Acknowledgments

This report, prepared by the National Cooperative Highway Research Program (NCHRP), acknowledges the members of NCHRP project panels, the research teams, the employees of state transportation agencies, and all other users of NCHRP research products who contributed the quantitative and qualitative evidence that forms the basis of this report. NCHRP also acknowledges the significant contributions of Lori Sundstrom, Hilary Freer, Elizabeth Sumerlin, Alphonse MacDonald, Elaine Ferrell and Deb Irvin in preparing and editing this report.

Questions about this report should be sent to Sid Mohan at smohan@nas.edu.

Version April 6, 2020
The National Academy of Sciences was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The National Academy of Engineering was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. John L. Anderson is president.

The National Academy of Medicine (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at www.national-academies.org.

The Transportation Research Board is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to provide leadership in transportation improvements and innovation through trusted, timely, impartial, and evidence-based information exchange, research, and advice regarding all modes of transportation. The Board’s varied activities annually engage about 8,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at www.TRB.org.
Systematic, well-designed, and implementable research is the most effective way to solve many problems facing state departments of transportation (DOTs) administrators and engineers. Often, highway problems are of local interest and can best be studied by state DOTs individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation results in increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In 1962, recognizing this need, the Chief Executive Officers of the American Association of State Highway and Transportation Officials (AASHTO) initiated an objective national highway research program using modern scientific techniques—the National Cooperative Highway Research Program (NCHRP). Funded by participating member states of AASHTO, NCHRP also receives critical technical support from the Federal Highway Administration (FHWA), United States Department of Transportation (USDOT).

The Transportation Research Board (TRB), part of the National Academies of Sciences, Engineering, and Medicine, was requested by AASHTO to administer the research program because of TRB’s recognized objectivity and understanding of modern research practices. TRB is uniquely suited for this purpose for many reasons:

- TRB maintains an extensive volunteer committee structure from which authorities on any highway transportation subject may be drawn;
- TRB possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry;
- TRB’s relationship to the National Academies is an insurance of objectivity; and
- TRB maintains a full-time staff of specialists in highway transportation matters and research project management to bring the findings of research directly to those in a position to use them.

The annual research program is developed on the basis of research needs identified by chief administrators and other staff of the highway and transportation departments, by committees of AASHTO, and by FHWA. Topics of the highest merit are selected by the AASHTO Special Committee on Research and Innovation (R&I), and each year R&I’s recommendations are proposed to the AASHTO Board of Directors, the National Academies, and FHWA. The scopes of research projects to address these topics are defined by NCHRP, and qualified research agencies are selected from submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Academies and TRB.
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SUMMARY

Each year, the NCHRP produces dozens of research results that offer guidance on a wide range of topics that are important to state DOTs as well as others within the highway industry. In some instances, the benefits of applying NCHRP research results are evident immediately, whereas the impact of applying other research results may not be understood or realized for several years. While there are no easy predictors or uniform measures of outcomes and impacts, the use of NCHRP research results has consistently and repeatedly generated value to practitioners, researchers, and decisionmakers from state DOTs and other transportation agencies and, consequently, to the general public.

The NCHRP Impact Report 2019, a follow up to the NCHRP Impact Report 2018, attempts to document and present that value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data and anecdotes compiled from various sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.

From 2015 through 2019, NCHRP produced nearly 300 research products. In the same period, NCHRP research products were also the focus of 109 webinars hosted by TRB, which were attended by over 36,000 attendees. Over 350 transportation practitioners provided feedback in 2018 and 2019 on where and how NCHRP research results were applied, and several anecdotes from these individuals are included in this report. In brief, all 50 states and the District of Columbia applied NCHRP research results to policy decisions or used them to introduce or change practice, as a reference source, or for new or additional research.
The National Cooperative Highway Research Program - NCHRP - has provided research-based solutions to challenges faced by state departments of transportation (DOTs) since 1962. NCHRP Research Reports, Syntheses of Highway Practice, Legal Research Digests, Innovations Deserving Exploratory Analysis (IDEA), and other research products form a comprehensive body of top-quality guidance relied on by state DOTs from coast to coast and entities around the world. Many of the dozens of research products that NCHRP produces each year offer guidance for immediate application—better ways to design, build, and maintain roads and bridges; keep motorists and highway workers safe; and manage DOTs more efficiently and effectively.

The state DOTs, working cooperatively as the member agencies of the American Association of State Highway and Transportation Officials (AASHTO) identify and prioritize their common challenges. Accordingly, the subject matter of NCHRP research products extends across the full spectrum of concerns within state DOTs and provides solutions to the many acute problems facing state DOT administrators and engineers.

Exhibit 1. Word cloud of NCHRP subject matter relevant to state DOTs
This subject matter is grouped into eight different areas:

**ADMINISTRATION**
Includes
Economics, Law, Finance, and Agency Administration.

**DESIGN**
Includes

**MAINTENANCE**
Includes
Snow and Ice Control, Equipment, and Maintenance of Way and Structures.

**MATERIALS AND CONSTRUCTION**
Includes

**SOILS AND GEOLOGY**
Includes

**TRAFFIC**
Includes

**TRANSPORTATION PLANNING**
Includes
Planning Methods & Processes, and Human & Natural Environment.

**SPECIAL PROJECTS**
Includes
All other subject matter not readily identified with the other areas.

NCHRP research products go through three distinct phases—Generating Knowledge, Disseminating Knowledge, and Producing Impacts—the rest of this document examines these phases and how the state DOTs and other stakeholders benefit from each phase.

