Research Stage 1 Problem Statement

PROPOSED TITLE: OPTIMIZING MAINTENANCE OPERATIONS AND FLEET ALLOCATION FOR WINTER WEATHER RESPONSE

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

Maintenance operations on Oregon's roadways are essential for safe and efficient travel, particularly during adverse weather events such as snow, rain, and landslides. However, declining fuel-tax revenue and resulting budget shortfalls are reducing ODOT's capacity to deliver critical activities including deicing, snow and debris removal, rockfall response, vegetation management, and routine asset upkeep. Limited funding forces difficult choices about how to allocate staff, equipment, and maintenance effort across regions. To maintain mobility standards under constrained resources, Oregon needs research on how to optimize the use of its maintenance fleet and workforce. Key decisions – such as regional fleet allocation and staffing, equipment acquisition and replacement (buy vs. rent), and maintenance scheduling to reduce downtime need to be made with a system-wide understanding of funding limitations, resource constraints, regional weather patterns, and resulting maintenance needs.

This project will integrate GIS data about ODOT roadway and maintenance assets along with winter weather patterns, with a resource-use simulation framework to identify optimal strategies for fleet allocation, equipment acquisition, utilization, and maintenance planning across the state. Optimizing existing resources will enable ODOT to achieve required mobility targets with limited resources. As a pilot test of the proposed framework, winter operations data from the past 3 years for Regions 4 and 5 will be processed into a software simulation model. Analysis of the model will allow detailed optimization of each asset and how to operate more efficiently together for typical winter maintenance operations. The model's outputs allow ODOT to create "what-if" scenarios for future seasons where the quantification of potential cost savings and performance improvements can be implemented.

Although this project will focus on winter weather response, the underlying modeling framework and decision-support insights are transferable to a range of ODOT fleet activities. These include rapid response to disruptive events (e.g., rockslides, debris clearance) and routine maintenance operations (striping, pavement repair) where similar constraints on equipment availability, routing, and scheduling apply.

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

The following products and datasets must be developed to enable practical research implementation:

1. **Operations and resource requirements for common winter maintenance activities:**
   We will study the major winter response activities in Regions 4 and 5 – such as deicing, spreading salt and sand, and plowing snow – to understand the steps involved, equipment needs, material

use, crew requirements, and route-planning considerations. We will combine this information with owning and operating costs and build reusable simulation models. These models will allow us to test different ways of acquiring, allocating, and scheduling equipment and crews across the regions, helping ODOT compare the expected costs and benefits of different strategies.

2. **Spatial data on ODOT assets and fleet distribution:**
   We will compile comprehensive GIS data describing the roadway assets, maintenance yards, and the current distribution of ODOT's fleet across Regions 4 and 5. This dataset will support analysis of regional maintenance demands and allow evaluation of equipment acquisition, replacement, and allocation strategies. This spatial analysis will also inform how best to position and assign fleet resources based on expected response needs across the regions.
3. **Historic, and forecasted weather, and operations data:**
   Historic winter weather data and corresponding maintenance response records data from the past three years will be analyzed for Regions 4 and 5 to understand how past weather conditions have influenced operational workloads. Forecasted conditions for upcoming seasons will then be used to generate scenario-based estimates of required maintenance effort and resource needs. This analysis will also support the creation of preventative maintenance schedules to minimize equipment downtime during peak winter periods.

Together, these three data components will be integrated into a GIS-based decision-support tool for ODOT maintenance operations managers. This tool will allow managers to evaluate "what-if" scenarios, identify optimal fleet allocation, acquisition strategies, and funding strategies based on expected weather conditions, operational demand, and budget constraints. The resulting software application will be delivered in a format that allows straightforward download and installation, with little to no ongoing support needed from ODOT's IT office.

3. (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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4. Other comments:

While the proposed project focuses on winter maintenance operations, the resulting tool will be designed to generalize to a wider range of maintenance activities – including rockfall removal, vegetation management, and striping. It will also be capable of optimizing fleet needs for individual regions or for the entire state, and support planning from a single winter season up to multi-year horizons.

