N. Hanna

Extreme events, such as fire, flood, earthquake, tornado, and hurricane, can cause widespread bridge damage. After such events, there is a need for the rapid, systematic, inspection of bridges in the affected area to assess damage, evaluate performance, and determine which structures can safely remain open to traffic and which must be closed pending repair. The information generated in these inspections assists emergency managers to coordinate their response, direct repair efforts, and maintain traffic operations in the affected area. Engineering evaluation of structural performance in these events informs updated design codes and standards that can improve performance and reduce impacts to the transportation network from future events. NCHRP Synthesis 497, *Post-Extreme Event Damage Assessment and Response for Highway Bridges*, identified common bridge hazards in responding states and the degree to which those states have developed response strategies and inspection processes. NCHRP Research Report 833, *Assessing, Coding, and Marking of Highway Structures in Emergency Situations*, presented a framework for deploying personnel, making damage assessments, and reporting findings. Many State departments of transportation (DOTs) and local agencies have independently developed post-event damage assessment plans but, while there are common elements to these plans, their depth and quality vary widely agency to agency. The goal of this study is the development of model procedures that transportation agencies at all levels of government might reference in the development of their own response plans.

The objective of the research is to develop model procedures that state DOTs can reference in the development of their emergency response plans to ensure that those plans address the need for thorough and effective bridge damage assessment. These procedures would provide a framework for a DOT to (a) identify potential hazards to the bridge inventory; (b) identify key personnel and their roles in the response; (c) define response levels; (d) define damage assessment stages and associated personnel qualifications, timeframes, and reporting efforts in conducting initial reconnaissance, preliminary damage assessment, detailed damage assessment, and engineering evaluation and investigation; (e) outline deployment logistics; (f) establish communication protocols; (g) establish data collection and reporting standards; and (h) establish decision escalation processes. This objective will be accomplished by the following tasks: (1) Identify and summarize response procedures already established by state DOTs and other nations; and identify common themes, unique approaches, and best practices; (2) Review current AASHTO guidance regarding emergency response and damage inspection, and identify guidance gaps regarding post-event damage assessment and potential vehicles for publishing the model guidance through AASHTO (guide specification, inclusion in an existing manual or specification, etc.); (3) Prepare an interim research report documenting the results of Tasks 1 and 2, and develop preliminary recommendations for the key aspects of the model procedures; (4) Prepare draft model procedures for post-event bridge damage assessment based on the results of Task 3 and comments from the review panel, and submit the draft procedures for the technical panel review and comment; (5) Address review comments and prepare model procedures and final research report presenting the complete results of the research; and (6) Develop draft AASHTO ballot language. The final products of this project will be (a) model procedures for post-event bridge damage assessment and engineering evaluation, (b) a research report with the complete results of the research, and (c) AASHTO ballot-ready manual language for the adoption of the model procedures as AASHTO guidance.

Project 15-69
Utility Conflict Impacts During Highway Construction

Research Field:	Design
Source:	AASHTO Committee for Right-of-Way, Utilities & Outdoor Advertising Control
Allocation:	$600,000
NCHRP Staff:	Camille Crichton-Sumners

A 2001 survey of State departments of transportation (DOTs), highway contractors, design consultants, and other user groups identified utility relocations and differing site conditions related to utility conflicts, environmental planning delays, permitting issues, and insufficient work effort by the contractor among the top ranked causes of delays in highway projects. Additionally, in 2018 Federal Highway Administration (FHWA) report identified utility issues as one of the top causes of project delays, confirming that inefficiencies in the utility process remain one of the main reasons that highway projects experience delays and cost overruns. The annual Damage Information Reporting Tool (DIRT) report, which is used to show decreases in damages to underground utility infrastructure during construction every year, has started to show increases since 2014.

FHWA and the American Association of State Highway and Transportation Officials (AASHTO) are implementing projects R01A, R01B, R15B, which emerged from the Second Strategic Highway Research Program (SHRP2). The focus of these projects was the identification and resolution of utility conflicts and more effective management of utility data, primarily during the pre-construction phase. A gap in this research and implementation effort has been how to manage the impact of utility conflicts during the construction phase which can cause delays that can extend the period of project delivery and increase total project costs, frustration for travelers, unnecessary utility relocations, and negative public perception about the project. However, a number of utility risk areas have not been addressed yet, including, but are not limited to, the following:

- Uncertainties during construction associated with existing utility location (X, Y, and Z)
- Structural characteristics and performance (e.g., soil and bedding characteristics, material properties, strength, resilience)
- Interaction among utilities that occupy a common, confined footprint
- Coordinated infrastructure project phasing with utility work schedules
- Constructability, traffic control, damage prevention, worker safety, and other construction factors
- Field inspection, verification, and production of as-built records.

The purpose of the research is to (a) quantify the impact of utility conflicts during construction; (b) prepare a catalog of best practices for managing utility conflicts during the construction phase; (c) develop and test prototype procedures for point-of-delivery utility inspections, i.e., in-place inspections and location data capturing in ways that maximize real-time data collection and processing; and (d) develop training materials.

Project 15-70
Valuation of Permitting Utility and Communications Installations in Public ROW

Research Field:	Design
Source:	AASHTO Committee for Right-of-Way, Utilities & Outdoor Advertising Control
Allocation:	$350,000
NCHRP Staff:	Dianne S. Schwager

State departments of transportation (DOTs) permit the use of highway right-of-way (ROW) for the installation of utility and communication facilities with varying approaches to the accommodation. For example, ROW along roadways without access control may provide for utility and communications accommodation at no cost while accommodation along limited access routes may be more complex. These complex accommodations may involve numerous agreement structures, ranges of fees, if any (or potentially other means of compensation), and varying legislation addressing these arrangements. The details of these accommodations are often not easily comprehended or communicated. Further, they vary from state to state, as there is no single national standard.

This issue becomes further complicated when specifically addressing communications facilities. In these instances, the owner of dark fiber optic facilities may be charging or leasing carrier companies for the use of their facility. In this arrangement, the facility owner, who may have been located on public ROW at no cost, is in essence profiting from the lease of their facility to telecommunications providers as third parties. While the accommodation of utilities and communications facilities in public ROW is generally considered a public benefit, there may be instances where DOTs should be compensated for accommodations that are currently accommodated in ROW at no cost.

Some DOTs have navigated or enacted legislation to allow for placing fees or leasing accommodation on ROW for communications and other utility company facilities. These approaches entail varying fee schedules and while some can be revenue neutral or operating at a loss, others could be generating revenue to supplement highway funds. With the rapidly expanding networks of broadband fiber optic networks and microcellular technology, investigating these approaches is necessary for determining effective practices and guidance in these accommodations.

There is a need to capture the approaches used by DOTs to evaluate and potentially charge for the permitted use or accommodation on ROW. As mentioned these charges may include fees, leasing, in-kind trading (such as allowing DOTs to use or share facilities), or other compensation means. A comparison of these approaches, the associated agreements, the fee structures, and related legislation is needed along various variables and scenarios. These varying characteristics include the types of utilities or communications facilities accommodated, the location of these accommodations (urban or rural), and the access control of the roadways where these accommodations occur.

The objective of this research is to prepare guidance and a collection of approaches used to evaluate and charge for the accommodation of utility and communication installations on public ROW. The guidance shall include a comparison of fees, leasing, and in kind trading along the various approaches used nationally. This collection of national rates and standards should be analyzed to identify variations among approaches and determine possible reasons for these variations, such as legislation, property values, etc. When presented, the approaches should be standardized, normalized, and converted such that the comparisons are evaluated in like terms. The guidance should provide DOTs the means and approaches necessary to execute a fee or leasing schedule for occupancy for general utilities or isolated to strictly telecommunications facilities.

Currently state DOTs are dealing with an abundance of accommodation requests for multiple utilities but specifically relating to microcellular and broadband fiber optic facilities. These accommodations could be much more standardized on the national level for mutual benefit to the state DOT and the utility companies

Project 15-71
Methodology for Addressing Project Constraints in Early Construction Cost Estimates

Research Field: Design
Source: AASHTO Committee on Design
Allocation: $250,000
NCHRP Staff: Ann M. Hartell

Early project cost estimates (planning, conceptual, and preliminary estimates) are used to develop and support the budget for the transportation project. Establishing accurate estimates at this stage are increasingly challenging as the primary cost drivers for the project (such as pavements, bridges, etc.) are heavily influenced by constraints to minimize disruptions to motorists and environmental constraints. These constraints can include schedule constraints (such as impacts of season restrictions, accelerated construction, restrictions for traffic control during night work only); phased construction (to maintain essential traffic); as well as tight project constraints such as limited access as in urban areas. Without the tools and guidance for how to account for the impacts these constraints have on the cost of the project in the conceptual and preliminary stages, projects may be significantly under budgeted. Under budgeting may result in the need to either revise the scope of the project or make significant adjustments in the agency's program to identify additional funding for the increased project costs.

Establishing research-based adjustment factors and methodology will increase the accuracy and reliability of early project estimates, which will allow for delivery of the project on budget, thus reducing the need for adjustments of project scope to meet the programmed budget or adjustment of the overall program to address the actual project costs.

The objective of the research is to develop national adjustment/contingency factors (or ranges) for constraints including construction schedule constraints (construction / MOT Restrictions); physical constraints (access limitations, such as in constricted urban setting); and environmental restrictions (streams, tree cutting). The research should include the development of a framework or method for states to establish and maintain state–specific adjustment/contingency factors.

Project 15-72
Methodology to Define New AASHTO Green Book 7.0 Context Classification Settings Implementation as Related to Active Transportation Infrastructure

Research Field:	Design
Source:	AASHTO Council on Active Transportation
Allocation:	$300,000
NCHRP Staff:	B. Ray Derr

In 2018, the National Cooperative Highway Research Program (NCHRP) published Report 855 *An Expanded Functional Classification System for Highways and Streets.* This document served as a key reference informing the recently published AASHTO Green Book 7.0 (Green Book). The new Green Book introduces a change in guidance for state transportation officials by introducing a broader set of land use context categories that combined with functional class are intended to guide design decision making. By introducing a more refined land use classification breakdown (including rural, rural town, suburban, urban and urban core) the guidance provides a mechanism for better targeting design solutions to specific contexts, while providing needed flexibility to address planning and design needs. The existing research and guidance, however, does not point to specific methodologies or parameters by which these land use contexts would be defined and operationalized to implement the Expanded Functional Classification System (FCS)

The objective of this research is to develop guidance to assist practitioners in selecting the new categories, such as suburban and rural town contexts, for a project. In the long term, the increased resolution of the context categories and documentation of that in operational databases, such as the HPMS, will allow for more refined research and guidance that addresses the specific and unique needs of the new categories being proposed.

In particular, the research will:

- Expand upon Report 855 and the Green Book guidance to ensure consistent implementation of the new functional class system within DOTs and local governments.
- Define more objective criteria, proposed modeling, and a validation process that can be used when considering each mode of transportation for each new functional class category that takes into account access management and projected traffic impacts and desired operational speed.
- Develop a "how-to" manual or implementation guide for DOTs to best incorporate these changes in planning and design.

The research will entail exploring available data sources and methodologies to provide more specific guidance on the process and parameters by which the newly proposed contexts would be defined. It will fill a key gap in the existing guidance by outlining more specific metrics for quantifying the proposed contexts, and by recommending more specific approaches for weighting the inputs and identifying appropriate ranges of values to inform their stratification. To advance this discussion, the work would include identifying and analyzing comparative land use data across a range of state or regional contexts and building from best practices and case studies to help inform state-specific methodologies for implementing the new guidance. Particular attention will be required to advance methodologies for estimating future land use impacts, which will usefully include analysis of protocols associated with trip generation rates and access management, to help strengthen the consideration of modal integration in a given roadway network.