*Exhibit 2. Key phases of transforming research into impacts*
One of the most immediate outcomes of NCHRP research is the generation of new knowledge and resources to support practice, guidance and standards, policy decisions, and further research. Research products such as final reports or other deliverables are a key means of disseminating this knowledge.

NCHRP research findings are published in several numbered series and, in the past 5 years, NCHRP has produced nearly 300 research products in support of new knowledge (Exhibit 3)—these products extend across eight broad areas of a state DOT—Administration, Design, Maintenance, Materials and Construction, Soils and Geology, Special Projects, Traffic, and Transportation Planning (Exhibit 4).

Exhibit 3. Number of NCHRP research products produced, FY 2015 to FY 2019

<table>
<thead>
<tr>
<th>Series</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-ROMs</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NCHRP Web-Only Documents</td>
<td>8</td>
<td>7</td>
<td>13</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>NCHRP Legal Research Digests</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>NCHRP Research Results Digests</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NCHRP Syntheses of Highway Practice</td>
<td>17</td>
<td>17</td>
<td>15</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>NCHRP Reports</td>
<td>20</td>
<td>19</td>
<td>28</td>
<td>31</td>
<td>25</td>
</tr>
</tbody>
</table>

Publications are distributed widely by TRB, with print runs for reports ranging from 600 to 1,000 copies. Print copies are mailed to the CEOs of state DOTs, AASHTO staff, panel members, the research contractor, and various individuals and organizations.
Exhibit 4. NCHRP research products produced from 2015 through 2019 by area
NCHRP uses a wide range of dissemination techniques to make users aware of what research is produced, how that research can benefit users and organizations when put into practice, and how that research can be implemented.

**DISSEMİNATING KNOWLEDGE THROUGH WEBINARS**

From 2015 through 2019, NCHRP research products were the focus of 109 webinars hosted by TRB, which were attended by over 36,000 attendees. Although attendees were primarily state DOT personnel, staff from educational institutions, federal organizations, and the private sector also participated.

*Exhibit 5. NCHRP webinars and average attendance, FY 2015 to FY 2019*

The average attendance of these webinars has grown in the last 5 years, as shown in Exhibit 5. In 2019, 13 webinars were held for NCHRP research results and attended by 4,838 attendees in total (with an average of 372 attendees per webinar).
ENABLING USE THROUGH DOWNLOADS, OPENBOOK SESSIONS, AND CATALOG SESSIONS

NCHRP research products have seen a significant increase in downloads, OpenBook sessions, and Catalog sessions since 2015. In 2019 alone, NCHRP research products were accessed using one of the above methods over 610,000 times.

Exhibit 6. Downloads, OpenBook sessions, and Catalog sessions of NCHRP research products from 2015 through 2019

OpenBook sessions are the number of times a report has been read online.
Catalog sessions are the number of times a potential reader has visited NAP.edu to get more information about a report.

THE WEBINAR EFFECT

Webinars are an effective tool in disseminating NCHRP research products to a broad audience. While NCHRP webinars consistently have high levels of participation, and elicit high satisfaction ratings from their respective participants, they also have a positive effect on the downloads, OpenBook sessions, and Catalog sessions of the research products. It is reasonable to assume that more users accessing NCHRP research products effectively increases the likelihood that the research will produce impacts.

An analysis of six NCHRP research products that were the focus of webinars in 2019, and which had sufficient data available, shows a clear increase in the number of downloads, OpenBook sessions, and Catalog sessions in the month before, the month of, and the month after the webinar.

Exhibit 7. Consolidated downloads, OpenBook sessions, and Catalog sessions of 6 NCHRP research products that were the focus of webinars in 2019
WHY ARE NCHRP RESEARCH PRODUCTS DOWNLOADED?

NCHRP research products bring value to practitioners, researchers, policymakers, decisionmakers, and the general public in many ways. An analysis of nearly 26,000 comments provided by downloaders of our research products in 2019 reveals that nearly three-quarters of all downloads are intended for use in practice, new or additional research, or as reference.

Exhibit 8. Intended use of NCHRP research products by all downloaders

For downloaders from DOTs, the primary intended use was for practice and as reference material, a pattern that is similar to downloaders from all public agencies (other than state DOTs). Downloaders from educational institutions primarily intended to use NCHRP research products in new or additional research.

Exhibit 9. Intended use of NCHRP research products by DOTs

Exhibit 10. Intended use of NCHRP research products by Educational Institutions
Voices from the field: Why NCHRP research products are downloaded by state DOTs

WASHINGTON
NCHRP Web Document
211: Close to Home: A Handbook for Transportation-Efficient Growth in Small Communities and Rural Areas
To add ideas to WSDOT’s Transportation Efficient Communities’ multi-agency efforts to enhance better consideration of transportation at the local land use decision-making level.

OREGON
NCHRP Report 650: Median Intersection Design for Rural High-Speed Divided Highways
To be used in a discussion with local government regarding potential safety improvements at highway/county road at grade intersections.

CALIFORNIA
NCHRP Research Report 905: Measuring the Effectiveness of Public Involvement in Transportation Planning and Project Development
To share information with a California Virtual Public Involvement team regarding ways to measure effectiveness of public involvement.

ARIZONA
To use the data to help understand trends seen in traffic crashes during the recession.

KANSAS
NCHRP Web Document 255: Improved Analysis of Two-Lane Highway Capacity and Operational Performance
As a reference to find out at what traffic volume data is needed to before considering adding capacity.

NEW YORK
NCHRP Research Report 889: Performance Measures in Snow and Ice Control Operations
As reference for travel corridor management and planning documents, specifically for the identification of snow and ice operation practices to minimize potential water quality effects.

