National Cooperative Highway Research Program

Fiscal Year 2023 **May 2022**

Announcement of NCHRP Synthesis Topics

The National Cooperative Highway Research Program (NCHRP) is supported on a continuing basis by funds from participating member states of the American Association of State Highway and Transportation Officials (AASHTO), with the full 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.

NCHRP syntheses are state-of-the-practice reports prepared under contract by outside individuals or firms. These reports seek to document current practice within state departments of transportation (DOTs), to identify ongoing and recently completed research, to learn what problems remain largely unsolved, and to organize and document the useful information acquired. They do not undertake new research, nor do they contain policy recommendations. Syntheses document and describe current practice in a given area and highlight practices that are viewed as successful by many of the DOTs surveyed in developing the synthesis or that are characterized as such in the literature reviewed by the synthesis author.

Nominations of others and self-nominations for panel members should be submitted by June 30, 2022, through the MyTRB portal at this link: https://volunteer.mytrb.org/Panel/AvailableProjects

You will be asked to log in to MyTRB. If you do not already have an account, you will be asked to quickly create one using your email and a password. To ensure proper consideration of nominations, please provide all of the information requested. A current resume is necessary to determine relevant knowledge and experience.

Before nominating yourself to serve as a panel member, please review our Conflict of Interest policy at https://www.trb.org/NCHRP/COI-CRP.aspx . Please be advised that if you are selected to serve on a panel and we receive Letters of Interest for that project that presents a conflict of interest for you, we will reject the Letter of Interest. This also applies to liaisons.

Communication to determine an individual's interest and availability in serving will be made from this office only after we have matched available expertise (e.g., knowledge and experience as presented in the resume) with that required by the nature of the project.

NCHRP is also looking for consultants to perform as synthesis principal investigators. To formally express interest in authoring a topic, a two-page letter of interest and professional resume or CV are required. The fixed-price fee is $55,000. Please submit letters of interest to the Letters of Interest Submission Portal.

The letter of interest and professional resume or CV should convey a concise idea of the principal investigator's knowledge of the topic and related work and experience in the subject area. **The deadline for letters of interest is August 26, 2022.** Virtual panel meetings are anticipated during September and October 2022. During the meetings, scopes of work will be finalized and principal investigators chosen.

National Cooperative Highway Research Program Synthesis Topics in the Fiscal Year 2023 Program
(Titles are HYPERLINKS)

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Synthesis Topic 54-01
Practices to Identify and Mitigate PFAS Impacts on Highway Construction Projects and Maintenance Operations

NCHRP Staff: Jo Allen Gause

Per- and polyfluoroalkyl substances (PFAS) are a group of manmade fluorinated chemicals that have been manufactured and used in a variety of industries since the 1940s. They are persistent in the environment and the human body, and there is evidence that exposure to PFAS can lead to adverse health effects and ecological risks. There are no federal maximum contaminant level standards for PFAS compounds. However, states have regulated various PFAS compounds at varying standards and in varying media.

Some state departments of transportation (DOTs) are navigating PFAS-related issues, at significant expense, due to situations such as: state DOT-owned legacy sites with PFAS impact; road construction and improvement through PFAS-contaminated soil and groundwater due to aerial deposition, stormwater runoff, and groundwater migration; increased assessment and analytical cost for soils to be graded, cut, or excavated; storage and disposal of spoil materials from roadway maintenance in areas with PFAS aerial deposition; PFAS impact in dewatered construction groundwater; and landfill testing requirements and restrictions leading to increased transportation and disposal costs.

A number of states directly address PFAS in their action plans with the focus on biosolids and wastewater treatment; sources that impact drinking water, air quality, landfills, and food safety; or airports where firefighting foams containing PFAS were known to have been used. With these focus areas in mind, several states have formed interagency groups to address minimizing human exposure to PFAS within their state. These groups are charged with developing PFAS management strategies, such as locating likely contaminated areas, sample collection and analysis, remediation/removal strategies, surveying inventory and improving storage practices of unused supplies of products containing PFAS, etc. However, none of the identified state action plans explicitly address the impact of PFAS contamination on state DOT construction and maintenance sites.

The objective of this synthesis is to document state DOT current practice for identifying locations of potential PFAS contamination and for mitigating the impacts of PFAS related to highway construction and maintenance operations.

Information to be gathered includes (but is not limited to):

- DOT policies, guidance, and current practice to identify locations of PFAS contamination;
- DOT policies, guidance, and current practice to mitigate PFAS impacts related to highway construction and maintenance operations;
- Tools used;
- Timing and approaches used to screen for PFAS contamination in construction sites; and
- Identification of materials used currently or in the past by state DOTs on construction sites that may contain PFAS.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Synthesis Topic 54-02
Outsourcing Stormwater Best Management Practice Inspection & Maintenance Activities

NCHRP Staff*:* Jo Allen Gause

All state departments of transportation (DOTs) are required under the federal Clean Water Act to comply with National Pollutant Discharge Elimination System (NPDES) permit requirements to routinely inspect and maintain (I&M) stormwater control measures, also traditionally known as best management practices (BMPs). Most state DOTs have hundreds or commonly thousands of stormwater BMPs located across the state that fall under I&M permit requirements. Each DOT approaches these stormwater asset management requirements differently, due in part to the absence of uniform nationwide NPDES permit requirements.

State DOT maintenance forces are often spread thin and typically focus manpower on the maintenance of pavement, bridges, and safety-related infrastructure along roadways, often leaving few human resources available to maintain stormwater conveyance and treatment infrastructure. Pollutant specific permit requirements have over time given rise to more sophisticated and highly engineered BMPs which necessitates more advanced training for state maintenance forces, thereby adding additional in-house resource burdens. As such, some DOTs are exploring the use of third-party contractors to perform BMP I&M activities required by NPDES stormwater permits, similar in concept to how many DOTs outsource roadside mowing and vegetation management activities.

The objective of this synthesis is to document state DOT current practices related to outsourcing stormwater BMP I&M compliance activities. The synthesis will focus on post-construction operations.

Information to be gathered includes (but is not limited to):

- Identification of state DOTs that partially or fully outsource BMP I&M activities and those that do not outsource these activities;
- Contractor prequalification process;
- Whether contract prequalification requirements are specified in contracts;
- Established standards for assessing the contractor's performance;
- Established remedy process for when BMPs are not maintained to the agency's standards;
- Established standards for assessing the contractor's performance;
- Level of DOT oversight during contract administration;
- Whether DOTs have performed a cost/benefit analysis for the outsourcing program; and
- How costs are established.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- NPDES program databases maintained by the TRB AKD50 Standing Committee on Hydrology, Hydraulics, and Stormwater, the AASHTO Stormwater Community of Practice, and FHWA.

