

# Research Need Statement 607

## I. Need Statement Champions and Information

### I.A. Need Statement Champion Information

I.A.1. First and Last Name of Research Champion: **Sarah Sondag**

I.A.2. Research Champion's Office: **MnDOT Bridge Office**

I.A.3. Research Champion's Phone Number: **651-366-4529**

I.A.4. Research Champion's Email: **sarah.sondag@state.mn.us**

### I.B. Research Co-Champion

I.A.1. First and Last Name of Research Co-Champion:

I.A.2. Research Co-Champion's Office:

I.A.3. Research Co-Champion's Phone Number:

I.A.4. Research Co-Champion's Email:

I.C. Research Needs Title (115 Characters): **Quantifying Benefits of Bridge Maintenance**

I.D. Project Sponsor: **Joint MnDOT and Local Road Research Board**

## II. Research Need Background and Description

### II.A. Research Need Background

II.A.1. Describe the problem or opportunity.

Bridge preservation is defined as "actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges; keep bridges in good or fair condition; and extend their service life". While it is widely accepted that bridge maintenance slows bridge deterioration rates and extends service life, there is limited research quantifying the benefits of bridge maintenance through actual bridge deterioration and life cycle cost data.

II.A.2. If applicable, describe how this project will build on previous research.

This project will look at actual bridge condition and maintenance data of selected in-service bridges to attempt to more definitively quantify the service life extension of maintenance activities and associated benefit-cost for Minnesota bridges. Many of the life cycle cost analyses and deterioration models presented in the previous research cited below rely on estimated benefit or expected service life extension based on engineering judgement. In addition, condition improvement and service life extension associated with maintenance treatments can vary due to local factors.

II.A.3. If applicable, include the title/s or previous research.

#### ***Completed Research***

- [Quantifying the Impact of Bridge Maintenance Activities on Deterioration: A Survey of Practice and Related Resources](#) (TRS 1509. MnDOT, 2016)  
This TRS concluded that “while all of the 22 agencies responding to the survey provided information about their experience with bridge maintenance treatments, relatively few agencies reported efforts to quantify the benefits of bridge maintenance activities”. Of the agencies that addressed questions about quantifying the benefits of bridge maintenance treatments, most indicated applying engineering judgement to quantify benefits. Kansas DOT uses funding models compared to performance targets.
- [Remaining Asset Service Life, Phase 1](#) (MnDOT Research Report 2018-23)  
This research identified that currently the remaining service life of bridges are not updated to account for preservation actions. The research team also recommended exploring additional metrics: Asset Sustainability Ratio and Deferred Preservation Liability. The Deferred Preservation Liability metric would attempt to estimate the impacts of deferred maintenance by identifying the higher costs required as assets deteriorate and require more extensive repairs prematurely because preventive maintenance was not performed.
- [Bridge Deck Preservation Portal, Phase 1](#) (2020 FHWA/Iowa DOT, Wiss, Janney, Elstner Associates, Inc.)  
The project’s goal was to develop a framework to assist engineers in selecting the optimum bridge deck preservation options. They developed a probabilistic algorithm to provide estimates for service life extension of bridge deck maintenance actions. Since there was limited empirical basis for the reduction factors used in the estimated service life calculations, the study recommends a parametric study to validate the parameters. A short description of the need for a parametric study is included in section 5.1.1, Optional Task A.1 and Section 5.2 Discussion and Next Steps.
- NCHRP Research Report 859: [Consequences of Delayed Maintenance of Highway Assets](#) (TRB, 2017).  
The handbook was developed to assist DOTs in making bridge preservation investment decisions.

[Appendix D](#): Procedure to Quantify Consequences of Delayed Maintenance of Bridges. This appendix indicates that “evaluating the consequences of delayed maintenance on bridges demands the evaluation of individual bridge components or elements” and “life extension provided by these [cyclical maintenance] actions is not well established in the literature”.

- [Deterioration Rates of Minnesota Concrete Bridge Decks](#) (MnDOT Research Report 2014-40) Section 6.2 of the research report suggests further study could include maintenance records in order to compare general condition performance of Districts with maintenance consistency.
- [Quantifying the Benefits of Routine and Preventive Maintenance: Survey of Practice](#) (Caltrans, 2020)  
Caltrans surveyed other DOTs regarding methodologies for quantifying the benefits of routine and preventive maintenance.