NEW JERSEY
NCHRP Synthesis of Highway Practice 527: Resilience in Transportation Planning, Engineering, Management, Policy, and Administration
To help the DOT develop a resilience strategy that covers all aspects of our business functions, from project development to maintenance and operations.

VIRGINIA
NCHRP Research Report 900: Guide for the Analysis of Multimodal Corridor Access Management
Review for possible incorporation of concepts into the Commonwealth’s Transportation Planning Process, and to suggest for consideration design elements to be incorporated into the Commonwealth’s highway design guide.

FLORIDA
NCHRP Report 723: A Model for Identifying and Evaluating the Historic Significance of Post-World War II Housing
To help develop a consistent method to consider post World War II housing in FDOT’s cultural resources management program, for the purposes of compliance with Federal and State historic preservation law.
Voices from the field: Why NCHRP research products are downloaded by Educational Institutions

OREGON HEALTH & SCIENCE UNIVERSITY
NCHRP Report 788: Guide for Effective Tribal Crash Reporting
For interpretation and context of tribal traffic safety data as part of an NIH funded grant with Northwest tribes.

OREGON STATE UNIVERSITY
NCHRP Report 615: Evaluation of the Use and Effectiveness of Wildlife Crossings
To report to local agencies on why it is important to streamline and standardize data collection for WVCs.

NEW MEXICO STATE UNIVERSITY
NCHRP Web Document 259: Guidelines to Improve the Quality of Element-Level Bridge Inspection Data
For improving data collection in bridge inspections performed for the state DOT.

UNIVERSITY OF ILLINOIS AT CHICAGO
NCHRP Synthesis of Highway Practice 540: Leveraging Private Capital for Infrastructure Renewal
To use as part of graduate level coursework to understand the role of private public partnerships in transportation policy.

UNIVERSITY OF ILLINOIS AT CHICAGO
NCHRP Research Report 888: Development of Roundabout Crash Prediction Models and Methods
To conduct a study about the safety of roundabouts.

MICHIGAN STATE UNIVERSITY
NCHRP Report 526: Snow and Ice Control: Guidelines for Materials and Methods
As reference to develop a comprehensive snow and ice control procedure.

DARTMOUTH COLLEGE
For producing a design of a roundabout for an Advanced Roadway Design class.

UNIVERSITY OF MAINE
To help with research on transportation infrastructure resiliency and interactions with green infrastructure.

UNIVERSITY OF RHODE ISLAND
To teach a course on pedestrian/bicycle infrastructure planning, and to guide students’ terminal projects in graduate city planning program.

CLEMSON UNIVERSITY
To assist in the teaching of a course - CES14 Prestressed Concrete Design.

THE UNIVERSITY OF TEXAS AT ARLINGTON
NCHRP Report 602: Calibration and Validation of the Enhanced Integrated Climatic Model for Pavement Design
For research at undergraduate program of Transportation Engineering in Pavement Design.

TEXAS A&M UNIVERSITY
NCHRP Web Document 258: Manual on Subsurface Investigations
For teaching a class on geotechnical site investigations.

THE UNIVERSITY OF MISSISSIPPI
To assist in the teaching of a course - CES14 Prestressed Concrete Design.
Voices from the field: Why NCHRP research products are downloaded by Metropolitan Planning Organizations (MPOs)

**VANCOUVER, WA**
For transportation program asset management planning.

**MEDFORD, OR**
NCHRP Research Report 888
Development of Roundabout Crash Prediction Models and Methods
To analyze roundabouts as an intersection treatment.

**SACRAMENTO, CA**
NCHRP Research Report 875: Guidance for Evaluating the Safety Impacts of Intersection Sight Distance
To determine best methods for measuring sight distance of intersections and driveways.

**CHINO, CA**
NCHRP Report 659: Guide for the Geometric Design of Driveways
To improve standards for proposed land development projects.

**CHEYENNE, WY**
NCHRP Report 710: Practical Approaches for Involving Traditionally Underserved Populations in Transportation Decisionmaking
To research a new process to include LEP and EJ populations in an updated Public Participation Plan for the Cheyenne MPO.

**MADISON, WI**
NCHRP Research Report 924: Foreseeing the Impact of Transformational Technologies on Land Use and Transportation
To help foresee the impact of emerging technologies on land use and transportation.

**CUYAHOGA FALLS, OH**
NCHRP Synthesis of Highway Practice 507: Traffic Signal Preemption at Intersections Near Highway-Rail Grade Crossings
To learn more about preemption at grade crossings and how that might apply to crossings located in the city.

**ROCHESTER, NY**
NCHRP Research Report 897: Tools to Facilitate Implementation of Effective Metropolitan Freight Transportation Strategies
To learn more about the relationship between railyards and truck traffic.

**ELIZABETH CITY, NC**
To inform the ADA Transition Plan for the city.

**ORLANDO, FL**
NCHRP Report 729: Automated Enforcement for Speeding and Red Light Running
To support efforts with red light camera program, and in defending the program with the Florida Legislature.

**DEPORT, TX**
NCHRP Synthesis of Highway Practice 414: Effective Delivery of Small-Scale Federal-Aid Projects
For information to better understand how to help a rural community.
NCHRP RESEARCH PRODUCTS INFORM RESEARCH THAT BENEFITS STATE DOTS

Each year, the AASHTO Research Advisory Committee (RAC) asks states to identify and document recently completed “high value” research (HVR) projects—innovative projects that impact transportation agencies’ practices and policies and that benefit the traveling public. Compiled into Research Impacts: Better – Faster – Cheaper, the resulting document is a great resource for state DOTs, serving as a quick reference to HVR projects and helping to eliminate or reduce duplication of research.