Synthesis Topic 54-03
DOT Practices on Road Safety Audits

NCHRP Staff: Trey Joseph Wadsworth

A Road Safety Audit (RSA) is a proactive and formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. RSAs were introduced in the United States in 1997 following a Federal Highway Administration (FHWA)-sponsored scanning tour of Australia and New Zealand investigating safety management systems in 1996. NCHRP completed *Report 336: Road Safety Audits* in 2004. The report found that seven state departments of transportation (DOTs) were using RSAs in their safety programs. Since then, DOTs have been developing their resources, procedures, and practices for RSAs; information is scattered, and new considerations have emerged for conducting RSAs. They may include but are not limited to active transportation and micro-mobility growth.

The objective of this synthesis is to document state DOT current practices related to RSAs.

Information to be gathered includes (but is not limited to):

- Frequency, quantity, and the purpose of DOT RSAs;
- Contexts for where RSAs are conducted (rural, urban, corridors, intersections, and interchanges);
- Growth, decline, or non-use of RSAs;
- Changes in RSA processes, reporting, or focus (e.g., speed management/target speed and vulnerable road users);
- Role of RSAs in DOT highway safety programs or other implementation mechanisms;
- Supporting materials developed by DOTs such as manuals, checklists, or procedures;
- Consideration of active transportation, micro-mobility, equity, and new technologies (e.g., LED lighting's widespread adoption since 2003); and
- Research gaps related to RSAs.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Federal Highway Administration Office of Safety Programs. Road Safety Audits. https://safety.fhwa.dot.gov/rsa/.
- National Academies of Sciences, Engineering, and Medicine. 2004. *Road Safety Audits*. Washington, DC: The National Academies Press. https://doi.org/10.17226/23343.

Synthesis Topic 54-04
Mobile Devices as a Tool for Digitalized Project Documentation and Inspection

NCHRP Staff: Leslie C. Harwood

Mobile devices, including smartphones and tablets, are increasingly used as innovative tools in construction project delivery, documentation, and inspection. Advancements in camera technology combined with increased accuracy in geolocation, graphical displays, and LiDAR abilities provide a very powerful engineering/construction technology that is also widely accessible and used by most construction professionals on jobsites. A sample of mobile device applications that can be utilized by construction professionals include digitalized documents; geolocation of data; augmented reality with engineering precession; capturing 3D images of as-built conditions through built-in LiDAR cameras; access to inspection history; and, improved communications.

The objective of this synthesis is to document state DOT current practices for using mobile devices to support digitized project documentation and inspection.

Information to be gathered includes (but is not limited to):

- Areas within DOTs using mobile devices for construction documentation and inspection (e.g., construction, maintenance, planning);
- Inspection functions (e.g., submission of inspection reports, capturing of as-built conditions, and retrieval of inspection documentation) supported through mobile devices;
- Other uses and applications (e.g., building information modeling);
- Specific mobile device technologies (e.g., LiDAR, augmented reality, cellular cameras, and digital display of 3D graphical models) being utilized by inspectors;
- Cost implications for using mobile devices (e.g., capital replacement, operational costs, costs of protective cases);
- Policies and practices regarding the use of personal and/or DOT-issued mobile devices; and
- Barriers and challenges (e.g., connectivity) associated with using mobile devices for construction and inspection.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Obaidat, M. (2020). "Cellular-Phone-Based System for Transportation Engineering Applications". Elsevier's *Alexandria Engineering Journal.* 59(3), pp. 1197-1204.
- Pew Research Center. https://www.pewresearch.org/internet/fact-sheet/mobile/. Last accessed February 16, 2022.
- Steenbruggen, J., Tranos, E., and Nijkamp, P. (2015). "Data from Mobile Phone Operators: A Tool for Smarter Cities". Elsevier's *Telecommunications Policy*. 39(3-4), pp. 335-346.

- Ordaz, M., and Doyle, J.D. (2021). "Quantifying Extreme Event-induced Pavement Roughness via Smart Phone Apps". ASCE *Geo-Extreme 2021*. November 7-10, 2021. Savannah, Georgia.
- Li, N., and Becerik-Gerber, B. (2012). "Assessment of a Smart Phone-Based Indoor Localization Solution for Improving Context Awareness in the Construction Industry". ASCE International Conference on Computing in Civil Engineering. June 17-20, 2012. Clearwater Beach, Florida.

Synthesis Topic 54-05
Practices for Statewide and MPO Coordination

NCHRP Staff: Trey Joseph Wadsworth

Federal transportation legislation requires formalized coordination between state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) in transportation planning and programming processes. It is unclear how agencies have adapted to and implemented the evolving requirements following recent changes to legislation. While communication often happens through meetings and correspondence, effective coordination requires practical strategies to resolve key differences.

The newest federal surface transportation funding reauthorization bill is the Infrastructure Investment and Jobs Act of 2021 (IIJA), recently signed into law by President Biden on November 15, 2021, and now referred to as the Bipartisan Infrastructure Bill (BIL). The BIL replaced the previous long-term highway fund reauthorization act, the *Fixing America's Surface Transportation Act* (FAST) of 2015. Both Acts continued the metropolitan transportation planning program where federal funding for highway and transit projects continues to flow through state DOTs, with MPOs having an increasingly important role in urbanized area transportation decision-making.

The objective of this synthesis is to document state DOT current practices related to coordinating planning and programming requirements with MPOs, as well as any common challenges with fulfilling regulatory requirements.

Information to be gathered includes (but is not limited to):

- Processes used to set priorities (e.g., mobility, accessibility, cost, safety, or environmental) and how to balance priorities between levels of government;
- Different models of cooperation for how DOTs approach differences in priorities, financial forecasts, and performance measures, and achieve consistency in data and assumptions for travel demand forecast models and air quality conformity;
- Project prioritization and process coordination (including project selection criteria);
- Coordination and implementation of Congestion Management Plans; and
- Capacity building needs (e.g., a technical resource center for small MPOs or municipalities).

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- American Association of State Highway and Transportation Officials. 2021. *Memorandums of Understanding (MOUs) with Metropolitan Planning Organizations (MPOs)*. Washington, DC: Special Committee on Research and Innovation. https://research.transportation.org/rac-survey-detail/?survey_id=497#.

- *Coordination Between State Transportation Agencies in Multi-State Metropolitan Planning Areas: A Survey of State Practice* Transportation Research Synthesis, Issue TRS 1502, 2015, 194p http://www.dot.state.mn.us/research/TRS/2015/TRS1502.pdf.
- National Academies of Sciences, Engineering, and Medicine. 2022. *Metropolitan Planning Organizations: Strategies for Future Success*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26555.
- National Academies of Sciences, Engineering, and Medicine. 2021. *Collaborative Practices for Performance-Based Asset Management Between State DOTs and MPOs*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26337.
- National Academies of Sciences, Engineering, and Medicine. 2019. *Management and Use of Data for Transportation Performance Management: Guide for Practitioners*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25462.
- NCHRP Planning Snapshot 2: Innovations in Long-Range Planning https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(120)_Snapshot2014-002LongRangePlanning.pdf.
- NCHRP Planning Snapshot 8: Integrated Transportation Planning (2016). https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(120)_Snapshot2016-008IntegratedPlanning.pdf.

