# SPR RESEARCH PROGRAM
# SECOND-STAGE PROPOSAL SUMMARY

## PROBLEM NUMBER AND TITLE

**27-42: Road Salt Mitigation with Low-Cost Biochar Application**

## PROBLEM SUMMARY

Chloride based road salt is a critical life safety countermeasure. ODOT's winter maintenance strategy is structured to incorporate environmental protection best practices with a safety-first approach of using *"the right tool, at the right time, in the right place."* However, providing safe transportation during adverse winter weather conditions while also supporting environmental sustainability is a pressing challenge as chlorides from road salt are highly mobile, may persist year-round in receiving waters, and conventional stormwater treatment facilities are not designed to remove chloride. ODOT sponsored research by the USGS recently confirmed elevated deicer-related signal in I5 Siskiyou Pass watersheds and potentially groundwater.

## ODOT OBJECTIVES

Emerging evidence suggests that biochar-amended soils may immobilize $Na^+$ and $Cl^-$ associated with road salt through electrostatic and adsorption interactions to potentially mitigate transport in soils and drainage systems. Integrating biochar into roadside drainage media or deployable filters may provide a practical approach for mitigating road-salt impacts that is supported by lab and field-based evidence. **The objective of this research is to evaluate whether biochar mitigation can provide a low-cost, durable, and scalable roadside treatment** that measurably reduces chloride concentrations in highway runoff across multiple seasons, without creating unacceptable risks of hydraulic failure or chloride release. This work will:

1) Establish the optimal biochar concentration and filtration-media blend for chloride uptake and retention under controlled conditions,
2) Develop field testing approach to determine biochar performance (chloride removal) and longevity (residence time, breakthrough) in an active highway drainage environment at Siskiyou Pass, leveraging two previous ODOT chloride contamination field studies at Carter and Wall Creek.
3) Develop time and materials cost information and implementation protocols for Districts.

## BENEFITS

With increasing customer demand for clearer roads under winter conditions, together with the need to balance both maintenance costs and environmental impact costs from chloride application, ODOT needs a methodology that mitigates the environmental risks of road salt. This proposal will evaluate the potential low-cost solution of biochar. The proposed objectives support agency priorities for process and material improvements, climate, safety and low-cost environmental stewardship practice, as well as protect ODOT's assets by reducing direct chloride damage, reducing wildfire risk to assets and reducing surface, ground and soil contamination risk.

## SCHEDULE, BUDGET AND AGENCY SUPPORT

***Estimated Project Length***: 40 months.
***Estimated Project Budget:*** $485,000
***ODOT Support: Alvin Shoblom (State Hydraulic Engineer), Patti Caswell (Maintenance Env. Program Manager)***

## FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/27-42.pdf

# SPR RESEARCH PROGRAM
# SECOND-STAGE PROBLEM STATEMENT
# FY 2027

## PROBLEM NUMBER AND TITLE

**27-42: Road Salt Mitigation with Low-Cost Biochar Application**

## RESEARCH PROBLEM STATEMENT

Chloride based road salt is a critical life safety countermeasure. ODOT's winter maintenance strategy is structured to incorporate environmental protection best practices with a safety-first approach of using *"the right tool, at the right time, in the right place."* However, providing safe transportation during adverse winter weather conditions while also supporting environmental sustainability is a pressing challenge as chlorides from road salt are highly mobile, may persist year-round in receiving waters, and conventional stormwater treatment facilities are not designed to remove chloride. ODOT sponsored research by the USGS recently confirmed elevated deicer-related signal in I5 Siskiyou Pass watersheds and potentially groundwater.