In 2019, NCHRP undertook a scan to determine the extent to which NCHRP research products inform these HVR projects. For the years 2014 through 2019, 31% of all HVR projects referenced at least one NCHRP research product, with 25 HVR projects referencing five or more NCHRP research products. Covering 43 states and 465 individual NCHRP research products, 564 references were noted, particularly prominent in the research areas of Pavements and Safety, indicating a strong relationship between research done at NCHRP and the research done at the states.

Exhibit 11. NCHRP research products in High Value Research, 2014 through 2019

From 2014 through 2019, High Value Research projects from 43 states referenced at least 1 NCHRP research product.

- 25 HVR projects referenced 5 or more NCHRP research products.
- 248 HVR projects referenced NCHRP research products 564 times.
- 465 individual NCHRP research products were referenced.

NCHRP research products on Pavements and Safety were the most frequently referenced products (30% of all references).
NCHRP RESEARCH PRODUCTS HAVE RELEVANCE TO STATE DOT PROBLEMS AND CHALLENGES

AASHTO’s 2020 report, “The Benefits of Transportation: The solutions State DOTs bring to people and their communities,” highlights several transportation projects that addressed significant transportation needs and the benefits those projects provided. Several of those projects are listed below, along with NCHRP research products that are relevant to the problems and challenges addressed by these projects. Full descriptions of the projects can be accessed at https://benefits.transportation.org/wp-content/uploads/2020/02/AASHTO_Benefits_of_Transportation_022820.pdf.

The Alaskan Way Viaduct/Tunnel Project

The Problem/Challenge: Replacing a nearly 70-year-old elevated highway with a single 2-mile-long double-decker tunnel designed to withstand strong earthquakes.


Focuses on inventory criteria used by highway tunnel owners; highway tunnel design and construction standards practiced by state DOTs and other tunnel owners; maintenance and inspection practices; operations, as related to emergency response capability; and specialized tunnel technologies.

NCHRP Research Topic Highlights on Roadway Tunnels

Summarizes the results of several research projects that have framed the problems and mitigation strategies associated with tunnels. Included are summaries of tunnel inspection, rehabilitation, and preservation; tunnel design; and tunnel safety and security.

The Georgia PATH 400 Trail

The Problem/Challenge: How to create more active transportation options for pedestrians and bicyclists in and around metropolitan Atlanta, using existing infrastructure where possible.

NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook

Presents a tool and guidance that may be used to help prioritize improvements to pedestrian and bicycle facilities, either separately or together as part of a “complete streets” evaluation approach.
Eller Drive/Intermodal Container Transfer Facility Overpass

The Problem/Challenge: Overhauling a roadway interchange just outside the main entrance to Port Everglades in Fort Lauderdale so it could not only handle more traffic volume, but to do so in a way that did not create congestion, interference between road/railroad freight movements, or harm to the environment.

NCHRP Report 687: Guidelines for Ramp and Interchange Spacing
Designed to help aid the decision-making process when an agency is considering new ramps or interchanges on existing facilities or modifying ramps and interchanges of existing facilities or when planning and designing new highway and interchange facilities.

NCHRP Web-Only Document 227: Design of Interchange Loop Ramps and Pavement/Shoulder Cross-Slope Breaks
Presents design guidance for interchange loop ramps based on observational field studies and safety analyses and includes suggestions for the next edition of *A Policy on Geometric Design of Highways and Streets* published by AASHTO.

The Utah Smart Transit Signal Priority Project

The Problem/Challenge: Traffic congestion affected the reliability of transit bus service along State Route 68 cutting through Salt Lake City.

Covers fundamentals and advanced concepts related to signal timing and addresses ways to develop a signal timing program based on the operating environment, users, user priorities by movement, and local operational objectives.

Wrong Way Driver Detection System

The Problem/Challenge: Combatting the problem of wrong-way driving after an increase in deadly crashes in 2016 and devising a system to alert law enforcement faster to locate and intercept wrong-way drivers.

NCHRP Research Report 881: Traffic Control Devices and Measures for Deterring Wrong-Way Movements
Provides an analysis of factors associated with wrong-way movements on unsignalized divided highways and freeways. The divided highway analysis focuses on design, signage, and roadway markings, while the freeway analysis emphasizes the effectiveness of signage with flashing lights.

The Median Guard Cable Project

The Problem/Challenge: Installing median cable barriers to reduce crossover crashes in Missouri.

NCHRP Report 711: Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems
Provides guidance to highway agencies on the selection, use, and maintenance of cable barrier systems to reduce serious injuries and fatalities as well as operational costs.

NCHRP Synthesis 493: Practices for High-Tension Cable Barriers
Reports on the current state of the practice for high-tension cable barriers (HTCB) used in the medians of access-controlled roadways in the United States. Information on high-tension cable barrier systems related to state agency specifications, special provisions, design standards, and installation and maintenance concerns was collected.
The I-84 Waterbury Widening Project

The Problem/Challenge: Adding highway capacity while minimizing traffic disruptions and protecting the environment.

NCHRP Web-Only Document 255: Improved Analysis of Two-Lane Highway Capacity and Operational Performance

Supplements the sixth edition of the *Highway Capacity Manual (HCM)* and introduces features to improve the ease of use of the methodology in the HCM.

The Route 72 Manahawkin Bay Bridges Project

The Problem/Challenge: Rehabilitating key traffic causeways while protecting the environment

NCHRP Research Report 895: Simplified Full-Depth Precast Concrete Deck Panel Systems

Describes new connections between full-depth precast concrete deck panels and beams. These connections are simplified with regard to constructability, inspection during construction, reducing the impact of construction on traffic, and future deck replacement.