Synthesis Topic 54-06
Ancillary Asset Data Stewardship and Data Models

NCHRP Staff: Leslie C. Harwood

Some states have started tracking some ancillary assets in their Transportation Asset Management Plans (TAMPs), but most states have not even though they inventory and manage many of these ancillary assets. There is a growing interest to create and maintain *dynamic* inventories of ancillary assets that provide centralized access to *accurate* and *current* ancillary asset information. Maintaining a *dynamic* inventory of *current* asset information is a cross-functional initiative. There are challenges for funding such cross-functional initiatives (e.g., statewide mobile LIDAR data collection and asset extraction) and also for stewarding the data. The data owner often has little control over the data life cycle. For example, capturing relevant information about construction activities is often the work task of an inspector, who may not have a vested interest in the data being collected. Stewardship of the data is critical to data quality but is often disconnected from asset stewardship.

The Federal Highway Administration is currently deploying Digital As-Builts through its *Every Day Counts* Round 6 initiative. Many agencies interested in implementing Digital As-Builts recognize that the as-built data primarily serves post-construction uses. As such, they need to locate the asset data stewards and access the data models before they can implement digital as-built collection. Agencies also recognize that the majority of asset inventory information is created in design and should only need to be verified or updated in construction. Consequently, some agencies are developing design software to automate the creation of asset inventory information and are developing solutions to extract the information for use/update in construction and delivery to the asset data steward.

The objective of this synthesis is to document state DOT current practices related to data models and data stewardship of ancillary assets.

Information to be gathered includes (but is not limited to):

- Which assets state DOTs are collecting;
- Incorporation of asset data in TAMPs;
- Responsibilities for data collection and stewardship;
- Quality control and confidence level requirements;
- The asset data life cycle management process (e.g., collection, maintenance, update, refresh cycle);
- Asset data models and/or data dictionaries being used; and
- How cross-functional asset data collection and data stewardship initiatives are funded.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- NCHRP 08-115. *Guidebook for Data and Information Systems for Transportation Asset Management.* (approaching completion) https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4362
- *Guide to Life-Cycle Data and Information Sharing Workflows for Transportation Assets* https://intrans.iastate.edu/research/completed/guide-to-life-cycle-data-and-information-sharing-workflow-for-transportation-assets/.
- UDOT Model Development Standards Manual. (Draft). Utah DOT. https://drive.google.com/file/d/105yj-z-B-33bznbS1ag0FSktg6_-eUpK/view.
- MnDOT As-built specification https://www.dot.state.mn.us/gisspec/index.html.

Synthesis Topic 54-07
Visualization for Public Involvement

NCHRP Staff: Leslie C. Harwood

Visualization, in its many forms, has long been recognized as an important element of public involvement in transportation decision-making. As visualization technologies and applications have matured and become more readily available, their potential to increase public understanding and inform dialogue during planning and project development has greatly expanded. Recent trends in public involvement practice have made it easier for agencies to show visualization products to a broad public audience. These trends include the dramatic increase in the use of video as part of social media communication and the move to virtual public involvement that greatly accelerated during the pandemic. An increased focus on meeting the needs of participants with limited English proficiency or low literacy also prompted greater reliance on visual communications.

Despite the transformative potential of newer visualization tools for public involvement, their uptake among state DOTs has been uneven, and the current state of the practice is not well understood. The most recent synthesis on visualization for highway projects was published in 2006. The most comprehensive guidance to date on selecting visualization tools for public involvement was the Federal Transit Administration's "Choosing Visualization for Transportation" tool, now over ten years old. Interest is evident among DOTs in obtaining guidance to advance their use of visualization in public involvement. This can be seen in recent FHWA peer exchanges on visualization conducted as part of the Every Day Counts (EDC) Virtual Public Involvement Initiative, which seeks to promote visualization, among other virtual tools. The formation of an FHWA Visualization Working Group with federal and state DOT participants is another example. Moreover, interactive visualization was a recent peer-selected focus innovation under AASHTO's Innovation Initiative.

The objective of this synthesis is to document state DOT current practices of visualization for public involvement.

Information to be gathered includes (but is not limited to):

- The types of visualization products currently used by state DOTs in public involvement for plans, programs, and projects, including the extent and uses of interactive and immersive techniques;
- The points in the project development sequence when these products are typically used;
- Methods used to show visualizations to the public (e.g., in-person meetings, virtual meetings, websites, videos, printed materials or displays, field-based use, etc.), and the opportunities or mechanisms provided for gathering feedback from participants;
- Steps taken to provide access and encourage engagement with visualization products by members of under-represented communities;
- Accessibility features or accommodations provided to achieve ADA or Section 508 compliance;
- DOT policies and procedures for the use of visualization in public involvement;
- Organizational structure and capabilities for visualization, resources required, and the role of consultant versus in-house efforts;

- Steps taken to gauge the effectiveness of visualizations in the public involvement process;
- Barriers to expanded use of innovative forms of visualization; and
- Staff training or technical assistance needs.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- AASHTO Innovation Initiative. 2020. Interactive Visualization http://aii.transportation.org/Pages/Virtual-Immersive-Visualization.aspx, accessed 1/28/2022.
- Cambridge Systematics, Inc. 2017. *NCHRP Web-Only Document 226: Data Visualization Methods for Transportation Agencies*. NCHRP 08-36 (128).
- Federal Highway Administration, 2021. Every Day Counts Virtual Public Involvement Initiative. www.fhwa.dot.gov/planning/public_involvement/vpi, accessed 1/28/2022.
- Federal Transit Administration. 2010. Choosing Visualization for Transportation (interactive portal).
- Hixon, C.L., III, Bergmann Associates. 2006. *NCHRP Synthesis 361: Visualization for Project Development.*

Synthesis Topic 54-08
Practices for Integrating Performance-Based Plans with Long-Range Transportation Plans and Statewide Transportation Investment Programs

NCHRP Staff: Trey Joseph Wadsworth

The Moving Ahead for Progress in the 21st Century Act (MAP-21), the Fixing America's Surface Transportation (FAST) Act, significantly expanded planning and performance management requirements for state departments of transportation (DOTs). Specifically, DOTs must prepare Strategic Highway Safety Plans (SHSPs), Highway Safety Improvement Programs (HSIPs), Transportation Asset Management Plans (TAMPs), and state freight plans. DOTs must integrate the goals, objectives, performance measures, and targets described in their performance-based plans into long-range transportation plans (LRTPs) and statewide transportation investment programs (STIPs). However, each state DOT has a unique structure and processes to meet federal and state requirements. There has been limited documentation of DOT practices to integrate performance-based planning requirements and outcomes into LRTPs and STIPs.

The objective of this synthesis is to document state DOT current practices related to integrating required performance-based plans (SHSP, HSIP, TAMP, and freight plans) with LRTPs and STIPs.

