

Research Stage 1 Problem Statement

PROPOSED TITLE: Surveying Targeted Locations at High-Risk of the Road Contaminant 6PPD-Q and Developing Cost-Effective Tools for Road-Runoff Remediation

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

A biproduct of the predominant antiozonant tire chemical 6PPD, 6PPD-Q has recently been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels in coho and other Oregon species¹. Species are primarily exposed by untreated stormwater runoff from road surfaces¹. A field validated 6PPD-Q transport model suggests 6PPD-Q accumulates on high-traffic roadways and is rapidly delivered to streams by stormwater system outfalls². A national reconnaissance effort³ and data from ODOT's Stormwater Technology Testing Center⁴ and Portland metropolitan area⁵ suggest 6PPD-Q may exceed the EPA screening value of 11 ng/L in highway runoff and urban stream water, and is especially high in high-traffic road-runoff and downstream of large outfalls. While not yet regulated, EPA has issued an advance notice of proposed rulemaking on 6PPD-Q prompting information gathering on the potential risks⁶. Leveraging state-scale mapping efforts together with field measurements of 6PPD-Q provides an opportunity to define the extent of the issue in Oregon and identify hotspot locations (e.g., high-traffic areas and impervious surfaces) for targeted action. Encouragingly, recent work has identified biofiltration as a cost effective and targeted potential solution to a possibly widespread problem. Several studies have shown that highway runoff filtered through amended soils removes 6PPD-Q to levels no longer toxic to coho salmon⁷⁻¹⁰. Investigations of the biofiltration capacity of ODOT right-of-way as well as stormwater treatment are warranted to develop cost effective BMPs for 6PPD-Q removal.

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

A focused approach is necessary to address the issue across ODOT's network of roadway and right-of-way. Therefore, this research will: **1. Develop tools to identify 6PPD-Q hotspots;** and **2. Assess current stormwater biofiltration effectiveness and potential new BMPs.** Mapping efforts will inform 6PPD-Q field sampling and provide a tool for targeted action. Fate and transport models and 6PPD-Q measurements will inform stormwater treatment effectiveness at anticipated hotspots. To note, ODOT has invested in an FHWA Pooled Fund that includes 6PPD-Q sampling across partner states. The proposal outlined here would provide critical information on targeted locations under ODOT jurisdiction, which is currently sparsely sampled. The generated map tools, datasets, and summary reports will:

1. Develop tools to identify 6PPD-Q hotspot locations along critical habitat

Integrated mapping tools that leverage existing layers will be developed/retrofit to identify 6PPD-Q hotspots that intersect with the distribution of sensitive species. Of use to this project, ODFW has recently released a draft coho vulnerability assessment model based on coho distribution and pollution estimates integrating EPA's National Pollutant Stream Network with impervious surface

datasets¹¹. Additionally, the USGS released a national scale 6PPD-Q hotspot map based on average consecutive dry days, road and traffic statistics, basin statistics, road-stream crossings, and precent impervious surfaces¹². Finally, WA Ecology has focused efforts on ecosystem-based mapping combining transportation and watershed characteristics¹³. Several aspects of this previous work will be utilized to generate tools that identify hotspots at the state and municipal or watershed level, and that may be adapted with green infrastructure, stormwater outfalls, measurements of 6PPD-Q, temporal changes, and soil and vegetation data.

Mapped hotspot locations will inform a 6PPD-Q field campaign. Sampling will capture the first flush from fall/winter rains likely to contain the highest levels of 6PPD-Q and will monitor 6PPD-Q levels under different flow conditions and at different stages of sensitive species migration. A focus site such as the coho bearing urban streams Johnson Creek¹⁴ and Beaver Creek⁵ will be selected for higher density sampling. Given that 6PPD-Q measurements are costly and often challenging¹⁵, promising 6PPD-Q proxies (fluorescence, zinc, cadmium, copper, TSS)¹⁶ can be investigated to extend the survey.

2. Identify if ODOT right-of-way and biofiltration facilities and potential new BMPs remove 6PPD-Q to below the EPA screening value.