Biochar has high porosity and surface area, which makes it a strong candidate for filtering and adsorbing contaminants in stormwater systems, including sodium and chloride. In support of this concept, recent research using roadside soil cores amended with biochar suggests that biochar may ameliorate osmotic stress in vegetated strips through adsorption (Finnegan et al., 2026), and potentially electrostatic interactions (Pahlahav et al., 2023). However, important information gaps remain that limit adoption:

- there is no standardized, low-cost and deployable roadside format specifically designed for chloride mitigation (e.g., modular filter socks or "biobags" placed at runoff entry points);
- the optimal biochar fraction and filter-media blend for chloride uptake under realistic flow conditions is unknown;
- the risk of chloride desorption after repeated exposure and drying–rewetting cycles has not been adequately quantified; and
- the field durability and seasonal performance of biochar-filled bags under snow-plow operations, freeze–thaw cycles, and high-sediment highway runoff has not been evaluated.

As a result, ODOT currently lacks a defensible, low-cost, and field-ready chloride mitigation option that can be deployed rapidly without major reconstruction of drainage infrastructure.

## RESEARCH OBJECTIVES

Emerging evidence suggests that biochar-amended soils may immobilize $Na^+$ and $Cl^-$ associated with road salt through adsorption and electrostatic interactions to potentially mitigate transport in soils. Integrating biochar into roadside drainage media or deployable filters may provide a practical approach for mitigating road-salt impacts that is supported by lab and field-based evidence. **The objective of this research is to evaluate whether biochar mitigation can provide a low-cost, durable, and scalable roadside treatment** that measurably reduces chloride concentrations in highway runoff across multiple seasons, without creating unacceptable risks of hydraulic failure or chloride release. This work will:

1) Establish the optimal biochar concentration and filtration-media blend for chloride uptake and retention under controlled conditions,
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(residence time, breakthrough) in an active highway drainage environment at Siskiyou Pass, leveraging two previous ODOT chloride contamination field studies at Carter and Wall Creek.

3) Develop time and materials cost information and implementation protocols for Districts.

## WORK TASKS, COST ESTIMATE AND DURATION

*Task 1: Focused literature review.* Synthesize relevant studies to assist with experimental design and analysis of biochar methodology for reduction of chloride.

*Task 2: Develop experimental design for benchtop testing.* Using the literature review from Task 1, the research methodology will be developed in consultation with the Technical Advisory Committee.

*Task 3: Benchtop experiments.* Determine optimal biochar material, formulation, residence time, particle size distribution, and concentration for high chloride adsorption and minimal desorption.

*Task 4: Develop field design for testing biochar application.* Using the literature review from Task 1 and findings from Task 3, develop pilot design and establish analysis methods.
develop pilot testing strategy in consultation with the Technical Advisory Committee.

*Task 5: Field testing and analysis.* Active drainage sites will be tested and analyzed to evaluate performance under operating conditions, most likely at Oregon's I5 Siskiyou Pass to leverage precedent data from SPR812 with the USGS.

*Task 6: Simplified cost analysis.* Determine cost feasibility for implementation, including sourcing, reliability, personnel needs, safety, and risk.

*Task 7: Reporting and implementation outreach.* Technical report covering all tasks will be delivered. Research team will also provide recommendations for implementation and serve as an advisor if needed for implementation plan development.

***Key Deliverables:*** *Biochar mix, cost benefit analysis, implementation protocols, final report*
***Estimated Project Length***: 42 months.
***Estimated Project Budget:*** $485,000

## EXPECTED ODOT IMPLEMENTATION ACTIONS

The NCHRP has funded two previous IDEA Program studies (IDEA 182, IDEA 211) to further DOT knowledge and practice of the costs and benefits derived from adding biochar to roadway soils. One study concluded that biochar is less expensive than 21 other BMPs – up to 10 times less (IDEA 211). If this project is successful, ODOT can use this research to make data-driven decisions on whether biochar could be used in current stormwater control measures (e.g. mixed with media in bioslope) and serve as a cost-effective supplement to existing stormwater practices for chloride mitigation in winter-maintenance corridors.