Information to be gathered includes (but is not limited to):

- Opportunities and challenges for DOTs when linking their performance-based plans to LRTPs and STIPs;
- Strategies to integrate federally required performance-based plans into the programming processes for LRTPs and STIPs (e.g., holistically driving investment decisions or flexing funds);
- DOT business units responsible for integration and implementation of performance-based planning requirements and performance management;
- Practices for addressing differences between planning horizons, balancing priorities between levels of government, and other technical issues;
- Differences in approaches for integration for LRTPs and STIPs that are vision- or policy-based compared with LRTPs that are project-based and may include a financial plan; and
- Practices for communicating or demonstrating the linkages between performance-based planning documents and LRTPs and STIPs to DOT partners, elected officials, federal authorities, or the public.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- American Association of State Highway and Transportation Officials. Transportation Asset Management Portal. https://www.tam-portal.com/.
- American Association of State Highway and Transportation Officials. Transportation Performance Management Portal. https://www.tpm-portal.com/.

- Federal Highway Administration, Office of Planning, Environment, & Realty. 2013. *Performance-Based Planning Guidebook*. Washington, DC: https://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/.
- National Academies of Sciences, Engineering, and Medicine. 2022. *Integrating Effective Transportation Performance, Risk, and Asset Management Practices*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26326.
- National Academies of Sciences, Engineering, and Medicine. 2019. *A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25285.
- National Academies of Sciences, Engineering, and Medicine. 2013. *Use of Transportation Asset Management Principles in State Highway Agencies*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22650.
- NCHRP 02-27, *Making Targets Matter: Managing Performance to Enhance Decision-Making.* https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4546.
- Volpe National Transportation Systems Center (Volpe Center), Statewide Long-Range Transportation Plan (SLRTP) Database. volpe.dot.gov.

Synthesis Topic 54-09
Hydraulic Engineering Practices for Construction and Temporary Facilities in Streams and Rivers

NCHRP Staff: Leslie C. Harwood

State DOTs undertake hundreds of construction projects each year that affect, and are affected by, streams and rivers. These include replacement and rehabilitation of bridges and culverts, as well as new construction and rehabilitation of highways in stream corridors. The hydraulic design standards for the completed bridge, culvert or highway are well established. However, there are elements of risk involved in any temporary occupancy of a waterway for construction, including: personal safety risks, economic risks to the transportation agency and contractor from delays or damage, and environmental risk from unanticipated flooding. These risks are associated with a wide range of structures, from minor drainage crossings to major river structures. While some states may have well-defined policies and methods to address hydraulic considerations for temporary construction facilities, other states may address these issues on a case-by-case basis.

The objective of this synthesis is to document state DOT hydraulic engineering practices for construction and temporary facilities in streams and rivers.

Information to be gathered includes (but is not limited to):

- Existing policies, practices, and specifications for temporary facilities in water;
- Bridge foundation cofferdams and level of protection against flooding;
- Waterway temporary diversions around construction work areas;
- Storm frequencies being used for temporary construction;
- Temporary causeways in rivers to allow access for bridge pier construction or demolition;
- Hydrologic methods being used for temporary structure sizing;
- How risk for temporary structures is quantified (e.g., through programmatic data driven or qualitative methods); and
- Methods to evaluate trade-offs for actions that improve construction access but increase risk of flooding damages (e.g., increased height of temporary causeways).

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Synthesis Topic 54-10
State Customization of Highway Safety Manual Methods

NCHRP Staff: Leslie C. Harwood

The AASHTO *Highway Safety Manual* (HSM) provides tools for predicting the safety performance of a roadway facility. These tools include safety performance functions (SPFs) which incorporate geometric and other conditions to predict the crashes expected on a facility. SPFs are developed using crash numbers, geometric, traffic conditions and other data from one or more states resulting in less accurate safety performance measures when used for analyses in other states. SPFs can be customized for a specific condition or region using a calibration factor. The calibration factor is then multiplied by the HSM model results to predict crashes that better represents the observed crash number in that state. States can develop jurisdiction-specific SPFs using their own state data, allowing analyses that more closely represent the individual states' experiences. Although the development of customized SPF is generally considered more accurate for crash predictions, it involves a higher level of data needs, expertise, and cost.

As the state of the practice in data-driven safety analysis advances, states are challenged to calibrate or develop models that meet their needs. Specific challenges include the availability of sufficient data or funding to collect data. In addition, states increasingly have questions about whether and how to apply particular factors or models to facility types that are not exactly similar to the ones used to develop the models. State practitioners have questions about whether calibration factors or SPFs are transferable and could be used by other states. An initial step to addressing this is synthesizing the work states have already done to calibrate the HS M SPFs or develop their SPFs.

The objective of this synthesis is to document state DOT current practices on calibration factors and development of jurisdiction-specific SPFs.

Information to be gathered includes (but is not limited to):

- Calibration factors and SPFs that states have developed;
- Decision factors, including barriers and challenges, related to the decision to calibrate existing SPFs or develop jurisdiction specific SPFs;
- What calibration factors are used and how often they are updated;
- Analysis of calibration factor and/or model sensitivity;
- Development of region-specific calibration factors or SPFs (i.e., mountain, piedmont, coastal) and how they are used;
- Adoption of calibration factors from other states;
- Metrics and methods of validation on calibrated factors;
- Metrics and techniques used to assess transferability; and
- Relevant factors, such as crash reporting thresholds, which would impact the applicability of calibration factors or SPFs to other jurisdictions.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Synthesis Topic 54-11
Quality Control Checks for Bridge and Structure Analysis Models

NCHRP Staff: Jo Allen Gause

The design of bridges and structures often involves the use of structural analysis models of varying degrees of complexity. Superstructure design models vary from approximate 1-dimensional line girder analysis models to complex 2- and 3-dimensional finite element analysis models. Substructure and foundation models often consider soil-structure interaction, second-order effects, dynamic response (for seismic analysis), and interaction with the superstructure. A variety of software analysis programs are used to create and run these models, both commercial software and user-developed software. These models, and the structures they represent, can be quite complex, with enormous amounts of input parameters and output of results.

Creating and performing quality control checks of these analysis models can be a daunting task, particularly for more complex designs. The engineer must understand the anticipated behavior of the structure and review the predicted behavior of the models to determine if the model is correctly representing and estimating the real-world performance of the structure. A simple "check the program input values" is not always practical, or sufficient, for checking these models. Often it is necessary to perform other actions to check the model, such as "sanity check" reviews of key model results, comparing the model results to the results of simpler analysis methods, performing full independent analysis modeling and comparing the results, or other methods.

The objective of this synthesis is to document state DOT current practices related to quality checking software-based structural analysis models for bridges and structures. The synthesis will focus on the responsibilities of the engineer in checking structural analysis models.

Information to be gathered includes (but is not limited to):

- Identification of DOTs that have an established process for quality control checking of structural analysis models and those agencies that do not have an established process;
- Written guidelines and procedures for control checking the models;
- Engineering practices regarding control checking and how the checking practice may differ relative to the type and complexity of the models being checked;
- Tools and techniques used for control checking the models; and
- How the results of the control checks are used.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Adams, A., et al. "Manual for Refined Analysis in Bridge Design and Evaluation," Report FHWA-HIF-18-046, Federal Highway Administration, Washington, DC, May 2019.
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- Varma, A.H., and Jungil, S. "Verification of LRFD Bridge Design and Analysis Software for INDOT". Report FHWA/IN/JTRP-2009/27, Joint Transportation Research Program, Purdue University, West Lafayette, Indiana, August 2009.