***In Progress Research:***

- NCHRP 14-36: [Proposed AASHTO Guide for Preservation of Highway Bridge Decks](#)
  - Currently in the final review stage for AASHTO; may be postponed to 2021 Ballot for Approval.
- (Wisconsin DOT) [Protocols for Concrete Bridge Deck Protections and Treatments](#)
  - The objective is to develop recommendations and guidelines for bridge deck treatments that would maximize the condition and longevity.

II.A.4. What is the **objective** of the proposed research?

The proposed research should consider select bridges within the MnDOT network with a variety of characteristics, including, but not limited to:

- Bridge design and material type
- Construction history, including cost
- Maintenance history with a goal of including bridges with low, medium, and high levels of maintenance
- Condition history of the various bridge components and elements, including initial construction defects
- Age
- Traffic
- Environment

Compare the change in condition of elements on selected bridges with similar characteristics (i.e. age, design type, traffic and environment) but with different levels of maintenance. Recognizing that numerous factors impact deterioration, the goal is to study similar bridges with varying maintenance in order to isolate that variable in the data. Additionally, a network level approach could be explored by comparing the maintenance history across MnDOT’s bridge network and compare to regional major preservation schedules and costs, deterioration and service life.

Determine the relationship between the bridge characteristics and preservation histories with past and expected condition in order to identify the extension of service life and most cost effective timing of various maintenance activities and impacts and costs associated with deferred maintenance.

Develop a tool (i.e. decision tree, matrix) to be used by planners, designers, bridge engineers, and public works managers to guide the selection of appropriate, cost-effective maintenance actions for various bridge types and characteristics, including recommendations for timing and frequency of those actions, to extend service life and reduce life cycle cost.

### III. Strategic Priorities, Benefits, and Expected Outcomes

**Section III. is for MnDOT sponsored and co-sponsored projects only; all LRRB projects proceed to section IV.**

#### III.A. MnDOT Strategic Priorities

*Instructions:* Briefly describe how the project aligns with the following MnDOT Research Strategic Priorities. Complete all that apply.

III.A.1. Innovation & Future Needs:

III.A.2. Advancing Equity:

III.A.3. Asset Management: **Understanding the relationship between the costs and benefits of bridge maintenance will help more efficiently spend limited funding**

III.A.4. Safety:

III.A.5 Climate Change & Environment: **Extending the life cycle of bridges will reduce the frequency of construction and associated impacts**

#### III.B. Expected Outcomes

*Instructions:* Check all expected direct outcomes of this research.

- New or improved technical standard, plan, or specification
- New or improved manual, handbook, guidelines, or training
- New or improved policy, rules, or regulations
- New or improved business practices, procedure, or process
- New or improved tool or equipment
- New or improved decision support tool, simulation, or model/algorithm (software)
- Evaluation of a new commercial product
- New or improved technical standard, plan, or specification
- Other. Please specify below:

### III.C. Expected Benefits

*Instructions:* Select all expected benefits that may be realized if the findings and recommendations from this research is adopted or implemented

III.C.1. Construction Savings Choose an item.

III.C.2. Decrease Engineering/Administrative Costs Choose an item.

III.C.3. Environmental Aspects Choose an item.

III.C.4. MnDOT Policy Choose an item.

III.C.5. Lifecycle **Other lifecycle impacted.**

**Allow selection of appropriate bridge maintenance activities to extend/maintain bridge life in a cost efficient manner**

III.C.6. Operations and Maintenance Savings **Other operational and maintenance savings. Understanding the service life extensions associated with various bridge maintenance activities will allow more efficient use of limited funding resources.**

III.C.7. Reduce Risk Choose an item.

III.C.8. Reduce Road User Cost Choose an item.

III.C.9. Safety Choose an item.

III.C.10. Technology Choose an item.

III.C.11. Other, please describe below:

#### IV. Technical Advisory Panel

*Instructions:* Please list the name and affiliation of individuals to consider for the Technical Advisory Panel.

Sarah Sondag, MnDOT Bridge Office

Regional Bridge Construction Engineer

MnDOT District Bridge Engineer from greater Minnesota district(s)

Dustin Thomas, MnDOT Metro Structures Maintenance Engineer

MnDOT Bridge Maintenance Supervisor from greater Minnesota district(s)

Mike Anderson, MnDOT Metro Bridge Maintenance Superintendent

City/County Engineers

Your assigned Project Advisor is available to answer questions and provide guidance (assigned by the Office of Research & Innovation).

Your Project Advisor is: Beth Klemann Email:[beth.klemann@state.mn.us](mailto:beth.klemann@state.mn.us)