NCHRP Synthesis 327: Cost-Effective Practices for Off-System and Local Interest Bridges

Examines off-system bridge design, construction, maintenance, financing, rehabilitation, and replacement.

NCHRP RESEARCH PRODUCTS CONTRIBUTE TO FORMULATING NATIONAL GUIDANCE AND STANDARDS

AASHTO, FHWA, and TRB all rely on NCHRP research as the basis for other publications widely used by transportation agencies. The publications serve as industry standards and are often the result of continuous cycles of research conducted under the NCHRP program.

AASHTO published its *Guide Specifications for the Design of Concrete Bridge Beams Prestressed with Carbon Fiber-Reinforced Polymer Systems, 1st Edition*, which addresses the design of prestressed concrete beams constructed of normal weight concrete and those prestressed via carbon fiber reinforced polymer (CFRP) systems.

The guide is based on *NCHRP Research Report 907 – Design of Concrete Bridge Beams Prestressed with CFRP Systems*, published in 2019.

NCHRP RESEARCH PRODUCTS APPLY TO ALL AREAS OF A TRANSPORTATION ORGANIZATION

In 2017 and 2019, NCHRP surveyed practitioners, researchers, and decisionmakers within state DOTs and the larger transportation community to determine how use of NCHRP research products benefits various areas of a transportation organization. Forty-eight publications from the year 2012 and 66 publications from the year 2015 were used in the surveys, and over 900 respondents provided valuable insights into how those publications were used and the benefits the publications produced within the respective organizations. Exhibit 12 shows the top 10 uses of NCHRP research products, as determined by the percentage of respondents who indicated that use.
Exhibit 12. Top 10 Uses of NCHRP research products (n= 904 respondents)

<table>
<thead>
<tr>
<th>Use of NCHRP Research Products</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the publication as a guidance document</td>
<td></td>
</tr>
<tr>
<td>Validating current practice</td>
<td></td>
</tr>
<tr>
<td>Changes to standards, specifications, or guidance documents</td>
<td></td>
</tr>
<tr>
<td>Management decisions</td>
<td></td>
</tr>
<tr>
<td>Getting ideas for new/ effective practices used by other DOTs</td>
<td></td>
</tr>
<tr>
<td>Policy changes</td>
<td></td>
</tr>
<tr>
<td>Design or layout design or layout of roads/facilities</td>
<td></td>
</tr>
<tr>
<td>Implementing new technology</td>
<td></td>
</tr>
<tr>
<td>Workforce development/Workforce training</td>
<td></td>
</tr>
<tr>
<td>Implementing a new program</td>
<td></td>
</tr>
</tbody>
</table>

Exhibit 13 shows the top 10 benefits provided by the use of NCHRP research products as determined by the percentage of respondents who indicated that benefit.

Exhibit 13. Top 10 benefits provided by the use of NCHRP research products (n= 904 respondents)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved safety</td>
<td></td>
</tr>
<tr>
<td>Long lasting facilities/Improved durability and quality of the highway</td>
<td></td>
</tr>
<tr>
<td>Improved operational efficiency</td>
<td></td>
</tr>
<tr>
<td>Improved system reliability</td>
<td></td>
</tr>
<tr>
<td>Improved workforce skills/training</td>
<td></td>
</tr>
<tr>
<td>Improved planning/preparedness</td>
<td></td>
</tr>
<tr>
<td>Improved communications</td>
<td></td>
</tr>
<tr>
<td>Improved compliance to regulations</td>
<td></td>
</tr>
<tr>
<td>Reduced operating costs</td>
<td></td>
</tr>
<tr>
<td>Reduced environmental impact</td>
<td></td>
</tr>
</tbody>
</table>
VOICES FROM THE FIELD

NCHRP conducted a user survey of our sponsors and volunteers in late 2018 through early 2019 to determine what NCHRP research products were used, how they were used, and what benefits they produced.

Covering 66 NCHRP publications published in the year 2015 (see Appendix A), including Research Reports, Syntheses, Legal Research Digests, Research Results Digests, and Web-Only Documents, the survey was distributed to two groups of users:

1. Publication participants: Members of the project panels, principal investigators and their teams, and NCHRP project officers who were involved in developing the publication;
2. RAC members: Members of the AASHTO Research Advisory Committee (RAC). RAC members were encouraged to take the survey themselves and to distribute the survey to as many members of their respective organizations as possible.

631 surveys were completed by 358 distinct respondents, and the following are what a selection of the respondents said on how they used those research products and the benefits that the products provided.

NCHRP Legal Research Digest 65: Liability Aspects of Pedestrian Facilities
I am a lawyer representing local governments in road liability cases, many of them involving claims against public works and transportation departments for pedestrian injuries and fatalities. This overview of pedestrian liability is useful in representing local governments on these cases and in providing advice about how the agencies can reduce their liability and improve their pedestrian features.

Michael E. Tardif
Friemund, Jackson and Tardif, PLLC

NCHRP Legal Research Digest 66: Due Diligence for Insurance Coverage in Transportation Construction Contracts
The research has been utilized within past year to change the language in contract documents regarding indemnification and insurance coverage for the owner.

Jay L. Smith
Missouri DOT

NCHRP Legal Research Digest 67: Permissible Changes in Scope of Work for Construction Projects
This digest was used to advise construction staff concerning contractor claims.

Anonymous

NCHRP Legal Research Digest 68: Liability of Design-Builders for Design, Construction, and Acquisition Claims
This digest was used to develop the agency’s alternative contracting procedures for design-build and CMCG project delivery.