Synthesis Topic 54-12
Programmatic Implementation of Alternative Delivery Methods by State Transportation Agencies

NCHRP Staff: Leslie C. Harwood

Alternative Delivery Methods (ADMs), including Design-Build (DB), Construction Manager/General Contractor (CM/GC), Public-Private Partnerships (PPP), and other combinations that may include Operations and Maintenance, have added a wide range of options for state transportation agencies to consider when delivering projects. Agencies have traditionally used the design-bid-build (DBB) method, by awarding a contract for construction to the lowest bidder, based on agency-designed plans. After many generations of use, the DBB delivery method is so engrained in local, state, and national agency processes, standards, and contracts that agencies are organized around this one delivery model. Implementing ADMs warrants different mindsets and approaches to processes, standards, risk allocations, and contracts to reach successful project outcomes. Most state transportation agencies across the country have used at least one form of ADM to deliver, operate, or maintain their transportation facilities. While some agencies have focused on a single project to test an ADM, or have developed each ADM project on an individual or one-by-one basis, other agencies have developed agency-wide programmatic approaches to build consistency when implementing ADMs across multiple projects or regions.

ADM procurement and implementation disrupt the traditional DBB project development and contracting processes. As agencies try to adapt to maximize the value of ADMs, they can find that even their organizational structures, built around traditionally discrete and distinct areas of professional expertise, must be reimagined. These agencies have had to rethink administrative processes and procedures, each developed over decades to accommodate the DBB delivery method, to be tailored to function successfully and sustainably in this evolving and dynamic environment of multiple delivery method options. Agencies that have implemented more than one ADM project have discovered the importance of building consistency from one ADM project to the next ADM project, much like the DBB practices now considered standard. This consistency brings greater efficiency and familiarity for agency staff, stakeholders, and industry participants. But whether and how an agency chooses to establish a programmatic approach to implementing ADM projects varies from one state to the next.

The objective of this synthesis is to document state DOT current practices of programmatic approaches to ADMs.

Information to be gathered includes (but is not limited to):

- Which DOTs have implemented programmatic approaches to using ADMs;
- Organizational changes by DOTs utilizing programmatic approaches; and
- Factors agencies considered for implementing programmatic approaches to ADMs.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- The Design-Build Institute of America (DBIA) and the Federal Highway Administration have databases on DOT and other government institutions that utilize ADM.

Synthesis Topic 54-13
Truck Escape Ramp Design and Operation

NCHRP Staff: Jo Allen Gause

Transportation agencies build and operate escape ramps to allow heavy vehicles that cannot maintain safe speeds on steep downgrades to safely exit the highway before losing control and crashing. Escape ramps involve important design choices specific to roadway, terrain, and vehicle characteristics. Some escape ramps use upward-sloping beds of loose aggregate to slow the vehicles, while others employ passive or active mechanical devices such as cables to retard their motion. The use of escape ramps also requires operational choices. Some agencies use intelligent transportation technologies to detect trucks that are exceeding or may soon exceed speeds appropriate for the vehicle and the location, and to warn drivers of the need and means to exit the roadway.

Because design and operations practices vary significantly among locations and agencies, no common design standards or recommended practices exist. Brake failures on heavy vehicles descending steep grades frequently occur, often involving serious crashes and fatalities.

The objective of this synthesis is to document current practices used by state departments of transportation (DOTs) to detect, guide, and capture heavy vehicles speeding on steep downgrades.

Information to be gathered includes (but is not limited to):

- Prevalence and extent of escape ramp use;
- Written policies and criteria for using escape ramps;
- Established design alternatives;
- Methods, including intelligent technologies, for detecting heavy vehicles that are already driving at excessive speed or are in danger of doing so;
- Methods used to inform drivers of endangered vehicles of the availability and location of escape ramps and how to access them;
- How state DOTs incorporate escape ramps into information provided to the public or trucking industry (e.g., traveler information systems, published documents, oversize and overweight vehicle permitting systems);
- How state DOTs incorporate truck escape ramps in the planning of future improvements, construction projects, or programs (e.g., permitting of oversize and overweight vehicles); and
- Opportunities identified by state DOTs for development or refinement of practice.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- *Truck Escape Ramps.* NCHRP Synthesis of Highway Practice, Issue 178, 1992, 62 p. This synthesis was comprehensive when performed 30 years ago, before prevalent adoption of mechanical capture devices and intelligent detection and warning technology.

- Alternative Arresting System Design for Truck Escape Ramps. *International Journal of Crashworthiness*, Volume 23, Issue 6, 2018, pp. 618-626.
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- Design for Approach Road of Truck Escape Ramp, Third International Conference on Transportation Engineering (ICTE), 2011, pp. 2725-2730.
- Connecticut Department of Transportation's Truck Escape Ramp (TER) - Avon, CT. 4th International Symposium on Highway Geometric Design, 2010, 13p.
- Evaluation of Truck Arrester Beds in Colorado, 2008, 46p.
- The Design of Truck Escape Ramps, 12th World Congress on Intelligent Transport Systems, 2005, 8p.
- Development of a New Concept in Emergency Truck Escape Ramp Design, VTI Rapport, Issue 380A PT1, 1992, pp. 193-214.
- A Review of the Dragnet Vehicle Arresting System as Applied to Runaway Truck Escape Ramps. Final Report, 1991, 21p.
- *Truck Escape Ramps: Recommended Practice.* ITE, 1989, 19p.

Synthesis Topic 54-14
Artificial Intelligence Applications for Automated Pavement Condition Evaluation

NCHRP Staff: Leslie C. Harwood

3D laser-based pavement imaging systems have been widely adopted by highway agencies in the last decade for automated pavement condition assessment while 2D imaging technologies and smart phone are also used to perform their pavement condition evaluation, especially for local transportation agencies. These collected pavement images are then used to extract pavement distresses semi- or fully automatically through various methods. Among these methods, models based on Artificial Intelligence (AI) with Machine Learning and Deep Learning (ML/DL) have gained high attention for pavement distress identification in the last several years. However, most AI models either have not yet fully connected with how highway agencies use the pavement distress data or have not been sufficiently developed to rely on quality 3D pavement image data.

The collected distresses such as cracking, faulting, flushing, and raveling are key indicators for triggering pavement maintenance and rehabilitation activities. Without clearly understanding the ultimate usage of this distress data by state agencies, the AI model development efforts for distress detection and/or classification, which includes AI model formulation, distress annotation, training, and performance evaluation, could be misguided thus failing to reach their full potential. For example, the AI-based models for automated crack detection using the classification of image blocks having cracking distress may not be able to output accurate cracking length and width information. Therefore, the produced model outcome may not meet the state agencies' need for project-level applications such as planning crack sealing projects.