The proposed work builds on the researcher's prior experience modeling how roadway operations unfold over time – much like a SimCity-style simulation that shows equipment, crews, and roads interacting on a map. For example, Figure 1 shows a hypothetical scenario in Clatsop County where multiple maintenance crews are dispatched from different ODOT depots to clear landslide debris. The visualization shows how crews move across the network, how long each task takes, and how different choices – such as which crew to send where with what equipment, which routes to take etc. – affect overall performance. This type of model allows ODOT to create and test "what-if" scenarios and identify the most efficient use of equipment, personnel, and funds before decisions are made in the real world.

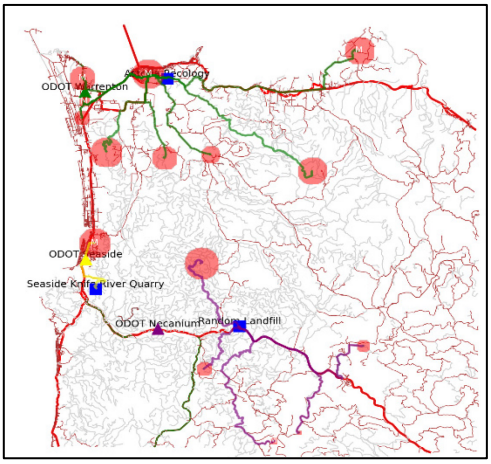

Figure 1: Landslide recovery operations in Clatsop County

5. State of Oregon Decision Making Lenses

State decision making lenses are a part of the state of Oregon's policy structure. State policy and federal policy are not always aligned. The state will prioritize research according to state policy, however ODOT may be required to skip prioritized proposals based on constraints placed on the use of federal funds. If state funds are available ODOT will attempt to fund prioritized research that is deemed ineligible for federal funding.

Please complete the following three sections. Your answers to these questions will be applied on a programmatic basis to support agency decisions. Answering yes to the questions below is not required. Resolving a narrowly focused technical research problem may meet agency needs without answering yes to any of the following questions. The ODOT Research Section will seek a balanced portfolio some projects will answer yes to one of the three categories below (e.g. climate, equity, and/ or safety) and other projects in a different category.

We are looking for an overall program balance and no one project is expected to balance all categories. Generally, a research problem statement is expected to be able to answer yes with clear and verifiable information in only one of the three categories below, some projects may be able to answer yes in two or even three categories. Some projects (i.e. needs focused on specific elements of infrastructure design), may have no 'yes' answers but may still be a high value research need.

Climate

Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. To that end, we seek research that reduces carbon emissions from construction activities and materials, and from maintenance equipment and operations. Oregon envisions a transportation system that is resilient, this means a system that is durable in the face of seismic events and extreme weather to avoid negative impacts, withstand them or bounce back quickly to resume system function. We seek research that improves the ability of the transportation system to adapt or cope with more frequent and extreme weather events. This may include innovations in data and data sharing, construction materials and project design, communication, emergency planning and response, and more. Similarly, we seek research that avoids negative impacts on key habitats and ecosystems that can buffer or reduce damage to infrastructure and improve environmental conditions for wildlife and native vegetation. For definitions

and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

5a. Will addressing the transportation issue identified as a need in Question 1 develop, or **validate methods for the estimation, measurement, or monitoring** of transportation generated greenhouse gases (GHG)?

☐Yes ☒No ☐Unsure

5b. If climate or GHG is not the focus of this **transportation issue** identified in this problem statement, will the research apply a GHG analysis to transportation infrastructure, planning, operations, maintenance, or materials?

☐Yes ☒No ☐Unsure

5c. Will addressing the **transportation issue** include development or testing of construction practices, methods, or materials to establish potential reductions in greenhouse gas emissions?