## POTENTIAL BENEFITS

With increasing customer demand for clearer roads under winter conditions, together with the need to balance both maintenance costs and environmental impact costs from chloride application, ODOT needs a methodology that mitigates the environmental risks of road salt. This proposal will evaluate the potential low-cost solution of biochar. The proposed objectives support agency priorities for process and material improvements, climate, safety and low-cost environmental stewardship practice, as well as protect ODOTs assets by reducing direct chloride damage, reducing wildfire risk to assets and reducing surface, ground and soil contamination risk.

## PEOPLE

***ODOT champion(s):*** Alvin Shoblom (State Hydraulic Engineer), Patti Caswell (Maintenance Environmental Program Manager)

***Problem Statement Contributors:*** Paris Edwards (Adaptation and Resilience Program Manager), Jennie Morgan (Stormwater Asset Management Coordinator), Ted Hart (Environmental Program Coordinator), Kira Glover-Cutter (Principal Research Analyst)

# REFERENCES


Ali, Shafaqat, et al. "Biochar soil amendment on alleviation of drought and salt stress in plants: a critical review." *Environmental Science and Pollution Research* 24.14 (2017): 12700-12712. Found 2/17/26 at: https://link.springer.com/article/10.1007/s11356-017-8904-x

Finnegan, Maxwell, et al. "Biochar reduces road-salt-induced osmotic stress and improves plant water availability in green stormwater infrastructure." *Water Research* (2026): 125598.

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Nakhli, S. A. A., Hegberg, C. H., & Imhoff, P. T. (2021). *Reducing stormwater runoff with biochar addition to roadway soils* (No. NCHRP IDEA Project 211). onlinepubs.trb.org/onlinepubs/IDEA/FinalReports/Highway/NCHRP211.pdf

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Pahlavan, F., Ghasemi, H., Yazdani, H., & Fini, E. H. (2023). Soil amended with Algal Biochar Reduces Mobility of deicing salt contaminants in the environment: An atomistic insight. *Chemosphere*, *323*, 138172. Found 2/17?26 athttps://www.sciencedirect.com/science/article/pii/S0045653523004393

Wang, H., Garg, A., Ping, Y., Sreedeep, S., & Chen, R. (2023). Effects of biochar derived from coconut shell on soil hydraulic properties under salt stress in roadside bioretention. *Waste and Biomass Valorization*, *14*(3), 1005-1022. Found 2/17/26 at https://link.springer.com/article/10.1007/s12649-022-01877-9.

# STAFF REVIEW PAGE

## LITERATURE CHECK

**TRID&RIP**

☒ A review of TRID & RIP databases found no existing research that answers the research question

## ODOT DECISION LENSES

***Climate:*** Climate change is increasing the risk of drought, wildfire and ecosystem sensitivity at the Siskiyou Pass and across Oregon. This study will reduce risk to roadside vegetation health and related wildfire risk at a very high-risk location, and it will reduce the risk of damage to water quality and aquatic habitat. The increased risk of severe winter storms and intense rainfall events due to climate change requires improve resilience to chloride contamination of soils and receiving waters. Previous study at the proposed location indicates that large precipitation events lead to pulses of chloride mobilizing from soil to nearby streams in large pulses. The proposed work measures the potential benefits of a BMP that will improve system resilience to the negative impacts of chloride deicer use.

***Equity:*** This work does not focus on equity, but it aligns with equity by mitigating impacts to water sources, cultural practices, fisheries and ecotourism that are highly valued by Tribes and surrounding rural communities. The segment of 1-5 proposed for study runs through an area experiencing "low-medium" levels of social disparity, according to ODOT's social disparity index.

***Safety:*** The use of deicer is currently a standard winter safety practice but it has significant drawbacks that may face increased scrutiny as climate stressors mount, and as ODOT contributions to land and water protections are called for state leadership and other state agencies (EO 25-26). By testing a low cost, high potential mitigation strategy for chloride contamination damage, ODOT is investing in reducing infrastructure, truck and environmental impacts, while retaining road safety practice.

## TECHNOLOGY & DATA ASSESSMENT

☒ No Identified T&D output

☒ At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

## CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units. `Hydraulics and MOB`
- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns. NA