In addition, the research should include preliminary analysis of key demonstration projects to inform how the classification system, and the specific processes or treatments associated with it, are to be evaluated. This component of the research is a critical component to ensure that application of these methods are rigorously tested, and to inform the systematic evaluation and refinement of the proposed approach. The case studies should include a range of project types as well as classifications, to help illustrate the utility and limitations of the new methods and guidance.

Project 15-73
Design Options to Reduce Turning Motor Vehicle–Bicycle Conflicts at Intersections

Research Field: Design
Source: California
Allocation: $600,000
NCHRP Staff: William C. Rogers

Each year, vehicle–bicycle collisions result in hundreds of cyclist deaths and many more non-fatal injuries (the exact numbers are difficult to define because of inconsistent reporting methods). The most common location for these collisions is at intersections, which inherently have a large number of turning conflicts. Reducing these conflicts is a key objective in improving intersection safety across all modes. Of particular concern for bicyclist safety at intersections are the conflicts between straight-through bicyclists and motor vehicle right-turns and opposing left-turns. Despite the widespread acknowledgement of this problem, transportation engineers and planners still lack definitive guidance on how to safely and effectively design for bicycles at intersections in the United States. Thus, research on effective methods to reduce these conflicts, with accompanying intersection design guidance, is a high priority.

The primary guidance documents for practitioners, including the AASHTO Guide for the Development of Bicycle Facilities and the NACTO Urban Bikeway Design Guide are often based on professional judgment rather than research. Research-based guidance tends to be more general, such as providing countermeasure options, but not specific design guidance (e.g., as in the forthcoming NCHRP 15-63 *Improving Pedestrian and Bicyclist Safety at Intersections* guidance and *BikeSafe*). Current design practices often drop bicycle pavement markings and signs at intersections, providing no positioning guidance for motorists or bicyclists—a practice that has led to confusion in some states as to who has the right-of-way through the intersection. Alternatively, other jurisdictions continue bicycle lane markings all the way through intersections; in others, the lanes are dashed. Moreover, innovative treatments including bike boxes, use of color, bicycle signals, and separated crossings are increasing across the country, and while some of these have been examined through research studies, their effectiveness is inconclusive. Research on alternative designs to reduce conflicts at intersections is required to determine best practices to meet these objectives.

The objective of the research is to develop guidelines for intersection design that minimizes the risk that motor-vehicle turning movements create for through-moving bicyclists. To accomplish this, the research should rely on conflict data to supplement often-sparse crash data. The research, at a minimum, will:

1. Identify typical and innovative design treatments for bicyclists at signalized intersections.

2. Identify prevalent motor vehicle–bicycle crash types at signalized intersections.

3. Conduct conflict studies at signalized four-way intersection approaches with and without the following design elements:

- Bike lanes
- Exclusive turn lanes
- Marked/dashed bike lane/bike travel path through intersections

- Colored pavement for bike travel paths through intersections
- Separate stop bar locations for motor vehicles and bicycles
- Bike boxes
- Alternative methods to accommodate bicycle left-turns
- Bicycle signal-heads with accompanying bicycle specific signal phasing
- Physical separation of bicycle facilities
- Other relevant pavement markings, signs, and signal designs.

4. Document safety impacts of various design treatments observed.

5. Summarize research results in a practitioner's guide for effective accommodation of bicycles at intersections.

Project 15-74
Safety Evaluation of On-Street Bikeway Designs

Research Field: Design
Source: California
Allocation: $600,000
NCHRP Staff: Ann M. Hartell

Separated bikeways (also known as cycle tracks) are bikeways within or adjacent to the roadway and separated from moving traffic by curbs, parking lanes, striped buffers, or other barriers. They do not include multiuse pathways, which are open to a variety of other non-motorized users and are typically located outside of roadway rights-of-way. On-street bike lanes are located on the roadway and traditionally only separated from traffic by lane markings. Some bike lanes are colored either over their entire length or through conflict areas. While on-street bike lanes have been used in the United States for many years, separated bikeways are becoming increasingly popular throughout the US, with recently installed facilities in many cities, and numerous other state and local departments of transportation exploring the potential for additional facilities.

Many transportation agencies view the separated bikeway facilities as an opportunity to attract higher volumes of cyclists than are attracted to on-street bike lanes. Studies of perceived risk show a preference for separated bikeways among both current and potential cyclists. While separated bikeways are popular with cyclists, only limited data are available on the safety outcomes of separated bikeways within North America. However, the European experience is that separated bikeways can lead to increased crash rates, especially when crossing side-roads and driveways, with the risk likely related to the amount of traffic crossing the separated bikeways, and the inter-visibility between motor vehicles and bikes on the facility. The risk is even higher with two-way bikeways, with many European cities having removed such facilities. Recent research in Montreal shows that while both separated bikeways and on-street bike lanes seems to be associated with higher total numbers of bicyclist-motorist crashes, they are also associated with lower risk per cyclist. Another Canadian study, using case-crossover design (a method commonly used in the health profession) found that separated bikeways were associated as very low risk at non-intersection locations. At intersections, the presence of bicycle-specific infrastructure including separated bikeways and on-street bike lanes was not associated with either increases or decreases in cyclist risk. Another study from Montreal found that the risk of injury for riders in cycle tracks was less than those riding in streets.

With over 600 annual cyclist fatalities in the United States, improving cyclist safety is a critical outcome for bicycle facility design, suggesting the need for objective research on the safety implications of separated bikeways in different situations and the alternative option of on-street cycle lanes. As documented by international experience, separated bikeways have the potential to create both safe and comfortable environments that can help transportation agencies meet their goals to provide improved transportation options. However, quantitative research on the safety of separated bikeways within a North American context is needed to provide designers with the guidance necessary to ensure that future bicycle facilities are as safe as possible and to determine whether to install such a facility, use on-street cycle lanes, or direct cyclists to totally separate cycle paths or bicycle boulevards.

The proposed research will quantify the safety characteristics of separated bikeways and bike lanes in the US. To accomplish this, the research must:

- Identify existing separated bikeway and on-street bike lane treatments with various adjoining land-use and side-road and driveway densities on roadways in the US;
- Review the experience of different types of separated bikeways and on-street bike lanes in North America with respect to crash and injury history;
- Identify prevalent crash and conflict types, including motor vehicle/bicycle, bicycle/bicycle, and bicycle/pedestrian, associated with each type of separated bikeways and on-street bike lanes at midblock, driveway, on-street parking, and at controlled and uncontrolled intersection locations;
- Isolate the physical and human factor causes for the various crash types identified;
- Identify effective designs to address the operational issues identified;
- Identify effective designs to address the crash factors identified;
- Codify designs and guidelines that are useful for designers for a variety of separated bikeway and on-street bike lane types under a range of conditions and roadway types;
- Determine which, if any, separated bikeway design features offer acceptable levels of safety based on the results of the research; and
- Identify future research needs.

The investigation should consider a range of separated bikeways and on-street cycle lanes immediately adjacent to roadways, including, but not limited to, one-way and two-way bikeways, bike lanes separated from motor vehicle traffic by barriers, pylons, or parking lanes; on-street bike lanes; and paths raised to sidewalk or near sidewalk level. It should consider applications on streets with and without parallel parking, and both signalized and unsignalized intersections. The impact of various design treatments should also be examined to the extent possible, including the impacts of signal phasing to separate cyclists and turning motorists; intersection approach treatments; removal of parking to improve sightlines; access management and driveway frequency; signs and pavement marking at intersections; advanced stop lines ("bike boxes") to allow bicyclists to queue ahead of motorists at signalized intersections; converting striped buffer-zone bike lanes into pylon separated corridors; and alternative methods to accommodate bicycle left-turns.

A possible outcome of the research would be information useful for the development of guidance that could be included in, supplement, or update the revised AASHTO Guide for the Development of Bicycle Facilities. One critical issue identified for this guide is the lack of research on various separated bikeway designs in the US. Research results could also be used to update other guidance documents, such as the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide, or influence updates to the Federal Highway Administration's Manual on Uniform Traffic Control Devices. The research could also be incorporated into the Highway Safety Manual, which is short on risk relationships for bicycle facilities. Other possible outcomes are a greater understanding of the safety, efficiency, connectivity, and maintainability issues associated with some separated bikeway designs, and the identification of additional research needs.

Project 15-75
Acceleration and Deceleration Rates Used in Roadway Design Criteria

Research Field: Design
Source: AASHTO Technical Committee on Geometric Design
Allocation: $500,000
NCHRP Staff: Amir N. Hanna

The values we are currently using for our design criteria may be outdated. As a result we may be designing roads that are not as efficient as they could be and more expensive to construct. In the current design criteria, a deceleration rate value of 11.2 ft/s^2 is used. This value may need to be updated and increased due to the current vehicle fleet's capabilities and changes in road wearing surfaces. Consideration of the appropriate deceleration and acceleration rates for driver comfort should also be considered with the vehicle fleet's capabilities. Vehicles are now able to stop more quickly, because more have anti-lock brakes, better tires, and better overall technology. A 95^{th} percentile value of 2.5 seconds for perception/reaction time (PRT) is also commonly used. In combination with the 11.2ft/s^2 deceleration rate, this may be overly conservative. Similarly, vehicles are also able to accelerate more quickly because of engine and other vehicle improvements. Changes in acceleration and deceleration rates will have a great impact on the design criteria used for designing roads. Locations most likely to be affected include interchanges and intersections. For example, entrance ramps could have a shorter required acceleration length, and exit ramps could have a shorter required deceleration length. This would not only lead to a decrease in construction cost, but could also decrease construction time, since less would need to be built. Also, if the deceleration rate is increased, the braking distance and, as a result, the stopping sight distance would decrease. The profession should also consider if the object height should be modified from 2 feet and if 3.5 feet is still an accurate height for the driver's eye. Our research will look at these values used in the design criteria and bring them up to date, in order to ensure we are constructing roads as efficiently as possible. Findings that recommend revisions to the acceleration and/or deceleration rates would then be considered for adoption in the AASHTO *Green Book* and then subsequently used in design by roadway engineers.

Based on NCHRP 400, *Determination of Stopping Sight Distances,* (a) Most modern countries use a perception reaction time (PRT) of 2 seconds instead of 2.5 seconds. This is closer to the 85^{th} percentile of drivers than the 95^{th} percentile used in the AASHTO policies; (b) The deceleration rate of 11.2 ft/s^2 is very conservative, and does not represent an emergency stop; (c) The object height of 2 ft is very conservative given the current fleet of vehicles with high–mounted center taillights and the driver's inability to recognize the need to stop for a 2 ft–high object at great distances; and (d) The 85^{th} percentile driver's eye height is higher as crossover, trucks, and SUVs represent a larger segment of the vehicle fleet and safety standards have resulted in much taller vehicles. This research will determine appropriate acceleration and deceleration rates to be used in design. PRT, eye height, and object heights will be evaluated and appropriate design values determined. The results are expected to be incorporated into the AASHTO *Green Book*. The values included in the *Green Book* should be based on current vehicle fleet operating capabilities. The values in the current edition of the *Green Book* are based on a prior vehicle fleet.