Anonymous

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 1: Scenario Planning for Freight Transportation Infrastructure Investment
It has been used in several engagements with different state DOTs. Arizona, Minnesota, Florida, Washington, and California to name a few.

Christopher Caplice
Massachusetts Institute of Technology

Document has been used as guidance for several projects and helped integrate risk from climate change and extreme weather into the KYTC TAMP.

Scott Schurman
Kentucky Transportation Cabinet

We raised the elevation of SR 4 to avoid future flooding. The cost benefit will be future cost avoidance.

Randell H Iwasaki
Contra Costa Transportation Authority
NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies

Report 750 is providing background for developing climate adaptation plans for National Forests.

Joseph A. Burns
USDA Forest Service

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies

Undertook a survey of staff at many levels to assess where we were as an agency. Spurred discussion and reflection for the sustainability team and high level managers on sustainability.

Lynn Weiskopf
New York State DOT

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies

Consulted during development of sustainability strategies.

Gary McVoy
Parsons Brinckerhoff

NCHRP Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection

Better-informed planning and maintenance.

David Patton
Arlington County

NCHRP Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection

Continue to reference it to all those asking us for guidance on non-motorized counts. Have been referring to it as a resources for our proposed non-motorized pilot count effort for our Pedestrian Safety Action Plan & Empire States Trails Programs.

James M. “Jim” Ercolano
New York State DOT

NCHRP Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection

Papers I’ve reviewed for the TRB Annual Meeting the last couple of years related to pedestrian and bicycle counting have referenced the report as a key resource/guidance document.

Anonymous

NCHRP Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection

Reference point for initiating data collection programs and/or strategies. Established awareness for pedestrian and bicycle volume performance measures.

Tony Hull
Toole Design Group

NCHRP Report 799: Management Guide to Intellectual Property for State Departments of Transportation

I know of a recent training at IL DOT. They were going to use the guide to inform some of their new initiatives regarding employee designs and inventions.

Joe Bradley

NCHRP Report 800: Successful Practices in GIS-Based Asset Management

In conversations with numerous State DOTs, several have pointed to this study as both a way in which their management was made more aware of the use of GIS in asset management, and to reinforce or validate their use of GIS in their asset management practices. Both the implementation guide (and associated web based case studies) and the Executive Guide were referenced, and found to be very valuable as a way to reinforce their view of the value of GIS in the asset management process, and to encourage further development of better asset management practices. In one case that I am aware of, it became an integral part of that agency’s asset management strategy, and their subsequent procurement and implementation strategy.

Terrence C. Bills
ESRI

NCHRP Report 800: Successful Practices in GIS-Based Asset Management

Helped build a data framework around the inventory and knowledge of assets and their life span.

Martin Kidner
Wyoming DOT

NCHRP Report 801: Proposed Practice for Alternative Bidding of Highway Drainage Systems

I have been teaching the tool at the University to
my undergraduate and graduate level construction management course students. Many of the graduate students work for consulting companies (and are doing their Masters degrees part time) so this will help to disseminate the information to those who support DOTs by doing designs for them.

Anonymous

NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook

Provides a rational, transparent process for prioritizing pedestrian and bicycle improvements on existing roads. We have used the ActiveTrans Priority Tool to prioritize pedestrian and bicycle projects for approximately 20 active transportation plans.

James B. Elliott
Toole Design Group


Publication of this guide assisted Caltrans in meeting environmental and carbon reduction goals set by the Governor.

Anonymous


Colorado DOT has used a modified version of the tool that was developed in our project to support their investment scenario planning. Here at Iowa DOT, Report 806 has influenced some of our thinking in developing our programming process.

Matthew S. Haubrich
Iowa DOT

NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction

This report serves as a guide for different types of project delivery at TxDOT.

Darren G. Hazlett
Texas DOT


Provided additional research that used to validate and enhance our current safety planning and implementation practices.

J. Thomas Bruff
Southeast Michigan Council of Governments


I taught several classes to Maricopa County, AZ agencies from the STMv2. While it is focused on beginners, I think almost anyone can learn something

Doug Gettman
Kimley-Horn and Associates, Inc.


NCHRP Report 812 has been adopted as an official reference, by the California Board of Professional Engineers, Land Surveyors, and Geologists.

Anonymous


The manual was incorporated into NHI course #133122. The course was piloted in Ohio in March of 2018.

Eddie Curtis
Federal Highway Administration

NCHRP Report 813: A Guide to Agency-Wide Knowledge Management for State Departments of Transportation

I believe that many agencies are using this guide. One specific example: Michigan DOT indicated that they are using the KM Guide to implement knowledge management as part of their workforce initiative. One state circulated a handout at the AASHTO KM Committee Meeting containing portions of the guide that they use internally.

Frances D. Harrison
Spy Pond Partners
**NCHRP Report 813: A Guide to Agency-Wide Knowledge Management for State Departments of Transportation**

Trying to implement KM and the guide is very useful whatever your level of practice.

Cynthia Smith  
Mississippi DOT


AASHTO has picked it up and is championing it with the states. There have been additional workshops as well. I do not know the details.

Ed Christopher  
Federal Highway Administration (Retired)


Led to data quality improvements which support many of the above. FHWA has funded workshops based on this guide. The AASHTO data management and analytics committee (and prior to this, the data subcommittee of SCOP) views application of the assessment tools in the guide as one of their emphasis areas. I have applied the agency-wide data management assessment in my consulting work with Oregon DOT and most recently, Caltrans. The Oregon DOT assessment provided one of the foundational elements for their strategic data business plan.

Frances D. Harrison  
Spy Pond Partners

**NCHRP Research Results Digest 393: Selected Indirect Benefits of State Investment in Public Transportation**

The research results have been used in the discussions of the relationship between public transit and social service partnerships.