☐Yes ☒No ☐Unsure

5d. Will solving the **transportation issue** in question 1 study or support the reduction of vehicle miles traveled and single occupancy vehicle travel or support transition to electric vehicles (or other types of zero emission vehicles) or low-carbon alternative fuels?

☒Yes ☐No ☐Unsure

5e. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, or monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☒Yes ☐No ☐Unsure

5f. Will solving the **transportation issue** in question 1 lead to work that may result in better environmental conditions for wildlife and native vegetation?

☐Yes ☒No ☐Unsure

5g. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

The transportation issue being addressed is the optimization of fleet allocation for winter maintenance operations. By improving the deployment and routing of equipment for tasks such as deicing and snowplowing, the project aims to reduce total vehicle miles traveled by the maintenance fleet (5d). In addition, the integration of winter weather forecasting into operational planning will enhance the resilience of the transportation system by enabling proactive preparation for expected climate-driven events (5e).

Equity

Equity can have many dimensions and impacts relating to communities and transportation. It is important that problem statement proposals clearly explain the equity dimensions or impacts being examined. Oregon commits to social equity in the OTP, specifically to *improve access to safe and affordable transportation for all, recognizing the unmet mobility needs of people who have been*

systemically excluded and underserved. Create an equitable and transparent engagement and communications decision-making structure that builds public trust. We seek research that studies elements of this goal or applies analysis to specific transportation topics to ensure the resulting research recommendation is consistent with agency equity goals. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

5h. Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐Yes ☒No ☐Unsure

5i. If the **transportation issue** is not focused on transportation equity, will the primary topic be assessed for equity benefits or impacts within the research project?

☐Yes ☒No ☐Unsure

5j. Is the implementation of potential findings from this research likely to directly involve participation from an identified group that would benefit from an equitable process or outcome?

☐Yes ☐No ☒Unsure

5k. Is the intended final product or information expected to support ODOT's equity efforts (Including but not limited to supporting one of the equity related objectives of the ODOT's Strategic Action Plan or Oregon Transportation Plan) ?

☐Yes ☐No ☒Unsure

5l. If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

Although this study does not have an explicit equity focus, the data compiled and the analyses conducted will create a foundation for future equity-focused evaluations. These datasets and models can support questions related to where funds are being spent, where new equipment is being purchased, and which areas are being underserved or overserved. Future analysis of equipment distribution, service levels, and response times can help identify any unintended inequities in maintenance operations.

Safety

Research outcomes may include interventions and countermeasures to prevent or reduce the frequency of crashes or other causes of transportation-related injury or death; or may include measures to reduce severity of injury (including prevention of death) after a crash or other injurious event. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan, Oregon Transportation Safety Action Plan and Oregon Transportation Plan.

5m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☒Yes ☐No ☐Unsure

5n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☒Yes ☐No ☐Unsure

5o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☒Yes ☐No ☐Unsure

5p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☒Yes ☐No ☐Unsure

5q. Will solving the **transportation issue** support improving safety through **investing strategically**? 5r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

This research directly supports safer travel during adverse winter weather by enabling more efficient and timely maintenance and response operations. By optimizing fleet allocation, routing, and resource use, the project helps ensure that winter maintenance operations run more efficiently directly saving time and costs. These gains in operational efficiency improve safety for the traveling public (5m) and maintains accessibility and livability for communities that may otherwise become congested (or even isolated) during severe winter events (5n).

The project leverages advanced operations simulation techniques integrated with GIS to process large volumes of spatial and operational data. This data-driven approach will provide ODOT with optimized resource allocation strategies and more strategic investment guidance, ultimately enhancing roadway safety and reducing risk for all travelers (5q).

6. Corresponding Submitter's Contact Information:

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7. ODOT Sponsor Contact Information (Required if Submitter is not an ODOT employee)

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This form is not a grant application or contract document. Please do not include proprietary information on this form. Once this form is received ODOT may revise and publish the problem statement. If selected, ODOT will assign investigator(s) of the department's choosing to conduct research.