Some of the tasks that could be completed in this project include (1) Completion of a comprehensive literature review. This review should include research on vehicle fleet composition, performance of the vehicle, advanced technologies and their presence in the vehicle, percentage of vehicles with the advanced technologies (i.e., anti-lock brakes and other performance/safety innovations related to braking and accelerating), tire/pavement friction based on current tires in production and typical pavement surface parameters. (2) Evaluate the current research and identify which components need additional research. This could include (a) Tire performance / friction factors; (b) Vehicle fleet: Eye height and Object height (tail light height); which vehicles to use in design (is it still heavy vehicles/trucks and everything else); and acceleration and deceleration capabilities; and (c) Vehicle operator: Acceptable acceleration rate, deceleration rate, and PRT; should the design parameters be modified if we have a high presence of "older" drivers? What would quantify "high presence"; what if the vehicle does not have a human operator? Should this be considered and will alternative design parameters result from this (autonomous vehicles with reduced PRT); and should different acceleration/deceleration rates be used in different road locations (e.g., interchange ramps, intersections, and other locations)?; (3) Perform the research based on needs identified above and make recommendations; and (4) Propose new text based on the results of the research project for the next edition of the AASHTO *Green Book*.

Project 15-76
Designing for Target Speed

Research Field:	Design
Source:	AASHTO Technical Committee on Geometric Design
Allocation:	$750,000
NCHRP Staff:	Camille Crichton-Sumners

The current state of practice for designing roadways within the United States is to choose a "design speed" for a roadway and use that speed as an input to determine other roadway factors. AASHTO defines design speed as follows: *Design speed is a selected speed used to determine the various geometric features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, the adjacent land use, and the functional classification of the highway.*

The definition for "target speed" is the speed that you intend for drivers to go, rather than "design speed". The topic of "design speed" versus "target speed" typically centers on roadways with speed limits between 25 mph and 45 mph especially where the 85^{th} percentile speed is higher than the posted speed limit. Agencies are often asked the question "What can be done to reduce the speeds to obtain a desired target speed"?

The purpose of this research is to investigate the question of what roadway/non-roadway elements influence operating speed. This research would focus on roadways with a posted speed limit between 30 and 40 mph, typically collectors and arterials within an urban/suburban context. The research would review various elements of roadways where the 85^{th} percentile speed is at or near the posted speed (within 5 mph) and those roadways where the 85^{th} percentile speed is over the posted speed limit by 10 mph or more. These elements could include roadway width, shoulder width, presence of curbs, driveway density, tree density and size, presence of on-street parking, presence of on-street bicycle facilities, presence of transit stops, roadway curvature (both horizontal and vertical), signal density, presence of sidewalks, sidewalk width and setback, building setback, land use, pedestrian and bicyclist activity, as well as others. The result of the research should provide the profession with better knowledge of what elements may affect speed and how to incorporate those elements into better design.

Given the recent push by local/county jurisdictions to identify characteristics to reduce speeds and implement the use of "target speed" instead of "design speed", there is a need to conduct this research to address the gap that exists on how various roadway and non-roadway elements influence speed and incorporate that knowledge into the design process.

Project 15-77
Aligning Geometric Design Controls, Criteria and Elements with Roadway Context, Modal Priority and Functional Classification

Research Field:	Design
Source:	AASHTO Technical Committee on Geometric Design
Allocation:	$350,000
NCHRP Staff:	B. Ray Derr

Since 1984, the AASHTO "Green Book" (*A Policy on the Geometric Design of Highways and Streets*) and other roadway design criteria have been primarily based on a functional classification system of a hierarchical network composed of arterials, collector, and local roads. This classification is further assigned by an urban or rural designation. This system is described in detail in *Highway Functional Classification Concepts, Criteria, and Procedures* (FHWA-PL-13-026).

This traditional system of highway and street classification has been under increasing scrutiny and discussion because of its inability to reflect emerging design issues such as context-sensitive design, livable communities, practical design, and other innovative approaches. The following are some key concerns with the existing system:

- Designation as simply urban or rural land use context is insufficient to adequately account for the full range of contexts that can exist along a highway or street.
- Classification leads to recommended or limited design choices that may not be optimal for the particular facility and its adjacent land use contexts. These restrictions promote "designing to standards" rather than use of engineering judgment in carefully considering the safety, operational, and other impacts of design decisions on all travel modes using facility.
- The public often questions the use of these classifications as the basis for design decisions.
- The current system is focused on the needs of vehicle drivers and does not fully or effectively address the needs of other types of user modes (e.g., pedestrians, bicyclists, transit riders, freight vehicles). In particular, it does not help with design decisions that must balance benefits for one mode against disbenefits for another.

NCHRP Research Report 855, *An Expanded Functional Classification System for Highways and Streets*, was published in 2018 and presents an expanded functional classification system for highways and streets that builds upon the current system to provide a better basis for the preliminary engineering of a design project, including developing the purpose and need. In particular, it provides additional contexts beyond urban and rural, facilitates accommodation of modes other than personal vehicles, and adds overlays for transit and freight.

The objectives of the research are to identify appropriate applications and ranges of design controls, criteria, and elements across a range of functional classifications, contexts, and modal priorities consistent with the recommendations of NCHRP Report 855. This work will identify the geometric design parameters for the types and designs of facilities needed to serve the travel demands of all current and planned user modes across a range of contexts within each functional classification. The results will be presented in the form of design guidelines supporting each of the cells of the table in Figure 25: *Expanded FCS multimodal matrix by context and roadway type*, from NCHRP Report 855.

This research will build on and advance previous and current geometric design research efforts for applying the design flexibility that currently exists in the Green Book to address the full range of system, context, and modal aspects of street and highway design in order to create a modal balance to achieve successful outcomes. These considerations will allow the planner/designer to identify potential areas of concern and determine the tradeoffs required to best accommodate all users and achieve the desired end operating conditions. Alternative designs should be developed and evaluated in order to deliver a design that is contextually appropriate and best achieves the balance of service, safety, convenience, and accessibility to all modes present or planned.

The research should include a literature review of previous research and current practice, development of a work plan to achieve the research objectives, collection of applicable best practices and supporting information, assessment of the safety and operational effects of various combinations of design controls, criteria, and elements, and preparation of a final report. The final report should include proposed changes to AASHTO documents, if the results support such changes.

Project 15-78
Trade-offs for Cross-sectional Reallocation on Urban and Suburban Roads

Research Field:	Design
Source:	AASHTO Technical Committee on Geometric Design
Allocation:	$600,000
NCHRP Staff:	Dianne S. Schwager

Transportation professionals strive to provide safe and reliable service for automobiles, freight, pedestrians, bicyclists, and transit in balance with the desire to enhance communities and minimize impacts to the environment. Designs for urban and suburban streets must effectively serve all transportation modes and provide an appropriate operational and safety balance among those modes.

The allocation of space within the travelled way (i.e. the road's cross-section) provides the elements that allow for the movement of vehicles, transit, bicycles and freight. Roadway design guidance exists for the individual elements of the traveled way, such as lane width, bicycle lanes, on-street parking, medians, midblock crossings and pedestrian refuge islands, and transit stops. However, current design guidance may not reflect the complex trade-offs transportation professionals must consider for roadways in varying contexts. Also, in constrained locations certain combinations of minimal widths for adjacent elements may have undesired consequences. For example, combining minimum width travel lanes adjacent to minimum width bicycle lanes and parking.

Many transportation agencies have reallocated existing cross-sectional pavement space through resurfacing projects as an effective and low-cost strategy to improve safety and develop multi-modal corridors. There are many options for reconfiguring a roadway to add bicycle lanes, sidewalks, on-street parking or transit stop pull-outs. Oftentimes these types of projects are referred to as "Road Diets". There are many potential benefits to reallocating the use of pavement space. Providing for a two-way left turn lane (TWLTL) can greatly reduce the risk of rear-end and angle collisions for mid-block left-turning motorists. Decreasing the number of road lanes reduces pedestrian and bicycle exposure to traffic when crossing the street and the extra space can be used to add pedestrian refuge islands, widen sidewalks, and enhance local businesses along the corridor by providing outside areas for showcasing merchandise or providing seating for restaurant diners. Cross-sectional reallocations can also provide opportunities to add bicycle lanes to the street or for installing bus pullouts so transit users can enjoy safer stops that do not hinder the flow of traffic. Cross-sectional reallocations can be relatively inexpensive to implement, especially when done through a resurfacing project.

Although cross-sectional reallocations can offer significant multi-modal benefits, they may not be feasible or appropriate in all locations. Transportation agencies must consider numerous factors in terms of feasibility and the overall objectives of the corridor for balancing service among modes. Since there are likely to be positive and negative effects associated with road configuration choices, it is critical to consider the potential outcomes for all users and assess both the beneficial and detrimental outcomes in relation to overall goals and objectives of the project. However, there is limited guidance available to transportation professionals on the key considerations and how to evaluate trade-offs when screening and evaluating cross-sectional reallocations on projects.

The objective of this research is to develop enhanced guidance on the key considerations when evaluating and designing cross-sectional allocations on urban and suburban streets. This guidance should be based on a combination of contextual considerations and quantitative operational and safety-performance information and should examine potential mitigation strategies to minimize negative effects. The enhanced guidance should consider the volume of traffic individually within each mode for the combination of modes being considered in both the before and after conditions. An evaluation framework, including appropriate performance measures is desired.

The research should examine the safety and operational aspects of a sampling of representative cross-sectional reallocations over a range of design parameters (i.e. lane widths, speeds, and varying cross-sectional elements, and various volume combinations for the modes being considered). The guidance should also consider driver expectations and behaviors over a range of traffic conditions. Development of this guidance will require the examination of field data and site observations supplemented with safety modeling considerations and traffic operational simulations.

The research should examine both performance and feasibility aspects related to cross-sectional reallocation. The issues associated with evaluating these proposals are complex and need research to offer modern perspectives and insights on safety performance and economic trade-offs associated with such roadway changes. The final report should include enhanced guidance targeted to design practitioners.

This research need has been identified as a high priority by the AASHTO Technical Committee on Geometric Design, the TRB Committee on Geometric Design, and the TRB Committee on Operational Effects of Geometrics at their June 2018 combined meeting. The research is needed to provide enhanced guidance that will directly affect future design practices for use nationally.

Project 17-95
Crash Modification Factors for Intelligent Transportation Systems (ITS) Applications

Research Field: Traffic
Source: AASHTO Committee on Transportation System Operations
Allocation: $400,000
NCHRP Staff: Edward T. Harrigan

It is generally understood that Intelligent Transportation Systems (ITS) applications, such as variable/dynamic/changeable message signs, CCTVs, traffic monitoring stations, ramp meters, and Road Weather Information Systems (RWIS), help manage traffic and improve incident response, thus enhancing safety on our roadways. However, actual data, specifically crash reduction data resulting from ITS applications, is very limited. Research is needed to develop crash modification factors (CMFs) for the typically deployed ITS applications.

This research would inform engineers, transportation agencies, and the public of the safety benefits of ITS applications by quantifying the reduction in crash frequency and/or severity resulting from ITS applications. It would help justify and obtain safety-related funding for ITS applications, as well as provide quantifiable information to message the need for ITS applications to transportation project delivery teams, planning organizations, and the public.

This research topic is supported by the AASHTO Special Committee on Research and Innovation, and is specifically relevant to the AASHTO Committee on Transportation System Operations (CTSO), Subcommittee on Technology, Working Group on Intelligent Transportation Systems.

The objectives of this research are to develop (1) crash modification factors (CMFs) for commonly deployed ITS applications including variable/dynamic/changeable message signs, CCTVs, traffic monitoring stations, ramp meters, and RWIS and (2) calculation procedures for safety benefit/cost ratios for each ITS application.