On the other hand, the performance of supervised-learning AI models for automated pavement distress extraction heavily relies on several factors including the used pavement image data quality, data size and diversity, the annotation quality (labeled ground truth distresses), the model formulation, model training, etc. However, the performance evaluation method used for many developed models is not always clear, especially for the diversity of the data used for that evaluation and its established ground truth. This ambiguity makes the comparison of the performance of different models challenging and unreliable.

The objective of this synthesis is to document state DOT current practices of automated pavement distress identification and AI (ML/DL) technologies for pavement condition evaluation.

Information to be gathered includes (but is not limited to):

- Requirements for automated pavement distress identification;
- Various applications of pavement distress condition information;
- Types of agency decision-making supported by pavement condition data;
- Artificial intelligence (e.g., machine learning, deep learning) technologies, tools, and models currently being applied to pavement distress detection and classification and to pavement condition evaluation; and
- Ground truth / reference / benchmark data used in AI-technique development, training, and evaluation.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Pierce, Linda M., and Weitzel, Nicholas D. *NCHRP Synthesis 531: Automated Pavement Condition Surveys*. 2019.
- Hsieh, Yung-An, and Tsai, Yichang James. "Machine Learning for Crack Detection: Review and Model Performance Comparison". *Journal of Computing in Civil Engineering*, September 2020.

Synthesis Topic 54-15
Prevention and Mitigation of Surficial Slope Failures on Highway Embankment Slopes

NCHRP Staff: Leslie C. Harwood

Highway embankment slopes with cohesive materials can become dried and desiccated causing shrinkage of the soil during the summer. This can result in cracks and fissures near the surface of the slope. During heavy rains, water infiltrates into the cracks and fissures, saturating the slope surface materials creating a perched water table. The increased water pressure has the effect of reducing the effective shear strength of the soil while simultaneously increasing the driving forces. In addition, cohesive materials near slope surface can softens over the time and loose strength. The soils along the slope face can swell and develop seepage parallel to the slope. This can result in surficial slope instability. Surficial slope instability is also dependent on regional climate and vegetation which can change over time.

Surficial slope stability issues in highway embankment slopes have been reported and typically occur during heavy rains. Only some state and local agencies have incorporated requirements to evaluate surficial slope stability in their design guidelines. It is important to incorporate surficial slope stability analysis, which includes a saturated depth which is appropriate for the specific site conditions. Site conditions that can impact stability include geometry, fill materials, and climate. When the analyses show a potential for instability, slope stabilization techniques such as mechanical, chemical, and biological stabilization methods may be required to address the surficial slope instability.

Surficial slope failures can create safety concern, traffic congestion, and increased maintenance. A proactive approach for the mitigation of surficial slope instability is generally not considered in the design. A reactive approach to fix the failed slopes as a maintenance activity is more common and significant resources are required to fix surficial slope failures.

The objective of this synthesis is to document state DOT current practices on training for, design, identification, prevention, and mitigation of surficial slope failures.

Information to be gathered includes (but is not limited to):

- Design of new embankment slopes, specifically related to surficial stability;
- Use of embankment slope materials;
- Maintenance costs to repair surficial slope issues;
- Proactive methods used to address surficial instability;
- Mitigation techniques for addressing surficial slope instability; and
- Impact of regional climate focusing on rainfall and temperature.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

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- Pradel, D., and Raad, G. (1993). "Effect of Permeability on Surficial Stability of Homogeneous Slopes". *Journal of Geotechnical Engineering*, ASCE, 119 (2).
- Day, R.W. (1994). "Surficial Stability of Compacted Clay: Case Study". *Journal of Geotechnical Engineering*, ASCE, 120 (11).
- County of Los Angeles Department of Public Works. Manual of Preparation of Geotechnical Reports. 2013. Geotechnical and Materials Engineering Division.

Synthesis Topic 54-16
Post-Construction Evaluation Practices for Highway Projects Delivered Using Alternative Contracting Methods

NCHRP Staff: Jo Allen Gause

Alternative contracting methods (ACMs) are defined as the realm of contract payment provisions, procurement procedures, and various types of project delivery methods (PDMs) that supplement traditional low-bid, design-bid-build contracting. The potential benefits of using ACMs includes reducing project construction duration, reducing operational and life-cycle costs, improving quality and constructability, promoting innovative solutions, improving risk allocation strategies, and allowing for alternative financing solutions.

The Federal Highway Administration has evaluated the performance of the three most commonly used PDMs (design-bid-build, design-build, and construction manager/general contractor) using a comprehensive dataset of 291 completed highway projects. The study outcome resulted in the creation of numerous guidelines at the state and federal levels to assist agencies in selecting the most appropriate ACM for a project given its current goals, resources and constraints.

An example on the federal level is the AASHTO Alternate Contracting Method Guideline, which was developed to provide guidance and aid in selecting the most appropriate ACM. On the state level, several departments of transportation (DOTs) have developed their own guidelines and ACM selection tools. However, there is very little information or guidance about looking back after a project is complete and evaluating the ACM decision that was made and the benefits that accrued from the decision.

The objective of this synthesis is to document state DOT current practices for evaluating ACM decisions after project completion. The synthesis will address the ACM selection in its entirety, including the PDM, procurement procedure, and payment provision selection.

Information to be gathered includes (but is not limited to):

- Current policies, procedures, and guidelines to evaluate ACM decisions after project completion, including any benefits realized in the following:
    - reduction in project duration,
    - reduction in operational and life-cycle costs,
    - quality of constructability,
    - promoting innovative solutions,
    - risk allocation strategies, and
    - allowing alternative solutions.
- Timing of post-completion evaluations;
- Formal and informal tools used for evaluating the ACM decisions for completed projects; and
- Whether post-completion evaluation measures are used to inform other ACM selection decisions.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- FHWA Publication No: FHWA-HRT-17-100. Alternative Contracting Method Performance in U.S. Highway Construction. 2018.
- *NCHRP Report 787: Guide for Design Management on Design-Build and Construction Manager/General Contractor Projects*. 2014.
- MDOT. *Innovative Construction Contracting Guide*. 2015.
- FHWA CASE tool, research documentation, 2020.
- *NCHRP Report 939*: *Guidebooks for Post-Award Contract Administration for Highway Projects Delivered Using Alternative Contracting Methods*

Synthesis Topic 54-17
State DOT Innovation Programs and Practices

NCHRP Staff: Leslie C. Harwood

The culture of innovation across state transportation agencies continues to grow and strengthen. Agencies are realigning their workforces to focus more directly on innovation as it relates to internal organizational excellence and external program and project development and delivery, as both aspects highly complement each other. Unlike research activities, which have established programs and processes, innovation programs are relatively new. Consequently, transportation agencies are primarily learning from each other through informal information exchanges. A synthesis of current practice in this area is needed to assist DOTs in this exchange regarding implementation and growth of innovation programs.

The objective of this synthesis is to document state DOT current innovation programs, practices, policies, tools, management techniques, and workflows.