Anonymous

**NCHRP Research Results Digest 397: Independent Cost Estimates for Design and Construction of Transit Facilities in Rural and Small Urban Areas**

Provided much needed guidance on developing independent cost estimates for transit facilities for programming and planning purposes. Also used to assist our grantees in developing preliminary budgets for proposed transit facilities.

David T. Spacek

**NCHRP Synthesis 467: Visualization of Geotechnical Data for Hazard Mitigation and Disaster Response**

Slope Stability Modeling with Lidar & SfM Hyper-detailed surface modeling and change detection methods have been developed to understand slope stability along critical Alaska highways at Glitter Gulch and Long Lake.

Keith Cunningham  
University of Alaska at Fairbanks

**NCHRP Synthesis 471: Practices for Developing Transparent Best Value Selection Procedures**

Better value in selecting design-builders/contractors.

Raymond S. Tritt  
California DOT

**NCHRP Synthesis 474: Service Life of Culverts**

Information is used by each District in evaluating current culverts and developing planning documents.

Steve Spoor  
Idaho Transportation Department

**NCHRP Synthesis 475: Fiber Additives in Asphalt Mixtures**

I have received requests for information on this from across the world, including US states, Chile, South Africa, Australia and Poland.

Anonymous

**NCHRP Synthesis 477: Methods and Practices on Reduction and Elimination of Asphalt Mix Segregation**

Dispute resolution guidance; application by Expert Witness for multiple state agencies.

Anonymous
NCHRP Synthesis 477: Methods and Practices on Reduction and Elimination of Asphalt Mix Segregation
Review of practices, specifications and use of newer technology was done by FLH materials engineers within the last 2-years.

Brad Neitzke
Federal Highway Administration

NCHRP Synthesis 478: Design and Load Testing of Large Diameter Open-Ended Driven Piles
As foundation designers, we’ve used the general information in the design of bridge projects across North America, including design-build projects.

Dan Brown
Dan A. Brown and Associates, PC

NCHRP Synthesis 478: Design and Load Testing of Large Diameter Open-Ended Driven Piles
This research lead to another research, INDOT SPR 4165 Verify Foundation design. I am part of the current committee representing the owner.

Anonymous

NCHRP Synthesis 478: Design and Load Testing of Large Diameter Open-Ended Driven Piles
Used in the FHWA as a good reference for a FHWA research study on large size diameter piles.

Naser Abu-Hejleh
Federal Highway Administration

NCHRP Synthesis 480: Economic and Development Implications of Transportation Disinvestment
Additional research on right-sizing sprang from this synthesis. It is much more in-depth and broader.

Ben T. Orsbon
South Dakota DOT

NCHRP Synthesis 481: Current Practices to Set and Monitor DBE Goals on Design-Build Projects and Other Alternative Project Delivery Methods
While we have not had DBE on a Design-build project yet, it is coming soon. The Idaho Transportation Department wants to make sure that we are following best practices when trying to integrate DBE goals into a design build project because these are typically lump sum projects and goals are difficult to establish without the specific work items.

Dana Dietz
Idaho Transportation Department

The publication helped with understanding what data was available and could be used, and ensuring we were using the best data.

Anonymous

The research has been used in the development of regional conformity determinations in Virginia in 2018. It helped to ensure accuracy and compliance with federal requirements.

James P. “Jim” Ponticello
Virginia DOT

WOD 210 has been a helpful guide for staff here using the MOVES model, and also a basis for follow-on research under NCHRP 08-101. The TRB AQ Committee has used it to revise research needs lists (trim completed research, add new needs).

Chris Porter
Cambridge Systematics, Inc.

NCHRP Web Only Document 213: Potential MUTCD Criteria for Selecting the Type of Control for Unsignalized Intersections
A paper was submitted for the 2019 TRB Annual Meeting that describes the project and its implementation efforts. The paper title is “Developing and Implementing MUTCD Criteria for Selecting Traffic Control for Unsignalized Intersections.” As identified in the paper, the only means of implementing the recommendations are by making changes to the Manual on Uniform Traffic Control Devices. This document is a federal regulation and can be changed only through the rulemaking process so changes are slow in coming. An intermediate implementation step is that the National Committee on Uniform Traffic Control Devices took the recommendations of the research and developed
their recommendations for changes to the MUTCD that are based on the research results. The NCUTCD Council approved the recommendations in January 2016. The FHWA has indicated that there is a chance that rulemaking for proposed MUTCD could start in 2019. It will likely be mid- to late-2019 before there will be any information on whether the research recommendations become actual proposed changes to the MUTCD, or whether actual rulemaking will take place at all.

Gene Hawkins
Texas A&M Transportation Institute

NCHRP Web Only Document 213: Potential MUTCD Criteria for Selecting the Type of Control for Unsignalized Intersections

The National Committee on Uniform Traffic Control Devices has made a recommendation (to the FHWA) to make changes to the Manual on Uniform Traffic Control Devices. Web Only Document 213 was the basis for the recommendation.

Jonathan Upchurch

NCHRP Web Only Document 216: Emergency Exit Signs and Marking Systems for Highway Tunnels

I received an email from Washington State Department of Transportation, indicating that exit signs similar to those recommended in the guidelines had been implemented in the SR 99 Tunnel in Seattle, and asking if the project report with the study findings was available.

Laura Higgins
Texas A&M Transportation Institute

NCHRP Web Only Document 216: Emergency Exit Signs and Marking Systems for Highway Tunnels

The running man signs have been used in 3 major Pittsburgh tunnels (Squirrel Hill, Liberty and Ft. Pitt). We will also be adding voice commands over a loud speaker in Liberty.