Project 18-20

Structural Design Methodology for Cured in Place Pipe (CIPP) Liners In Gravity Stormwater Conveyance Conduits

Research Field:	Materials and Construction
Source:	Florida
Allocation:	$600,000
NCHRP Staff:	Waseem Dekelbab

State transportation agencies are increasingly using trenchless strategies to rehabilitate and repair aging infrastructure within urbanized areas. Performing pipe repairs to existing systems, as compared to pipe replacement, significantly reduces the construction time and maintenance of traffic operations and roadway reconstruction. This provides increased public safety and cost savings to the states. One of the most common types of cured in-place pipe liners, felt tube impregnated with resin, does not have sufficient service life and structural capacity material testing. Therefore, it becomes very difficult for DOTs to establish a pipe service life and structural capacity rating after a cured in-place liner is installed.

Cured in-place pipe liners are a trenchless technology that provides a method to structurally rehabilitate concrete and metal gravity stormwater conveyance conduits with minimal impact to the travelling public. The liner consists of a resin-based felt material that is inserted into the host pipe. The felt liner is sealed on one side and either hot water or steam is pumped into the tube to both inflate and cure-in-place the liner against the existing damaged host pipe. The liner will provide the structural load carrying capacity without the requirement to adhere to the host conduit.

The objectives of this research are to develop (1) a design methodology for cured in-place pipe (CIPP) liners for structural rehabilitation of gravity stormwater conveyance conduits; (2) a laboratory test method to verify the proposed structural design for conduits that have been rehabilitated using the cured in-place pipe liner technology; (3) an accelerated laboratory methodology to determine liner material durability; and (4) laboratory material testing for the felt tube liner and resin.

Thus, better knowledge will be available to designers to make well-informed decisions relating to the design thickness and service life of the rehabilitated pipe system. There are existing testing procedures available for various pipe materials types that can be modified to evaluate this methodology; therefore, the work proposed as part of this proposal, along with the implementation and training, should realistically be achieved within the estimated budget. Likewise, the results of this research will be developed such that the information and guidance can be used by all DOTs.

Project 19-17
The Application of Federal Funding Flexibility at the State DOTs

Research Field: Administration
Source: AASHTO Committee of Funding and Finance
Allocation: $400,000
NCHRP Staff: Dianne S. Schwager

Congress has provided state departments of transportation (DOTs) with some flexibility to transfer funds between federal highway funding categories. State DOTs use this flexibility to fund state and local transportation projects, transit services, and generally maximize the effectiveness of their federal funds. However, some programs have restrictions on transferability that impede project implementation.

The existing flexibility has allowed states to better align priority needs and available funds, accelerate projects, and helped some states manage the impacts of federal fund rescissions, which exempts certain funding categories and therefore restricts states from allocating these resources to optimize transportation services. Some states DOTs have used the existing flexibility to transfer federal funds to local transportation projects as well.

States value this critical flexibility; however, there is little research showing how crucial this transferability is and the effect of existing transferability restrictions on project implementation. This research project will attempt to measure the extent to which states have used transfer authority, the type of transferability needed, and measure how flexibility has helped state better meet transportation needs and achieve their goals and national goals. It will help determine the additional types of transferability that are needed.

The proposed research would identify and describe the benefits of existing transferability and identify additional transferability opportunities that can improve efficiency, lower costs, and speed project delivery. It would generate a summary report that describes:

- The various transfer methods and philosophies used by state DOTs,
- The effectiveness of the various methods,
- The impact of this flexibility in managing the impact of rescissions of federal funding and improving project delivery, and
- The impact of transferability restrictions on project implementation.

An executive presentation summarizing the effects and successful approaches would be developed to communicate the finding to transportation officials who may be interested.

The summary report and presentation would convey the limitations, benefits, and new opportunities for transferability.

Over the past decade, federal transportation funds have become increasingly tight, and states have had to increase their creativity to deliver transportation services. Federal funding uncertainty has not shown signs of slowing (as shown in the FY2019 problem statement *Managing the Effects of Uncertain Federal Funding*, now labeled as NCHRP Project 19-16), and federal fund flexibility is a crucial to combat its effects. This is the top research priority for the AASHTO Committee on Funding and Finance for this research cycle.

Project 20-127
Development of Business Case and Communication Strategies for a State DOT Resilience Program

Research Field:	Special Projects
Source:	AASHTO Committee on Transportation System Security and Resilience
Allocation:	$350,000
NCHRP Staff:	Stephan A. Parker

State departments of transportation (DOTs) have faced significant disruptions to transportation system performance for a variety of reasons. Flooding, extreme heat, wildfires, cyberattacks, critical infrastructure failure, coastal erosion, and storm surge are just some of the hazards state DOTs have had to respond to along with many of their partners. A focus on system disruptions, the ability of the transportation system to anticipate and respond to such disruptions, and the subsequent consequences to transportation system performance and to a state and its communities are primarily perceived as system resilience and security concerns.

The future portends even more disruptions from a variety of sources. The transportation sector is the 3rd most vulnerable sector to cyberattacks according to leading insurance magazine. Worldwide, transportation is the #1 target of terrorists. Future climate and extreme weather conditions are likely very different than historical trends (with expectations of greater impacts on the transportation system). Disruptions to transportation systems have significant multiplier impacts to the economy and society. With an increasingly interconnected world, transportation systems are often dependent on assets and infrastructure over which transportation officials have no control (e.g., the electrical grid). And, of course, such disruptions are highly visible and the ability to mitigate them is often viewed as a measure of the effectiveness of an agency.

In addition, the Fixing America's Surface Transportation (FAST) Act included several requirements for transportation agencies that reflected an increasing concern for resilience and security. For example, statewide and metropolitan transportation planning processes were to consider projects/strategies to improve the resilience and reliability of the transportation system. It continued all prior National Highway Performance Program (NHPP) eligibilities, and added among four new eligible categories, one for projects to reduce the risk of failure of critical NHS infrastructure (defined to mean a facility, the incapacity or failure of which would have a debilitating impact in certain specified areas). It is apparent that system resilience is becoming an ever more important concern for transportation officials at all levels of government.

TRB's Cooperative Research Programs have devoted substantial resources to investigating many different aspects of system resilience and security. However, as will be discussed in the literature review section, no research has been conducted on resilience-oriented communications strategies and how state transportation officials can make a business case for investing in resilience strategies. This was a key conclusion reached at a recent meeting of the AASHTO Committee on Transportation Security and System Resilience (CTSSR). A significant need exists in providing state transportation officials with such a framework and set of strategies.

This research topic will explore how a state DOT can institute formalized processes to ensure the public is aware of how resiliency is part of the organization's overall mission and how to advocate for resiliency in the life cycle of a DOT's planning, engineering, design, operations and construction activities. The proposed research would collect examples of state DOT communications best practices and lessons learned.

This research is directly related to the strategic plan/work plan for the CTSSR, Committee on Performance-Based Management, Committee on Environment and Sustainability and other program delivery and operations committees.

CRP programs have devoted considerable resources to the resilience and security challenges facing transportation agencies (see TRB's periodic update review of such research at http://onlinepubs.trb.org/Onlinepubs/dva/SecurityActivities.pdf). A review of this literature shows that much of it focuses on physical or cybersecurity threats and how DOTs can prepare for, address, and respond to related disruptions. A good example of this type of research is *Protection of Transportation Infrastructure from Cyber Attacks: A Primer* (NCHRP 221/TCRP 67) that examines different functional areas of a DOT and how they can protect themselves against cyberattacks. Much of the literature focuses primarily on raising awareness of how important resilience is to the effective performance of transportation systems. When searching the research databases under "communications" and "resilience" labels, no references relating to the proposed research topic were returned (except as they related to communications technologies).

With respect to ongoing or proposed research, the current NCHRP 20-117, "Deploying Transportation Resilience Practices in State DOTs" is focusing on guidance to state DOTs on how to become more resilient. Part of this project includes the development of a guidebook for state DOT officials on desired resilience actions, and one of the chapters in the guidebook presents the need for effective internal and external communications. However, the chapter will not provide detailed guidance on how to do so. The guidebook also suggests as part of this communications strategy the need to develop a cogent business case on why state DOTs should be concerned about resilience. This business case is intended to explain to other government officials, legislators, and the public why the DOT should spend funds on a range of activities that are needed in the event of major disruptions.

Although not a research project, it is noteworthy that several TRB committees sponsored a competition, "Communicating the Unique Challenge of Transportation Resiliency and Sustainability." The winner of this popular competition presented at the October 8-10th, 2018 National Resilience Summit.

The research proposed by this 20-127 problem statement will build upon the NCHRP 20-117 project as well as others that have mentioned the need for effective communications for enhancing transportation system resilience and supporting resilience-oriented DOT activities.

This research will 1) examine state DOT communication strategies and processes to make the public and stakeholders aware of how resiliency is part of the state DOT's overall mission, and 2) build a business case for investing in resilience strategies. It is expected that the research would examine best communications practices of transportation agencies relating to both the evolutionary nature of considering resilience in agency activities and the more immediate communications efforts in response to disruptions (e.g., Georgia DOT bridge deck fire, Caltrans wildfires, South Carolina DOT hurricane efforts, and Washington State DOT I-5 Skagit River bridge collapse). The intent would be to analyze best case applications of effective communications strategies (including the technology of information dissemination) and lessons learned from recent disruptions. In addition, the research would focus on how to build a business case for including resilience in a DOT's activities.

The desired outcomes would include a guideline on identifying and implementing effective communications strategies, and prototype business case descriptions.

This research topic was identified by the CTSSR as one of the most pressing needs for state DOT officials in fostering a resilience culture in their agencies. As DOTs and state transportation officials increasingly face more system disruptions, having an effective communications program will be a critical component of their success in response. Given the nature of the topic and the importance it has for all those involved with transportation system resilience at all levels of a DOT, the research will create significant benefits to state DOT officials. The likelihood of implementation of research results is extremely high.

Project 20-128
Organizational and Operational Models Used by State DOTs for Emergency Response

Research Field:	Special Projects
Source:	AASHTO Committee on Transportation System Security and Resilience
Allocation:	$400,000
NCHRP Staff:	Stephan A. Parker

NCHRP Report 525, Volume 16: A Guide to Emergency Response Planning at State Transportation Agencies was adopted in 2012 as a guide to state DOTs on how emergency response should occur within transportation agencies. Since then NCHRP has sponsored other research to add practical guidance to the emergency response function of DOTs (to be discussed below in the literature review). However, there is a gap in the research relating to recommended state DOT operational models for emergency response. The importance of the topic has been well established; the types of actions and related responsibilities have been identified; desire outcomes have been defined, but research is lacking on recommended ways DOTs should organize themselves for effectively participating in emergency response.

A key research need identified by the NCHRP Project 20-117 panel and research team is effective organizational structure for the Emergency Response activities of transportation agencies. The importance of Emergency Management activities to tate DOTs is highlighted in AASHTO's 2014 Fourth Generation Strategic Plan which helped form the basis for the new AASHTO Committee on Transportation System Security and Resilience; and, in fact, the following three of the six goals of AASHTO's 2014 Fourth Generation Strategic Plan which helped form the basis for the new AASHTO Committee on Transportation System Security and Resilience (TSSR) are related emergency management.

- Goal 3: "Investigate, develop, and report on recent advances in infrastructure protection, security, and emergency management issues in urban and statewide environments, including consideration of their social and economic impacts.
- Goal 4: Advance the state-of-the-practice and awareness of transportation infrastructure protection and emergency management through training, technical assistance and technology transfer activities.
- Goal 5: Develop, promote and encourage effective working relationship among state transportation officials and other stakeholder responsible for various aspects of transportation infrastructure protection, emergency management and system operations."