Information to be gathered includes (but is not limited to):

- Identification of state DOTs that have Chief Innovation Officers (CIOs) or similar roles;
- Organizational charts for state DOT innovation offices, including roles and responsibilities;
- Supporting programs (e.g., Innovation Challenges, Innovation Days, Awards and Recognition programs);
- Funding sources for innovation programs;
- Culture of innovation self-assessment tools; and
- Internal and external communication and marketing strategies.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- *NCHRP Research Report 885: Guide to Creating and Sustaining a Culture of Innovation for Departments of Transportation.* 2018.
- NCHRP Project 20-68A, Scan 18-02: "Leading Practices in Modifying Agency Organization and Management to Accommodate Changing Transportation Systems". 2018.
- NCHRP Project 20-123(09): "Feasibility Study for a Platform to Capture Innovations from State Departments of Transportation". 2021.
- AASHTO Innovation Initiative and Innovation Community of Practice.
- FHWA Office of Transportation Workforce Development and Technology Deployment.

Synthesis Topic 54-18
Wintertime Pavement Maintenance Practices

NCHRP Staff: Jo Allen Gause

Pavement maintenance is broadly classified into two categories: proactive and reactive. Proactive, or planned, maintenance describes actions that are programmed to occur at a convenient time in terms of climatic conditions, traffic, availability of personnel and equipment, and so on. It may be accomplished either by contract or with in-house staff. The need for reactive maintenance, on the other hand, can occur at any time. Maintenance needs that arise during winter and must be completed to maintain the safety and serviceability of roadways may be particularly problematic. Safe operations during adverse conditions and repair material performance in winter weather are two considerations that make winter maintenance challenging. Cold weather maintenance consists of critical actions which must be done immediately to maintain the safety and serviceability of roadways. These actions include patching potholes and punch outs, removal of snow and ice, and deicing.

The objective of this synthesis is to document current state departments of transportation (DOTs) practices for performing reactive winter roadway maintenance.

Information to be gathered includes (but is not limited to):

- Roadway maintenance activities performed during the winter;
- How reactive wintertime roadway maintenance may differ from when these activities are done at the optimal time;
- Whether winter maintenance treatments are considered temporary, with plans to conduct repairs in better weather, or whether they considered as permanent repairs;
- Special considerations for the impact of snow and ice removal on winter maintenance performance;
- Material selection, timing, procedures, and required equipment specific to winter maintenance operations; and
- Whether information about wintertime pavement maintenance operations is integrated into a DOT asset management system.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected DOTs for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Dailey, J., Dave, E. V., Barman, M., and Kostick, R. D. (2017). *Comprehensive Field Evaluation of Asphalt Patching Methods and Development of Simple Decision Trees and a Best Practices Manual* (No. MN/RC 2017-25). Minnesota. Dept. of Transportation. Research Services & Library.
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- Ullah Sajid, Hizb; Naik, Dayakar L.; and Kiran, Ravi. Improving the Ice-Melting Capacity of Traditional Deicers. *Construction and Building Materials*, Volume 271, Issue 0, 2021.
- Zegeye Teshale, Eyoab; Calhoon, Thomas; Johnson, Eddie; and Dai, Shongtao. Novel Approach for Evaluation of Pavements Affected by Pavement Tenting (Crack-Heaving): Integrated, Multi-Sensor Non-Destructive Testing System. Transportation Research Board 100th Annual Meeting, Transportation Research Board, 2021, 20p.
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- Hershey, Benjamin W., McClellan, and Anthony K., Mewes, John J. Decision Support Technologies: Beyond Winter Operations. *Transportation Research Circular, Issue E-C162,* 2012, p. 104.
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- Ruotoistenmaki, A., Makela, O., Sipila, J., Valkeisenmaki, A., Savolainen, S., Jylha, K., Venalainen, A., and Laapas, M. The Effect of Climate Change on the Routine and Periodic Maintenance of Roads. Tiehallinnon Selvityksia, Finnra Reports, Volume 3201122, Issue 8/2009, 2009, 66p+app.
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- Ye, Z., Veneziano, D., and Shi, X. (2013). Estimating Statewide Benefits of Winter Maintenance Operations. *Transportation Research Record: Journal of the Transportation Research Board*, 2329(1), 17-23.

Synthesis Topic 54-19
Practices for Controlling Tunnel Leaks

NCHRP Staff: Jo Allen Gause

Water infiltration is a common defect encountered in tunnel structures. However, the degree of severity and acceptance criteria associated with tunnel leakage varies and is not always unanimously agreed on. While every structure has a design life, poor control and management of leaks can reduce this expectation.

A huge investment in time and money can be put into combating leaks, and the result will typically not yield a completely water-tight tunnel. Methods of addressing tunnel leakage are hardly one-size-fits-all. The challenge for tunnel owners is to match the appropriate mitigation measure to the relevant leak type and source.

The objective of this research is to document current practices used by state department of transportation (DOT) tunnel owners to control tunnel leaks.

Information to be gathered includes (but is not limited to):

- DOT categorization of tunnel leak types;
- Methods and procedures for detecting tunnel leaks;
- Methods and procedures for mitigating various types of leaks; and
- Differences in treatments between underwater tunnels and tunnels impacted solely by groundwater.

Information will be collected through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- Tunnel Waterproofing: Available Technologies and Evaluation through Risk Analysis. *International Journal of Civil Engineering*, Volume 17, Issue 1, 2019.
- Study on Mountain Tunnels Water Reducing Measures and Tunnel Behaviors by Post Grouting. *Journal of Japan Society of Civil Engineers*, Ser. F1 (Tunnel Engineering) Volume 75.
- Grouting Technology in Tunneling. *Geomechanics and Tunneling*, Volume 6, Issue 3, 2013.

Synthesis Topic 54-20
Practices to Promote Gender Equity in the DOT Workforce

NCHRP Staff: Trey Joseph Wadsworth

Women comprise only 15% of the overall transportation workforce, and this statistic declines in executive and leadership positions. For women of color, the numbers are even more disparate. In 2021, the U. S. Department of Transportation issued a Request for Information for Transportation Equity Data. More than 300 comments were received, including comments focused on the lack of representation of women in transportation agencies and the lack of equity in compensation by gender, leading to low gender diversity. In addition, commenters called for a reliable system for monitoring diversity, including gender, race/ethnicity, and ability, in the transportation workforce.

The American Association of State Highway and Transportation Officials (AASHTO) has a priority on creating pathways to equity during the term of its current president, Dr. Shawn Wilson. This priority includes fostering a culture within and across the state department of transportation (DOT) community that expands opportunities for under-represented populations based on age, gender, ethnicity, and race. DOTs have implemented programs, policies, and practices to address gender equity. However, a synthesis of current practice does not exist to examine challenges and solutions to take a step toward gender equity in the DOT workforce.

The objective of this synthesis is to document state DOT current practices related to promoting gender equity in their workforces (including attracting, retaining, and promoting women and those who identify as women).