Fate and transport models will inform BMPs for 6PPD-Q biofiltration. The EPA applied their Visualizing Ecosystem Land Management Assessment (VELMA) ecohydrology model to simulate urban watershed fate and transport of 6PPD-Q¹⁷, and the USGS is in Phase 1 of applying their Stochastic Loading and Dilution Model (SELDM) to simulate 6PPD-Q in highway and urban runoff to receiving streams in Oregon¹⁸. VELMA suggests that 6PPD-Q is primarily sorbed by soil carbon in the top 1 m of the soil layer¹⁷, suggesting that vegetated right-of-way may already remove 6PPD-Q; this must be confirmed by 6PPD-Q measurements in soil porewater. These models can be used and adapted to assess passive (e.g., vegetated right-of-way) and active (e.g., flow-through stormwater treatment facilities like bioslopes and bioswales) biofiltration for 6PPD-Q removal.

Samples will be taken along right-of-way near the identified hotspot to determine the effectiveness of unaltered and unamended roadside embankments. Samples will also be taken within targeted stormwater biofiltration facilities¹⁹. Soil media used in ODOT bioswale projects are native soils, or amended/imported soils for organic matter, infiltration, or quality standards compliance²⁰. Given the cost and logistics of implementing or retrofitting facilities with soil additives, it is critical to first acquire baseline data on 6PPD-Q concentrations filtered through soil mixes within current ODOT biofiltration facilities. Sampling will include inflow, groundwaters, and outflow of passive and active biofiltration systems. Remaining water will be preserved and sampled for metal toxins, total phosphorus, and other stormwater contaminants of concern likely to be impacted by biofiltration. New promising BMPs for 6PPD-Q removal, including porous pavement⁵ and adsorptive materials²¹ can be explored through simulations and applications by partnering groups^{5,17,4} to inform applied science and engineering solutions.

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.

Name	Title	Email	Phone
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4. Other comments:

Citations

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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:

5b Justification: This work will provide data that informs the effectiveness of the current best management practice for soils in bioswales. An update to best management practices may include, for example, biofiltration media within the high performance biofiltration soil mixes currently adopted by WA Department of Ecology²². The sourcing of this media, particularly the product coconut coir, which is not locally available, is likely to have a climate impact that will need to be assessed.

5e Justification: 6PPD-Q from highway runoff has been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels²³, and demonstrates the potential for wider effects to aquatic ecosystem health^{24, 25}. New research has shown that 6PPD-Q is also harmful to other aquatic species present in Oregon and included in Oregon's ODFW Habitat Conservation Plans, including rainbow trout and steelhead ($LC_{50} = 0.64, 1, 2.26$ ng/L), chinook salmon ($LC_{50} = 67.3, 82.1$ ng/L) and coastal cutthroat trout (LC_{50} likely similar to coho)²⁶. This work supports Oregon State Executive Order 25-26 Sections 3a and b²⁷ by increasing the protection of receiving waters and helping restore breeding populations of affected species (e.g., coho salmon).

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:

5i and 5k Justification: This research aims to survey hotspot locations and assess current strategies to filter out the toxic tire-derived chemical 6PPD-Q from entering coho bearing streams in anticipated hotspot areas. This sampling will provide the first insights into the extent and magnitude of 6PPD-Q contamination across Oregon. Our study aims support ODOT priorities for social equity: to invest in the protection of marginalized communities from environmental hazards. 6PPD-Q from highway runoff has been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels²³, and demonstrates the potential for wider effects to aquatic ecosystem health^{24, 25}. Although little is known of its effects on human health²⁸, 6PPD-Q has been measured in adults, pregnant people, and children^{29, 30} and has reproductive toxicity in mammals with prolonged exposure³¹. If adverse impacts of human exposure to 6PPD-Q are found, there is likely a direct environmental justice concern for near roadway communities already impacted by air pollutant exposure^{32, 33}. The loss of coho salmon and potential food web and ecosystem effects have direct and indirect impact to communities, in particular Pacific Northwest Tribal Nations for which salmon have cultural and economic importance³⁴. This proposal will help identify best management practices for reducing environmental and human exposures through biofiltration along ODOT roadways.

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:

6. Corresponding Submitter's Contact Information:

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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.