Organizational structure can and does make a difference in the effectiveness of emergency response and related emergency activities and initiatives. As noted in 2017 AASHTO Understanding Transportation Resilience: A 2016–2018 Roadmap for Security, Emergency Management, and Infrastructure Protection in Transportation Resilience, emergency management is an essential component of resilience, but the current frameworks may not be ideal.

For decades, state DOTs have been developing and honing all-hazards emergency response procedures and protocols, and have become adept at responding to a range of emergencies and incidents, and fulfilling their federal responsibilities, namely ESF#1 responsibilities such as emergency access and evacuation support.

However, the increased frequency and intensity of disasters have galvanized the transportation community to start focusing on resilience and systematic resilience-based approaches to plan, prepare, respond, and recover from these costly events. Further, new federal guidance requirements such as the 2015 Fixing America's Surface Transportation (FAST) Act incorporates the concept of resilience into transportation planning guidance, and evolving and expanding state, regional, and local requirements provide state DOTs with additional impetus to integrate resilience practices and initiatives into emergency response, and identify effective organizational and operational models for emergency response. This effort will help agencies save money as well as lives and support state DOTs in their path towards resilience.

NCHRP currently has a project under development entitled "Emergency Management in State Transportation Agencies." This project is intended to more "effectively bridge the gap between all-hazards emergency response research and DOT practice and thereby improve the DOT's response over a broad continuum of emergencies affecting the nation's travelers, economy, and infrastructure."

The research objective of this requested project is to augment the purpose of the project currently in development. The project will examine how state DOTs utilize different organizational models to fulfill their Emergency Support Function 1 and related Emergency Response responsibilities, facilitate timely and effective emergency response on DOT assets, and support communities impacted by different conditions that may require DOT resources to support response and recovery of operations. More specifically, the research is expected to:

- Analyze and capture the different organizational and operational models used by state DOTs
- Identify best practices and options
- Capture how the models were implemented, cost of implementation, how they were evaluated, and how they may have evolved

The methodology will likely include a survey of state DOTs and case studies of best practices implemented by state DOTs.

Because effective emergency response is a key component of a resilient transportation organization, understanding the influence of organizational and operational structures on emergency response and best practices and options with respect to those structures is important and ultimately affects the ability of the state DOT in providing the best possible response for a given situation. This translates into lives saved, injuries averted, and damage to transportation infrastructure and assets mitigated. As natural disasters increase in frequency and intensity, the negative impacts of the disasters on transportation assets and infrastructure and systems will increase as well.

Project 22-42
Impact Performance Assessment of Barrier Performance at High Speeds

Research Field:	Design
Source:	AASHTO Committee on Design/Technical Committee on Roadside Safety
Allocation:	$600,000
NCHRP Staff:	Mark S. Bush

Recent data indicates that sixteen states have speed limits of 75 mph or higher. Seven of these states currently have speed limits of 80 mph, with almost all of them adopting this higher speed within the last 5 years. The AASHTO *Manual for Assessing Safety Hardware (MASH)* specifies impact speeds for crash testing and evaluation of barrier systems such as guardrails, median barriers, and bridge rails. The highest impact speed defined by MASH for passenger vehicle is 62 mph. This impact speed was derived from analyses of reconstructed crash data that is now nearly 20 years old. Preliminary data from NCHRP Project 17-43, under which a new database of reconstructed run-off-road crashes is being developed, indicates that for highways with a posted speed limit of 70 mph or greater, the 85th percentile impact speed is 77 mph (1). This indicates a need for a higher design impact speed for barriers used on these higher speed roadways.

With more states adopting higher speed limits and posting an increasing number of miles of roads with speed limits of 75 mph and higher, there is a growing recognition of the need for evaluating barriers for higher impact speeds in order to maintain the level of safety for motorists on these roadways. There is no determination of recommended design impact speeds for evaluation of barrier systems intended for use on roadways with higher speed limits and no direct assessment of barrier performance at these higher impact speeds through computer simulation or full-scale testing.

This objective of this project is to determine impact conditions and barrier designs appropriate for use on roadways with posted speeds of 75 mph and greater. The research will determine appropriate impact conditions for roadways with higher speed limits (75 mph and greater) through crash data analysis; assess performance limits of existing barrier systems using engineering analysis and finite element simulation; and evaluate new or modified barrier systems capable of accommodating recommended design impact conditions using finite element simulation and full-scale vehicle crash testing. The resulting barrier designs will allow updates to appropriate sections of the AASHTO *Roadside Design Guide* (RDG), and recommended design impact conditions can be incorporated in a future update of the AASHTO *Manual for Assessing Safety Hardware* (MASH).

Project 22-43
Developing Testing Protocol for a Family of Devices—Signs, Breakaway Poles, and Work Zone Devices

Research Field:	Design
Source:	AASHTO Committee on Design/Technical Committee on Roadside Safety
Allocation:	$500,000
NCHRP Staff:	Waseem Dekelbab

To encourage state departments of transportation (DOTs) and hardware developers to advance hardware designs, the FHWA and AASHTO collaborated to develop a MASH implementation policy that includes sunset dates for various roadside hardware categories. The joint FHWA/AASHTO implementation plan for MASH devices requires highway agencies to evaluate many different designs of permanent signs, breakaway poles, and work-zone devices. The new policy by the FHWA and AASHTO requires that sign supports and breakaway hardware, including breakaway poles and temporary work zone devices, installed on federal aid roadways after December 31, 2019 to have been evaluated to MASH 2016.

In a May 26, 2017 letter from the FHWA, all tests required by MASH for a given device must be performed to get an FHWA eligibility letter. Also, with FHWA's changing role in determining crashworthiness, highway agencies and manufacturers have been left in a situation where a significant number of systems still need to be evaluated to MASH, including permanent signs, breakaway poles, and work-zone devices. For each device, up to three full-scale crash tests need to be conducted, and these crash tests can be expensive to perform. There are thousands of variations of breakaway sign support systems, luminaire supports, and work-zone traffic control devices that the state DOTs utilize. The costs of these tests will fall directly on to transportation agencies and the public. Thus, it is not feasible to test all possible combinations to MASH.

Finding a more cost-effective way to determine the crashworthiness of a "family" of devices will speed implementation of new hardware and save transportation agencies funds.

The objectives of this project are to (1) determine what critical features a surrogate or bogie vehicle should have to determine crashworthiness; (2) review previous literature and research on testing signs, breakaway poles, and work-zone devices; (3) define the critical traits that make a "family" of devices; and (4) determine the "Worst Practical Condition" for some devices that have similar designs.

Transportation agencies must start adopting MASH-approved hardware now, as the new MASH implementation policy by the FHWA and AASHTO requires that sign supports and breakaway hardware, including breakaway poles and temporary work zone devices, installed on federal aid roadways after December 31, 2019 to have been evaluated to MASH 2016. This research will aid agencies in implementing MASH hardware and allows development of hardware in a less expensive manner.

Project 22-44
Development of a Crash Data Collection Tool and Application Guidelines for MASH In-Service Performance

Research Field:	Design
Source:	AASHTO Committee on Design/Technical Committee on Roadside Safety
Allocation:	$400,000
NCHRP Staff:	Edward T. Harrigan

The AASHTO/FHWA joint implementation plan called for Manual for Assessing Safety Hardware (MASH) testing to be required for the development of new hardware beginning January 1, 2011. As these higher–performing systems are placed into service, adequately planned and conducted in-service performance evaluations (ISPEs) will allow determination of field performance of roadside safety hardware. A more comprehensive data collection tool and guidelines will provide a ready-to-use mechanism for agencies to collect the ideal data for conducting ISPEs. A single source of data collection guidelines will lead to data which can be readily combined across multiple states or agencies, ultimately resulting in a more meaningful, universal data set for ISPE evaluations.

This project seeks to develop an improved, more consistent in-service data collection tool and associated guidelines for the evaluation of roadside safety features. This tool would enable first responders and responding DOT maintenance staff at crash scenes to collect needed data with respect to photographic information, hardware characteristics, and others. The developed crash data collection tool would also support state DOT maintenance personnel for a more consistent crash-related and roadside inventory data.

As part of the proposed project, a pilot study should be developed to test the developed tool and associated guidelines as well as to develop plans for disseminating the tool to interested agencies.

The objective of this research is to develop a crash data collection tool and associated guidelines for MASH in-service performance. Accomplishment of this objective shall require the following tasks: (1) conduct a literature review of documented research to identify best practices of existing tools and methodology currently utilized by agencies for crash data collection; (2) develop improved recommendations and a tool for first responders and DOT maintenance personnel at crash scenes for easy and efficient collection of crash data; (3) conduct pilot testing to determine the efficiency of the tool and associated guidelines; and (4) develop a plan, including workshops, for implementing the use of the tool and associated guideline by the state DOTs and other transportation agencies.

Project 22-45
Understanding and Analyzing Crash-Contributing Factors

Research Field: Design
Source: AASHTO Committee on Safety
Allocation: $650,000
NCHRP Staff: William C. Rogers

Successful safety management practices require a thorough understanding of the factors contributing to crashes. The continuous advancements in the science of data-driven safety analysis, as well as the countermeasures and technologies available for addressing crashes, create challenges in maintaining a safety workforce that is always proficient in the state of the practice. In many cases, agencies continue to use approaches, such as descriptive statistics and anecdotal information to perform this diagnostic assessment without a thorough understanding of what should be expected for a given context or road type. A secondary issue is that once the nature of the crashes at a location are assessed, choosing an effective countermeasure requires an examination of the human factors, behavioral factors, future development, prevailing or predicted crash type(s) or mix of road users to determine the most appropriate treatments to apply. Doing so allows the selected countermeasure to reduce crashes to the greatest extent possible. However, in many cases, practitioners have limited experience and background to assess these contributing factors, reducing the likelihood of safety investment success. Further, the practitioner may have limited understanding of the potential for a treatment to increase exposure to the more vulnerable road users. For instance, installing a turn lane might also increase vehicle speeds or crossing distance. By having a better understanding of these tradeoff, changes can be made in the design and operations of facilities upfront, rather than waiting for crashes to occur before addressing the less than optimal road design.

The objective of this research is to assess best practices in crash diagnosis across crash types in modal diverse contexts, recognizing that vehicle and mode mix matters in the success of investment strategies. The research will then develop additional diagnostic tools that leverages the availability of crash, roadway, traffic volume, human factors, behavioral, socioeconomic, and demographic data to advance the art of the practice in crash diagnostics that consider both modal priority and facility context. It is anticipated that the research effort to meet the objective would include the following tasks:

1. Identify the previous research on crash diagnosis and countermeasure selection for various modes of transportation and determine if the necessary research literature is coordinated, not coordinated, or contradictory.
2. Outline a process or procedure for identifying what steps are needed to develop enhanced or new comprehensive diagnostic assessment methods for determining crash-contributing factors across modes and in different roadway contexts using crash type, severity, and integrated safety and other data for the system.
3. Identify a technical working group of safety engineers, designers, traffic engineers, planners, behavioral experts, and others to provide input to the project and to review these diagnostic and countermeasure selection tools as they are proposed and developed. Note that the focus of the project is not to capture existing practice but to advance the limited approaches currently deployed.