Information to be gathered includes (but is not limited to):

- Challenges, solutions, and actions in promoting gender equity in the DOT workforce;
- Practices, strategies, and plans to mitigate women's low representation in DOTs and inequities in compensation;
- Systems or tools in use by DOT human resources departments to track demographic information and uses of the data to promote gender equity;
- Recruitment practices in use to improve gender equity (e.g., updating job postings to remove gender bias or use of diverse hiring panels);
- Training programs and flexible workspace programs used to improve gender equity;
- Adaptable practices to promote gender equal opportunities in the workforce; and
- Leadership actions and principles addressing gender equity.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- American Association of State Highway and Transportation Officials, 2021. Presidential Emphasis Areas. https://www.transportation.org/wp-content/uploads/2021/10/21_22-Dr-Wilson-EA-brochure_web.pdf.

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- National Academies of Sciences, Engineering, and Medicine 2021. Attracting, Retaining, and Developing the Transportation Workforce: Transportation Planners. Washington, DC: The National Academies Press. https://doi.org/10.17226/26429.
- National Academies of Sciences, Engineering, and Medicine 2021. Resource Guide for Improving Diversity and Inclusion Programs for the Public Transportation Industry. Washington, DC: The National Academies Press. https://doi.org/10.17226/26230.
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- National Academies of Sciences, Engineering, and Medicine 2022. TRB Snap Search: Workforce – TRB's involvement in research on Workforce from 2020-2022. https://onlinepubs.trb.org/onlinepubs/snap/workforce.pdf.
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- White House, 2021. Fact Sheet: National Strategy on Gender Equity and Equality. https://www.whitehouse.gov/briefing-room/statements-releases/2021/10/22/fact-sheet-national-strategy-on-gender-equity-and-equality/.

Synthesis Topic 54-21
Practices to Address Climate Change in the Transportation Planning Process

NCHRP Staff: Trey Joseph Wadsworth

Climate change is a problem that requires multidisciplinary expertise and multi-level collaboration to address. How state departments of transportation (DOTs) address climate change in transportation planning can play an integral role in successfully meeting this challenge. DOT practices on addressing climate change in their federally required statewide long-range transportation plans (LRTPs) and a statewide transportation improvement programs (STIPs) vary from state to state. Practices could include policies on greenhouse gas mitigation, investment and programming selection criteria, or engineering directives on resiliency. Additionally, the tools, data, and methodologies in use by DOTs vary for estimating climate change implications, resiliency, or emissions.

The objective of this synthesis is to document state DOT current practices related to climate change (reducing GHG emissions and increasing resiliency) in their LRTPs and STIPs.

Information to be gathered includes (but is not limited to):

- Strategies in use by DOTs (or planning to use) reduce emissions and enhance resiliency in the transportation network;
- Policies, goals, or other documented commitments to reducing greenhouse gases or increasing resiliency;
- Approaches and methodologies to quantifying emissions, measuring system impacts, and forecasting change (including data sources);
- Mechanisms to measure or forecast extreme weather events and frequencies;
- Climate risk quantification and incorporation into LRTPs and STIPs;
- DOT practices to coordinate with metropolitan planning organizations and other partner agencies (including local governments) on greenhouse gas reductions or resiliency; and
- Where in the planning process is climate change addressed.

Information will be gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- National Academies of Sciences, Engineering, and Medicine. 2022. *Methods for State DOTs to Reduce Greenhouse Gas Emissions from the Transportation Sector*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26523.
- National Academies of Sciences, Engineering, and Medicine. 2014. *Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22473.
- U. S. Department of Transportation, Office of the Secretary of Transportation. 2021. *Climate Action Plan: Revitalizing Efforts to Bolster Adaptation & Increase Resilience*. Washington, DC. https://www.sustainability.gov/pdfs/dot-2021-cap.pdf.

- U. S. Government Accountability Office, Report to Congressional Requesters. 2021. *Climate Resilience: Options to Enhance the Resiliency of Federally Funded Roads and Reduce Fiscal Exposure*. Washington, DC. https://www.gao.gov/assets/gao-21-436.pdf.

Synthesis Topic 54-22
Practices for Capturing Costs of Maintenance Operations in Maintenance Management Systems

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Enhancing or replacing existing maintenance management systems (MMS) by state departments of transportation (DOTs) is costly, time-consuming, and involves considerable risk because these systems are typically in place for many years. One of the fundamental objectives of an MMS is to capture costs of maintenance at an appropriate level of detail for analysis. The expenditures against these budgets have been captured in maintenance management systems for many years, but the level of detail, accuracy, and timeliness of this cost capture varies considerably due to the many different approaches being used. The use of this cost information varies but ideally includes analysis and reporting of costs down to a reasonable level of detail, including such categories as organizational unit, geographical jurisdiction area, road functional class, maintenance activity, asset and/or location, and cost type (such as labor costs, equipment costs, materials costs, and other costs).

Apart from general organizational visibility into where costs are being incurred, another major use of cost information is to process claims for reimbursement of costs. Reimbursement cost accounting may range from FEMA or emergency relief funds, to claiming reimbursement from an insurance company for a guardrail, sign, or bridge hit.

The ability to capture maintenance costs down to the desired level of detail has evolved over the last couple of decades to include varying levels of integration with agency financial and enterprise resource management (ERP) systems. Factors such as where labor, equipment, and materials usage costs are captured (e.g., in the field on a mobile device, copied from paper forms in the office into the MMS, or captured directly into the financial system) can make a large difference in the level of detail, accuracy, and timeliness of the cost information collected. In addition, the level of effort can vary greatly depending on the design and configuration of various integrations with both the financial system but also with the equipment management module/system and the materials management module/system.

The objective of this synthesis is to document state DOT current practices to capture maintenance costs in their MMS, the level of detail captured, and the level of integration and synchronicity with financial systems and ERPs.

Information to be gathered includes (but is not limited to):

- Level of detail of maintenance costs captured including labor, equipment, materials; indirect/overhead costs;
- How and where the different types of cost are captured (e.g., in the field on a mobile device, copied from paper forms, captured directly into the MMS); and
- Level of integration and synchronicity with financial systems and ERPs (and other systems such as linear referencing management systems).

Information will be collected through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for the development of case examples. Information gaps and suggestions for research to address those gaps will be identified.

Information Sources (Partial):

- NCHRP Project 08-115: *Guidebook for Data and Information Systems for Transportation Asset Management* (approaching completion).
- NCHRP Project 08-136: *Guidance on Using Performance-Based Management Approaches for Maintenance* (in progress).
- NCHRP Project23-*08: A Guide for Incorporating Maintenance Costs into a Transportation Asset Management Plan* (in progress).
- *NCHRP Synthesis 470: Maintenance Quality Assurance Field Inspection Practices.*
- *NCHRP Synthesis 548: Development and Use of As-Built Plans by State Departments of Transportation.*
  NCHRP Project 20-101: *Guidelines to Incorporate the Costs and Benefits of Adaptation Measures in Preparation for Extreme Weather Events and Climate Change.* *NCHRP Report 688: Determining Highway Maintenance Costs.*
- *NCHRP Research Report 944: Guide to Calculating Ownership and Operating Costs of Department of Transportation Vehicles and Equipment: An Accounting Perspective.*