Louis J. Ruzzi
Pennsylvania DOT

NCHRP Web Only Document 216: Emergency Exit Signs and Marking Systems for Highway Tunnels

We have been applying the results as part of our design work for clients throughout the US.

Paul Lutkevich
Parsons Brinckerhoff

Bias Statements for AASHTO Standard Methods of Test TP 98 and TP 99

FHWA used the information in the development of a new noise measurement handbook. States are using the standards to measure pavement noise and identify quieter pavements.

Adam T. Alexander
Gannett Fleming

NCHRP Web Only Document 217: Precision and Bias Statements for AASHTO Standard Methods of Test TP 98 and TP 99

Used for quieter pavement research at Washington State DOT.

Timothy V. Sexton
Minnesota DOT
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APPENDIX A

LIST OF 2015 NCHRP PUBLICATIONS

Bituminous Materials
Report 807: Properties of Foamed Asphalt for Warm Mix Asphalt Applications
Report 815: Short-Term Laboratory Conditioning of Asphalt Mixtures

Forecasting
Report 798: The Role of Planning in a 21st Century State Department of Transportation—Supporting Strategic Decision-making
Report 800: Successful Practices in GIS-Based Asset Management

General Materials

Impact Analysis
Report 809: Environmental Performance Measures for State Departments of Transportation
Web Only Document 211: Close To Home: A Handbook for Transportation-Efficient Growth in Small Communities and Rural Areas

**Maintenance of Way and Structures**
Research Results Digest 396: Approach to Level-of-Service Target Setting for Highway Assets

**Operations and Control**
Web Only Document 213: Potential MUTCD Criteria for Selecting the Type of Control for Unsignalized Intersections

**Pavements**
Report 810: Consideration of Preservation in Pavement Design and Analysis Procedures

**Special Projects**
Legal Research Digest 64: Legal Aspect of Environmental Permitting in the Emergency Response Environment
Legal Research Digest 65: Liability Aspects of Pedestrian Facilities
Legal Research Digest 66: Due Diligence for Insurance Coverage in Transportation Construction Contracts
Legal Research Digest 67: Permissible Changes in Scope of Work for Construction Projects
Legal Research Digest 68: Liability of Design-Builders for Design, Construction, and Acquisition Claims
Report 750: Strategic Issues Facing Transportation, Volume 1: Scenario Planning for Freight Transportation Infrastructure Investment
Report 750: Strategic Issues Facing Transportation, Volume 3: Expediting Future Technologies for Enhancing Transportation System Performance
Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies
Report 750: Strategic Issues Facing Transportation, Volume 5: Preparing State Transportation Agencies for an Uncertain Energy Future
Report 799: Management Guide to Intellectual Property for State Departments of Transportation
Report 813: A Guide to Agency-Wide Knowledge Management for State Departments of Transportation
Research Results Digest 392: Continuing Project to Synthesize Information on Highway Problems
Research Results Digest 393: Selected Indirect Benefits of State Investment in Public Transportation
Research Results Digest 394: Estimating the Long-Term Impacts of MAP-21 on the Nation’s Local Rural Transit Bus Infrastructure
Research Results Digest 395: Claims Related to Stormwater Discharge
Research Results Digest 397: Independent Cost Estimates for Design and Construction of Transit Facilities in Rural and Small Urban Areas

Synthesis 466: Alliance Contracting—Evolving Alternative Project Delivery

Synthesis 467: Visualization of Geotechnical Data for Hazard Mitigation and Disaster Response

Synthesis 468: Interactive Training for All-Hazards Emergency Planning, Preparation, and Response for Maintenance and Operations Field Personnel

Synthesis 469: Impacts of Energy Developments on U.S. Roads and Bridges

Synthesis 470: Maintenance Quality Assurance Field Inspection Practices

Synthesis 471: Practices for Developing Transparent Best Value Selection Procedures

Synthesis 472: FEMA and FHWA Emergency Relief Funds Reimbursements to State Departments of Transportation

Synthesis 473: Indefinite Delivery/Indefinite Quantity Contracting Practices

Synthesis 474: Service Life of Culverts

Synthesis 475: Fiber Additives in Asphalt Mixtures

Synthesis 476: Practices for Permitting Superheavy Load Movements on Highway Pavements

Synthesis 477: Methods and Practices on Reduction and Elimination of Asphalt Mix Segregation

Synthesis 478: Design and Load Testing of Large Diameter Open-Ended Driven Piles

Synthesis 479: Forecasting Transportation Revenue Sources: Survey of State Practices

Synthesis 480: Economic and Development Implications of Transportation Disinvestment

Synthesis 481: Current Practices to Set and Monitor DBE Goals on Design-Build Projects and Other Alternative Project Delivery Methods

Synthesis 482: Work Zone Speed Management

Web Only Document 216: Emergency Exit Signs and Marking Systems for Highway Tunnels

Specifications, Procedures and Practices

Report 801: Proposed Practice for Alternative Bidding of Highway Drainage Systems

Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction

Research Results Digest 391: Modulus-Based Construction Specification for Compaction of Earthwork and Unbound Aggregate

Web Only Document 212: Alternative Quality Management Systems for Highway Construction

Web Only Document 217: Precision and Bias Statements for AASHTO Standard Methods of Test TP 98 and TP 99

Traffic Planning

Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection

Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook

Web-Only Document 205: Methods and Technologies for Pedestrian and Bicycle Volume Data Collection
Vehicle Barrier Systems

Report 794: Median Cross-Section Design for Rural Divided Highways
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