4. Meet with selected transportation and safety organizations, such as state DOTs, state highway safety offices, FHWA, NHTSA, TRB committee(s), and others, to identify needed skills for understanding crash diagnostics and countermeasure selection that is responsive to the needs of mixed modes of traffic across the five contexts used in the AASHTO Green Book.
5. Develop new diagnostic assessment and countermeasure selection tools considering, multiple factors, multimodal needs and multiple contexts, along with draft instructions for users and materials describing the basis for the tools, assumptions, and limitations for application.
6. Plan and conduct two pilot data–driven diagnostic assessments and countermeasures selection tools to: (1) illustrate how multimodal road use safety needs can be addressed using the newly developed tools; and (2) how other existing safety tools (including the human factors guides and mode specific tools) can be used to supplement these activities. Use the pilots to update and clarify new or existing materials and analysis approaches (e.g., Every Day Counts initiative on Data–Driven Safety Approaches, and road safety audits).
7. Update the diagnostic assessment and countermeasure selection tools, accompanying documentation (including the basis for the tools, assumptions, and limitations for application).
8. Determine the most effective method to disseminate and share this information, including how to incorporate this research when using these diagnostic and countermeasure selection tools with data driven safety analysis, from the development through implementation of safety projects.

Project 22-46
Supporting Data-Driven Decision Making through an Expansion of the Human Factors Guidelines for Road Systems

Research Field:	Design
Source:	AASHTO Committee on Safety
Allocation:	$550,000
NCHRP Staff:	Mark S. Bush

The Human Factors Guidelines for Road Systems (HFG), published as NCHRP Report 600 is a tool for considering road user characteristics into roadway design and operational decisions. The HFG provides guidelines for individual intersection, roadway segment, and other element types and is currently being revised to update existing information and to address additional elements, including bicycle facilities, pedestrian facilities, and roundabouts. Additional critical gaps in guidance on considering human factors were identified during the early stages of planning for the first HFG materials, and users have indicated that development of these materials would be beneficial to their efforts to reduce fatalities and serious injuries.

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 publications and future editions would be driven by practitioner needs. The 3rd Edition will add new chapters on bicycles, pedestrians, and roundabouts after responding to a survey of desired HFG changes to increase modal understanding and newer intersections concerns. Similarly, after receiving user input the 4th Edition is proposed to have new chapters on transit, older road users, road diet, and complete street topics. The HFG end users also indicated a need for support with application of the HFG in countermeasure selection, road safety audits, roadway signage reviews, determination of crash contributing factors, root cause analysis, human factors training and teaching. Further, the research also intends to include updates to existing chapters that could not be updated in the 3rd Edition as other human factors and safety research has continued to evolve rapidly in recent years. The 4th Edition would include new practice-ready content—guidelines, tutorials, tools, etc. that support and illustrate how data-driven safety analysis tools (such as the AASHTO Highway Safety Manual, (HSM)) and performance–based-decisions reflecting road user needs, capabilities, and limitations will enhance highway safety.

The objective of this project is to review existing published highway–related human factor road-users research literature; update as needed existing guidelines in HFG, Edition 3, and develop new technical chapters with guidelines for inclusion in HFG, Edition 4. All new guidelines will use the format as published in the Edition 3 of the "Human Factors Guidelines for Road Systems," NCHRP 600. The research also intends that the HFG be a supplement and coordinated document with the AASHTO HSM and other safety tools and processes such as road safety audits, operational reviews, performance planning, data driven design and operations of the road system.

Project 22-47
Incorporating Driver Behavior Considerations in Safety Performance Estimates of Infrastructure Improvements

Research Field: Design
Source: AASHTO Committee on Safety
Allocation: $600,000
NCHRP Staff: William C. Rogers

Driver characteristics are one of the most influential contributing factors to traffic crashes. However, the advancements in data-driven safety analysis tools available to safety practitioners are focused on infrastructure-related factors affecting crashes. Research is needed to include driver behavior factors in crash prediction models to allow for a more comprehensive assessment of existing and expected safety performance. Regression models for expected crash frequency and severity used for development of crash modification factors (CMFs) and estimation of predicted crashes do not incorporate driver characteristics. This creates a problem for those considering safety applications since one of the most important factors is not included. This will lead to safety solutions that may work as intended. In the Highway Safety Manual (HSM) the measures of driver characteristics are divided into several categories such as attention and information processing, vision, perception-reaction time, and speed choice. But these categories are provided at a very high level. The driver characteristics such as gender, age, speeding, blood alcohol content, seatbelt use, and distracted driving are usually reported by police officers called to the crash scenes. These factors can be used to assess the impact of driver characteristics on crash frequency, type, and severity. Several studies have evaluated the impact of these factors on crash severity. There is, however, a need to incorporate these factors in widely implemented crash prediction models such as Safety Performance Functions (SPF), Severity Distribution Functions (SDF) and other types of crash prediction models to achieve a better picture of the true potential impacts of safety decisions. Including the driver behavior factors will help improve the prediction accuracy of the aforementioned crash prediction models and will provide the highway safety agencies with a better assessment of the contributing factors of traffic crashes.

The objective of this research is to develop a methodology to incorporate aggregate driver characteristics into safety models such as the SPFs and SDFs, as one or more explanatory variables in the models. The research will also identify the list of driver characteristics or factors that can be aggregated for a given segment, block group, and other spatial units, and used in safety model prediction. These findings will be incorporated into tools such as the HSM predicative methods. The following tasks, as a minimum, are anticipated to meet the objective:

1. Review of the literature that have evaluated/estimated the impact of driver characteristics on safety to identify the list of driver characteristics variables (or measures) that have been found to contribute to the roadway safety.
2. Identify the data needs, including readily available data sources, and outline the data collection and compilation plan. The potential data sources would include but are not limited to Police Citations, FARS and GES, DOT Police crash reports, SHRP 2/NDS, US Census, DMV, and so on.

3. Select the list of driver behavior variables that can be aggregated over a given spatial unit based on the results of Tasks 1 and 2.
4. Propose the statistical methodology to conduct the data analysis, including the data collection plan, statistical analysis approach for developing the crash models incorporating driver characteristics, and expected outcomes of research into the HSM and other authoritative safety tools.
5. Assess the advantages of the developed methodology and compare to the HSM.

Project 22-48
Methods for Short-Term Crash Prediction

Research Field: Design
Source: AASHTO Committee on Safety
Allocation: $650,000
NCHRP Staff: Camille Crichton-Sumners

Current crash prediction methods—such as those in the AASHTO Highway Safety Manual (HSM)—consist of safety performance functions (SPF), crash modification factors (CMF), and severity distribution functions (SDF). These tools use annual average daily traffic (AADT) data along with geometric and operational characteristics to predict annual average crash frequency of roadway sites. While these models have statistical merit, they do not allow users to accurately predict crashes for short-term periods (which are defined as months, weeks, days, hours, or peak periods for this research) and this can be an issue for agencies wanting to assess the impacts of temporary works zones or facility changes. The annual prediction convention also limits the models' ability to quantify the effects of variables that fluctuate more often than year-to-year, such as operating speeds, operating speed variance, or seasonal fluctuations. Agencies require the ability to more accurately assess what seasonal or daily changes could have on crash outcomes. There is a need to explore the development and functional forms of crash prediction methods using finite exposure measures and representing short-term roadway conditions to better account for these variables and understand short-term fluctuations in highway safety performance.

One of the most significant limitations of the HSM—and quantitative safety performance research in general—is the omission of speed-related factors from nearly all aspects of safety predictive methods. Recent research has made little substantive progress in incorporating speed-related factors into crash predictive models. There is an urgent need for research to explore new data, revised aggregations, and newer statistical methods to better understand how to effectively quantify highway safety on a daily, hourly, or other short-term basis to overcome these limitations of current methods to provide for more useful applications by transportation agencies.

The purpose of this research is to explore the development of short-term crash prediction models to estimate the safety performance of roads for specific geometric, operational, and exposure characteristics (such as those related to detours, variable speed limits or routes that experience significant changes throughout the year). The research should identify the appropriate measures of exposure, explanatory variables, statistical and machine learning models, model limitations, and other necessary factors to assist researchers in developing models and practitioners in interpreting their results. This research should explicitly explore the use of more precise measures of exposure than AADT and variations in those exposure measures over time to predict crashes.

This research has the potential to start to account for speed and other real-time operational data, special events, and unique roadway situations that represent safety concerns to DOTs, which are not yet well understood using existing safety prediction methods. The research would help estimate safety performance and address safety concerns related to shorter term or temporary events, and would help states better meet the needs and expectations of road users.

Project 22-49
The Effect of Vehicle Mix on Crash Frequency and Crash Severity

Research Field:	Design
Source:	AASHTO Committee on Safety
Allocation:	$400,000
NCHRP Staff:	Camille Crichton-Sumners

The USDOT Bureau of Transportation Statistics estimates that truck travel is expected to increase from 282 million miles per day in 2012 to 488 million miles per day by 2045 (2017). In traffic volume estimates for planning and project development, vehicles are typically classified into two broad categories: 1) passenger vehicles (motorcycles, cars and pickup trucks) and 2) trucks over 10,000 pounds gross vehicle weight. Trucks are often further sub classified, for example as buses, single unit trucks, and combination trucks. A more complete classification system has been established by the Federal Highway Administration (FHWA). The FHWA vehicle classification system separates vehicles into 13 different class groups or categories ranging from motorcycles to multi-trailered trucks with seven or more axles (there are 2 additional groups – group 14 which is not used, and group 15 for unclassified multiple configurations). Data conforming to this classification system has been routinely measured by states across all facility types and reported to the FHWA over a number of years. It well known that vehicle mix is not constant and varies considerably among all facility types. Additionally, vehicle mix is expected to change significantly over time as truck travel continues to increase.

The AASHTO *Highway Safety Manual* (HSM) has become a key safety management and evaluation toolbox for state and local highway agencies, MPOs, and the safety, design, and operations community. Current HSM tools include predictive methods for a wide variety of highway facility types and site conditions. The current methods account for traffic volumes and other roadway characteristics but not for vehicle mix or distribution of vehicle types. Recent studies indicate that predictive methods for crash frequency and severity would be significantly improved with the inclusion of consideration for vehicle mix.

The objective of this research is to determine the effect of vehicle mix on crash frequency and crash severity for selected facility types using a statistically valid methodology based on and compatible with HSM principles and methods. It is expected the research will result in new safety performance functions and/or vehicle mix adjustment factors that will improve the accuracy and reliability of crash frequency and severity estimates.

Project 23-02
Secure Information Environments for Collaboration and Knowledge Sharing: Guidance for State DOTs

Research Field:	Administration
Source:	AASHTO Committee of Knowledge Management
Allocation:	$350,000
NCHRP Staff:	Andrew C. Lemer

Transportation agency business practices are evolving rapidly, with increasing expectations for information access, knowledge transfer, and collaborative work environments among practitioners within and among agencies. However, states department of transportation (DOTs) and other such agencies have various practices for ensuring information security, cybersecurity, and physical security and controlling permissions for interactive tools, which can make collaboration, information access, and knowledge sharing frustrating and ineffective.

Security is a significant business risk, but excessively restrictive security can increase agency workloads by limiting legitimate access to business-critical data and information and stimulating public disclosure requests. On the other hand, lax or ineffective security can have dire consequences as a succession of newsworthy examples have demonstrated. In the transportation community, the issues of balance between information security and access cut across all modes, jurisdictions, and users.

Research is needed to develop a guidebook of effective practices that support the evolving business needs of DOTs and provide appropriate data and information security. The guidebook should address information security and access practices, context and resources for effective use of the practices, and applications of these practices to specific categories or classifications of data and information of interest to DOTs. Topics such as these may be included: (1) strategies to assess information security risks; (2) technology needed to support management and protection of digital assets; (3) security management strategies and governance and operational policies to promote good practices in data sharing and management; (4) security policy guidelines and interoperability measures for the harmonization of practices across agencies and their stakeholders; (5) knowledge management strategies that enhance DOTs' understanding of their digital resources and the sharing of such resources among individuals, teams, and organizations in the transport sector and in other sectors; (6) guidelines for sharing of transport-related data among transport-sector stakeholders, including sharing of cybersecurity data (such as cyberthreat data, attack scenarios and practices in response and defense).

