Oregon Department of Transportation

Stage 1 Research Problem Statement

Number*: 25-65*

Proposed Title: *Extending Bridge Useful Life through Risk-Based Inspection Planning*

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.

In Oregon, the average age of state-owned highway bridges is over 50 years. Considering the common design service life of 75 years, a majority of the bridge stock is approaching the end-of-life. Nonetheless, through regular inspection and proper maintenance, the useful life of older bridges can be greatly extended beyond their design life. The challenge of extending bridge useful life lies in the fact that the financial and human resources required for inspection, maintenance, and other life-cycle activities are often significantly constrained. The new SNBI Final Rule, published in May 2022, brought in several major changes that can potentially support cost-effective extension of bridge useful life. These include: (a) wide adoption of element-level condition data that can be used to clearly define useful life and distinguish assets with the same general condition rating, (b) ability to set flexible inspection schedules following the principles of risk-based inspection in NCHRP Report 782, and (c) emphasis on nondestructive evaluation and monitoring techniques for in-depth and special inspections. The proposed research aims to capitalize on the transition to the new SNBI by proposing streamlined and defensible processes for risk-based inspection planning in compliance with the Final Rule. The ultimate goal is to extend bridge useful life more cost-effectively by freeing up resources spent on unnecessary inspections. This will be primarily achieved by automatically generating flexible and adaptable inspection plans that utilize the element-level condition history and leverage new and existing nondestructive evaluation (NDE) results accessible to ODOT.

2. Document how this **transportation issue** is important to Oregon and will meet the Oregon Research Advisory Committee Priorities

The proposed research is important to Oregon by directly contributing to the following research focus: **cost reductions or savings to construction, operations, or asset maintenance**. Contributions to this area will be primarily achieved by (a) generating return on the considerable effort of SNBI transition that has already been taking place at ODOT and (b) providing data-driven and risk-based approaches to flexible inspection schedules that can facilitate FHWA approval and reduce asset life-cycle cost.

3. What **final product or information** needs to be produced to enable this research to be implemented?

To fulfill the research goal, activities will be carried out in phases with clearly defined deliverables described as follows:

- **A clear definition of bridge useful life based on element-level condition data.** This will be achieved by a comprehensive literature review on bridge health indices, key performance measures, and bridge posting protocols proposed by researchers and/or used by different state DOTs and in various nations. If needed, new definitions of useful life for bridges and bridge components will be proposed in close collaboration with ODOT.
- **Bridge deterioration models that use element-level condition data and adapt to condition history.** Compared to existing models, this type of models can distinguish the useful life of bridges with the same general condition rating based on (a) differences in element-level damage distribution and (b) the entire condition history unique to a bridge. The models will be developed using a Bayesian approach previously established by

the PI, and emphasis will be placed on easy integration with common Bridge Management Systems (e.g., AASHTOWare and AgileAssets). Models will focus on bridge deck components in a pilot study.

- **Processes to utilize NDE and site information for deterioration model updating and useful life prediction.** NDE and other site-specific data can refine element-level condition and provide more in-depth information such as spatial distribution and quantitative extent of damage. Through the established processes, the benefit of such in-depth information will be reflected in improved useful life prediction. The development of these processes will focus on NDE and site data already available to or directly attainable by ODOT, e.g., deck chloride profile, deck defect maps from chain drag, GPR, and IR, etc.
- **A framework of risk-based inspection planning to cost-effective useful life extension.** Based on the previous results, the probability of reaching the end of useful life can be consistently estimated within any given time interval. This enables risk-based inspection planning in compliance with the new SNBI and NCHRP Report 782. The framework and the supporting data from this research can be directly used by ODOT for seeking FHWA approval on varying inspection intervals. The freed-up resources for inspection can contribute to other life-cycle activities extending useful life, forming a virtuous cycle for asset maintenance.

Overall, these phased deliverables will form the final product of the research to support practical implementation.

4. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

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5. Other comments:

Apart from addressing ODOT research priorities, the proposed research can directly contribute to "**Policy SP.2.2: Maximize the useful life and minimize the life-cycle cost of transportation assets**" under the Strategic Direction "**Stewardship of Public Resources**" of the Oregon Transportation Plan.

6. Corresponding Submitter's Contact Information:

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