Project 23-03
Targeted Guidance and Information Support to State DOT CEOs on Cybersecurity Issues and Protection Strategies

Research Field:	Administration
Source:	AASHTO Committee on Transportation System Security and Resilience & Committee on Data Management and Analytics
Allocation:	$350,000
NCHRP Staff:	Camille Crichton-Sumners

Cyberattacks against financial/credit agencies, health organizations and military establishments have occurred more frequently over the past several years. What is less known to the general public, and perhaps to transportation officials, is that the transportation sector is a prime target for such attacks. As noted in an influential insurance business magazine, "transportation is now the third most vulnerable sector exposed to cyberattacks….GPS tracking, used within the transportation network to identify the location of goods and trucks, the computer networks themselves, and automation are all specific vulnerabilities within this industry"...[1] Over the past two years, cyberattacks against the Colorado DOT and Maersk have highlighted the challenges that public and private transportation organizations could face with such threats. This portrayal does not mention the other functions of state DOTs that could also be highly vulnerable such as human resource and employee databases, data storage, enforcement records (in some cases), legal/contract documents, etc.

This research focuses on the current and likely future challenges facing state transportation agencies with respect to cybersecurity. While material is available on the technical aspects of protecting agency operations, very little is aimed at DOT agency leadership that explains how the agency can prepare/prevent such attacks, what to do when they occur, and how to recover from attacks. Given the increased likelihood of future cyberattacks against transportation assets, this research addresses a critical need in a DOT's security and continuity of business strategies and protocols. Importantly, the research will provide a comprehensive examination of <u>all</u> the functions, services, data-focused activities, and sensitive data storage that could be a target of a cyberattack. It will provide DOT officials with an easy-to-use assessment guide on how to identify the greatest risks to the agency, and what types of strategies might be considered.

The purpose of this project is to identify the information needs of high-level state DOT officials with respect to cybersecurity prior to, during, and after a cyberattack. These information needs would then be the framework for developing targeted information materials aimed at letting DOT leadership know how they should be preparing their agency for these incidents. It is expected that the project would include a variety of multimedia outreach strategies. Another key element of this research would include identification of best practices in terms of training and maintaining a level of awareness of the criticality surrounding cybersecurity.

[1] Alicja Grzadkowska, "Transportation is now the third most vulnerable sector exposed to cyberattacks." Insurance Magazine, July 24, 2018 https://www.insurancebusinessmag.com/us/news/cyber/transportation-is-now-the-third-most-vulnerable-sector-exposed-to-cyberattacks-106900.aspx

Project 23-04
Cost–Savings Analysis of Statewide Insurance Pooling for Public Transit

Research Field:	Soils and Geology
Source:	AASHTO Council on Public Transportation
Allocation:	$300,000
NCHRP Staff:	Velvet Basemera-Fitzpatrick

Transit agencies are finding it increasingly difficult to locate, purchase, and maintain adequate and affordable insurance coverage for public transit vehicles. Not only is the cost of adequately insuring all the vehicles in every transit agency increasing, but the ability to cover costs for each agency's individual policy premiums is a challenge as well.

Last year, across-the-board increases in premiums with identical coverage affected all transit providers, especially rural transit providers where the increase was a sizable part of their annual programming. Additionally, the number of smaller insurance agents is decreasing due to the volatile nature and demands of the insurance industry, and insurance coverage requirements in general. Finally, small rural transit agencies often face the largest cost increases due to their small fleet sizes and high annual mileages per vehicle. Since state departments of transportation either directly purchase the vehicle insurance policy or fund the transit provider's vehicle insurance policies, this research will provide solution for states seeking to consolidate this practice and implement statewide insurance pools for insuring transit vehicles.

The objective of this study is to examine the types of insurance available to the transit industry for covering vehicles and explore the cost savings that could be realized with statewide insurance coverage for all the transit and paratransit vehicles in states. The study should also determine the percentage of insurance administrative costs that could be saved from this approach in comparison to the current individual providers subscribing to a separate policy coverage for fleets. Developing recommendations for implementing statewide insurance pools, including work plan, responsibilities matrix, and timeline to transition from single-agency insurance policies to state-level insurance pool plans.

Project 23-05

Addressing Construction Inspector Qualifications for the Future: Best Practices for Education, Training and Certification

Research Field:	Administration
Source:	South Dakota
Allocation:	$450,000
NCHRP Staff:	Ann M. Hartell

In recent years, state DOTs have faced increasing demands for Construction Inspection (CI) staffing due to a more technically and contractually complex construction project environment. This has been exacerbated by the retirement of the baby-boomer generation from the workforce and with them, their many years of experience. According to the Georgetown Center on Education and the Workforce, by 2020, 65 percent of American jobs will require some form of post-secondary degree or credential. The required skill set of the CI has also changed, requiring not only technical skills that have been in place for decades, but also the adaptation of those skills due to improvements in technology and differing forms of construction contracting, such as Design-Build and Risk Based Inspection.

In some states, construction volume has increased and/or the numbers of state employees has decreased, giving consultants a larger role in supporting state DOTs' CI needs. The lack of a national standard for the required combination of skills, especially for consultant-hired inspectors, is a dominant factor supporting the need for research. State DOTs recognize that the performance of CI is necessary in order to fulfill policy directives of ensuring that projects under their jurisdiction are constructed in conformance with the state–and FHWA–approved plans and specifications. Consultant Inspection must be utilized to augment state DOTs' workforce. However, outsourcing CI tasks to consultant inspectors presents specific challenges to state DOTs. One of the main challenges currently faced is the lack of a national standard for the skill set of consultant inspectors on the basis of validated formal education, experience and certifications.

The main objective is to identify activities and policies that have demonstrated a potential to ensure that inspectors possess the capabilities that will be required in the years ahead. This will be done by studying the current status of inspector capabilities and by benchmarking state-of-the-practice programs for the formal education, experiential learning, and certification of personnel:

- Existing Skills: Identify existing educational and career backgrounds, and levels of relevant skills of individuals who are entering their first CI jobs.
- Formal Education: Identify formal education and training programs for individuals entering CI positions.
- Certification: Identify programs that provide for the certification of an individual's acceptable levels of appropriate CI skills.
- Experiential Learning: Identify programs that provide formal internships that combine education with on-the-job training and experience for individuals training to become inspectors.
- Quality: Identify programs that provide assured training, experience and certification of inspectors.

- Increasing Skills: Investigate inspector career pathways that result in increased capabilities, and the additional formal education, additional experience, and additional certifications that form the basis for the increased capabilities.

This study will assemble a national set of effective practices and develop reports, case studies, and guidelines that can be utilized by agencies to implement based on local statutory and/or policy requirements for the development and implementation of individual state CI formal educational, experiential and certification qualification programs and standards. The guidelines should include a methodology to compare existing program alternatives on a basis of both potential cost and time savings. It should also incorporate guidance that allows DOTs to be able to justify the costs of the proposed CI formal educational, experiential and certification qualification and development program alternatives on a basis of offsetting construction quality benefits.

A compendium of reports, case studies, and guidelines should allow implementation to be customized by each state DOT and private sector firm, while facilitating the portability of qualifications by CIs who perform inspection work for different agencies. This would enable utilization of common training and credentialing resources, which, in turn, spreads out the costs of those resources, while increasing the pool of expertise available for their production.

Project 23-06
Developing an AASHTO Guide to System–Level Asset Valuation in Support of Transportation Asset Management Decision Making

Research Field:	Administration
Source:	AASHTO Committee on Performance-Based Management
Allocation:	$600,000
NCHRP Staff:	Andrew C. Lemer

Return on assets is widely accepted as a measure of performance for asset management and investment analysis and is widely used as a basis for allocating scarce resources—money, for example—among diverse activities that may use those resources to produce desirable goods and services. State departments of transportation (DOTs) are stewards for public infrastructure assets that are essential to our economic vitality, public safety, and quality of life. Accurate, relevant, and reliable asset valuation is crucial for decision making to ensure the effective, efficient and economical management of our highway and transit assets.

The current federal highway statute (23 USC 119) and regulations (23 CFR 515) require state DOTs to develop a risk-based transportation asset management plan (TAMP) that includes a valuation of pavements and bridges on the National Highway System (NHS). State DOTs are complying with these requirements through various approaches, but have struggled to incorporate asset valuation into asset management practices or infrastructure investment decisions in a consistent, meaningful way. Practices used internationally for incorporating asset valuation into an organization's financial statements have not been much used in the U.S. Some guidance has been produced (for example, the Federal Highway Administration's (FHWA) report on *Incorporating Asset Valuation into Transportation Asset Management Financial Plans*; NCHRP Reports 483, 608, and 898), but detailed assessment of the issues and practical procedures for valuation and management for public-sector transportation assets in U.S. practice are needed.

The objectives of this research are to examine methods for valuation of system assets and to develop guidance and tools to demonstrate quantitative asset-level valuations for an agency. The research should (a) review various approaches for asset valuation, such as GASB34 and Depreciated Replacement Cost, with a focus on identifying whether current replacement cost or a market value approach should be used, how each is beneficial and can be incorporated into asset management plans and practices; (b) determine a baseline of existing practices currently undertaken by domestic and international highway and transit agencies to identify specific objectives for a standard asset valuation methodology, including case studies of successful implementation; and (c) develop a transportation asset valuation guide and methodology for U.S. transportation agencies, including a roadmap for implementation of appropriate valuation approaches into work planning and programming practices, practical examples that can be used by asset owners, system operators, and planning organizations to utilize asset valuation to improve the effectiveness of investments in transportation infrastructure.

Project 23-07
Guidebook for Identifying and Implementing Forecasting Techniques for Effective Target Setting

Research Field:	Administration
Source:	AASHTO Committee on Performance-Based Management
Allocation:	$500,000
NCHRP Staff:	Ann M. Hartell

In the Transportation Performance Management (TPM) framework, forecasting of performance is a key element in effective setting of performance targets. In the seven national performance goals defined by MAP-21 and its successive legislation, the established performance measures capture several dimensions of performance; reflect distinct and varied underlying processes that relate actions to outcomes; and are subject to varying degrees of influence by, and interaction with, factors and covariates affecting or driving performance. The forecasting of performance in this diverse context would benefit from techniques that are tailored to each particular context and business process designed to impact outcomes. Whereas asset management systems may be adept and sufficiently developed to predicting performance for pavements and bridges, other performance dimensions such as highway safety and system reliability may require different approaches. Consequently, there is a need to provide guidance to the performance manager in selecting a reasonable and effective approach for forecasting performance that is well suited to the specific performance dimension that is being managed. This need extends beyond specific national performance measures to all performance measures used by transportation agencies to monitor and positively impact outcomes in their sphere of influence.

Forecasting techniques have been developed in a variety of areas of human activity, in economics, social and natural science, and the technical and engineering fields, and there is an opportunity to draw on general principles to apply an appropriate forecasting methodology to transportation performance measures.

The objective of this research is to develop a guidebook for transportation performance managers to identify, select, and implement forecasting techniques that are appropriate for each performance measure. The guidebook should enable performance managers to identify general types of performance measures and pair them with the most promising methodologies for forecasting performance that will help achieve the goal of effective target setting. The guidebook should also treat the subject of secular changes in the phenomena being measured and how to address the impact of these unforeseen changes on the estimation of future outcomes using each of the forecasting techniques. The guidebook should also contain a step-by-step procedure that can be applied to any performance measure. It would be useful to include an actual forecasting example as a case study so that state DOTs have information about what kind of work is necessary after the guidebook has been used. For this purpose, existing national performance measures could be examined in the latter part of the research.

Project 23-08
Guidelines for Incorporating Maintenance Costs into a Transportation Asset Management Plan

Research Field:	Administration
Source:	AASHTO Committee on Maintenance
Allocation:	$350,000
NCHRP Staff:	Lawrence D. Goldstein

MAP-21 established a performance-based Federal-Aid Highway Program that includes a requirement for state transportation agencies to develop and update a risk-based Transportation Asset Management Plan (TAMP) that identifies investment and management strategies to improve or preserve asset conditions and the performance of the National Highway System (NHS). Although only pavements and bridges on the NHS are required to be included in the TAMP, states are encouraged to include all roadway assets within the right-of-way. At a minimum, the TAMP should include the following information: 1) a summary of NHS pavement and bridge assets, including a description of conditions; 2) asset management objectives and measures; 3) the identification of any performance gap; 4) a life-cycle cost and risk management analysis; and, a 5)10-year financial plan and corresponding investment strategies.

While most states are able to capture past and planned expenditures on capital projects, they are finding it challenging to incorporate maintenance costs into their TAMP. This situation is influenced by a number of factors: 1) maintenance data are not easily linked to pavement and bridge management systems so it is not easy to track maintenance applied to specific pavement sections or bridges; 2) maintenance plans have short-term horizons while longer-term planning documents, such as the Statewide Transportation Improvement Program (STIP), include only capital investments; and 3) maintenance funds are not committed to a single asset type, i.e., agencies generally do not establish a budget specifically for guardrails or culverts.

The absence of maintenance cost data in a TAMP must be addressed to capture the full level of investments being made by states in the transportation system. This requirement is especially important as state transportation agencies shift their focus from system expansion to system preservation, which places more of an emphasis on preventive maintenance activities. The guidance developed under this research will provide the information needed by practitioners to use available pavement and bridge maintenance data to address each of these elements of a TAMP. In addition, the guidance will address the use of available information to incorporate other roadside assets (such as guardrails and culverts) into a TAMP.

The objective of this research is to develop guidance that can be used by state transportation agencies to incorporate maintenance costs more effectively into life-cycle cost analysis, financial plans, and investment strategies included in a TAMP. In support of this objective, the research should include the following steps: 1) Review of existing TAMPs and summarize the extent to which maintenance costs are incorporated into the life–cycle cost analysis, financial plan, and investment strategies; 2) Identify content areas where maintenance costs could be better incorporated into a TAMP; 3) Determine adequacy of available maintenance data to support the needs in each TAMP content area; 4)

Develop guidance to better account for past and planned maintenance costs as states develop their TAMP; and 5) Prepare a final report that includes the findings, provides guidance for state transportation agencies, and identifies further research needs in this area.

Project 24-49

Guidance on the Selection and Use of Flow Resistance Values in Two-Dimensional (2D) Hydraulic Models

Research Field:	Soils and Geology
Source:	Ohio
Allocation:	$600,000
NCHRP Staff:	Waseem Dekelbab

Manning's n values for channels and floodplains are typically estimated from standard tables that have been developed from well-documented studies (e.g. Chow, 1959; Barnes, 1967; Arcement and Schneider, 1989; Brunner, 2016). Where field data are available, Manning's n values can be determined as part of a calibration effort. Manning's n values can be estimated for various land use types based on field reconnaissance, aerial imagery, site photos, or proposed project plans.

The transportation hydraulics community of practitioners recognizes that flow resistance values (or "roughness" values) along with channel and floodplain geometry are the two most important factors in estimating discharge capacity and water surface elevations (Zevenbergen et al., 2012). Where possible, calibration to actual flood events with known discharges and high-water marks is strongly encouraged, along with sensitivity analysis and testing. The Manning's n value impacts bridge scour predictions, floodplain management, and hydraulic sizing of bridges and culverts. Projects involving pavement overlays, roadway widening, realignment, and/or bridge or culvert replacement are very common examples.

At present, the FHWA recommends using unadjusted Manning's n values from resources such as those cited above for estimating roughness values for use in 2D models (Zevenbergen et al., 2012). However, as stated in Vennard and Street (1975), "There is no substitute for experience and judgment in the interpretation and selection of values for n," and in current practice, this selection is done by the hydraulic modeler.

The objectives of this research effort are to (1) assess and document the state of the practice with respect to the selection of Manning's n values for 2D hydraulic modeling applications and (2) develop guidelines for selecting roughness values for 2D modeling.

Measures to improve the accuracy, reliability, and consistency in selecting roughness values for the application of 1D and 2D hydraulic models at highway crossings and in transportation corridors will represent a major step forward in the evolving state of practice.

Implementation of new guidance would be oriented toward revisions of FHWA Hydraulic Design Series (HDS) manuals on 1D and 2D hydraulic modeling approaches and recommendations, the AASHTO drainage manual, and the FHWA's Every Day Counts (EDC) 2D Hydraulic Modeling Reference Manual (currently in preparation).

Project 25-61
Effective On-Bridge Treatment of Stormwater

Research Field:	Transportation Planning
Source:	AASHTO Committee on Environment and Sustainability
Allocation:	$500,000
NCHRP Staff:	Ann M. Hartell

Stormwater treatment of bridge deck runoff has always been a difficult design challenge. Traditional methods of treating bridge deck runoff suggest treating an equivalent area of roadway offsite that discharges to the same receiving water body or piping the bridge deck stormwater to an offsite treatment location. NCHRP Report 778: *Bridge Stormwater Runoff Analysis and Treatment Options* states, "Treatment of runoff from a comparable section of highway on land is preferable to treatment of runoff from the bridge deck…". In situations where offsite mitigation is not acceptable due to local regulations surrounding the sensitivity of the receiving water body or site-specific bridge conditions (load restrictions or long bridges with very flat grades) that make piping bridge runoff to the bridge ends for offsite compensatory treatment infeasible or undesirable, stormwater designers have very few options for effective on-bridge treatment of stormwater.

There is an urgent need to develop more options for on-bridge treatment of stormwater. NCHRP 778 gives a step-by-step analysis to aid stormwater designers in selecting BMPs for treating bridge runoff. However, the only on-bridge BMP suggested in NCHRP 778 is use of Permeable Friction Course (PFC). NCHRP 767: *Measuring and Removing Dissolved Metals from Stormwater in Highly Urbanized Areas* says PFC overlays are effective in reducing Total Suspended Solids (TSS) in highway runoff but lack the effectiveness in removing dissolved constituents. Because of this PFCs will not work over rivers, streams, or lakes where there are stringent discharge requirements, or water quality or endangered species concerns. NCHRP Report 767 presents a conceptual on-bridge BMP design that includes an inlet scupper and filtration media to treat metals discharged in stormwater runoff.

Compared to collecting and conveying bridge runoff for offsite treatment, on-bridge stormwater treatment has many challenges to overcome which this research proposal would address. Depending on how efficient the on-bridge BMPs are at treating and discharging water through the bridge deck, they could add weight to the bridge design, which could increase the overall cost of the bridge. The on-bridge BMP might also require more spread width for flow to allow runoff to enter the inlet if the media isn't very efficient at treating and passing stormwater through the drain. Maintenance of on-bridge BMPs may require closing down one lane which might inconvenience the traveling public and increase safety concerns.

An on-bridge BMP must be able to remove the pollutants of concern from bridge deck runoff, have comparable weight requirements to a standard 'collect and pipe to offsite' system, be quick and easy to maintain, and have a relatively long life. A significant benefit of an on-bridge BMP would be the ability to allow treated stormwater to drop into the waterbody below without further stormwater pipes or infrastructure. This would work well for a stormwater retrofit of an existing bridge.

The objective of this research is to build on current treatment technologies that utilize media filtration to remove pollutants of concern to develop and evaluate an on-bridge stormwater treatment application. The research will identify media filter materials and different media filter material mixes that effectively remove the major classes of highway runoff pollutants dissolved metals, nutrients and petroleum hydrocarbons (including Polyaromatic Hydrocarbons–PAH) from stormwater. The materials must be usable in the on-bridge BMP configuration(s) by having the appropriate hydraulic characteristics for efficient drainage, sufficient pollutant removal capacity, and minimal maintenance and replacement frequencies. The configurations should be feasible for new bridge and bridge retrofit scenarios without requiring increases in the load bearing capacity of the bridge, and should allow for easy access and maintenance. The research will test potential filter media mixes in two phases: (1) laboratory testing will focus on pollutant removal capability and capacity and hydraulic characteristics and (2) field testing of media types that laboratory testing indicates are well suited for on-bridge BMPs. (The field testing should follow national BMP testing protocols such as the Washington State Department of Ecology's *Testing Approval Protocol Ecology* (TAPE) or the *New Jersey Corporation for Advanced Technology* (NJCAT) to show what types of pollutant removals each BMP design achieves.) The results of the laboratory and field testing will be used to select preferred media mixes and to inform one or more standardized BMP designs.

The results of the research will be accompanied by guidance on the selection, design, placement, and maintenance of the identified on-bridge stormwater treatment BMPs, the selection of the appropriate media filter materials and mixes, and the advantages and limitations of the BMPs and media filter materials. The guidance is to be aimed at designers.

Project 25-62
National Synthesis of Project-Level Programmatic Agreements for Expediting Section 106 Consultation in Project Delivery

Research Field:	Transportation Planning
Source:	AASHTO Committee on Environment and Sustainability
Allocation:	$200,000
NCHRP Staff:	Ann M. Hartell

Resolving effects of transportation projects on historic properties pursuant to Section 106 of the National Historic Preservation Act and 36 CFR 800 can be one of the most time–consuming environmental activities in project development. The streamlining value of statewide program-level Section 106 programmatic agreements (PAs) is well established and studied at the national level (NCHRP 25-25, Task 106 in preparation). What is less known is the value of project-level Section 106 PAs to expedite the delivery of individual, complex transportation projects, typically those for which environmental assessments (EAs) or environmental impact statements (EISs) are being prepared for NEPA purposes. Typically such project-level PAs transform elements of the Section 106 process into post-Section 106 commitments (e.g. deferring archaeological surveys until after a preferred alternative is selected), thus allowing Section 106 to be administratively completed earlier in project development. However, the full range of how project-level Section 106 PAs are being used by state departments of transportation (DOTs) and the Federal Highway Administration (FHWA) presently is unknown, including "extreme" examples that may push the limits of what's allowed by regulation of the Advisory Council on Historic Preservation (ACHP, 36 CFR 800). In the absence of any substantive examples of how project-level PAs are used, state DOTs, the Federal Highway Administration (FHWA), and their State Historic Preservation Officer (SHPO) partners must rely on anecdotal information and outreach to colleagues across the country for examples of project-level PAs.

The objective of this research is to compile and synthesize information on the use, content, and efficiencies provided by Section 106 project-level PAs from across the U.S. This national synthesis will focus on identifying and summarizing project-level PAs that have been executed in the last decade by state DOTs and FHWA, but may also include relevant examples of project-level PAs that have been executed by other agencies like the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), and the Federal Aviation Administration (FAA). The synthesis also will include recommendations on successful practices, especially for project-level PAs that result in expedited completion of Section 106 requirements for complex transportation projects, including those being implemented by design-builders and/or P-3 concessionaires.