SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

27-25 Using Recycled Asphalt Pavements (RAP) for Pavement Preservation to Reduce Material Costs and Environmental Impact

PROBLEM SUMMARY

With rising asphalt concrete paving costs and declining annual paving lane miles, affordable pavement preservation treatments such as chip seals are becoming increasingly important. The 2024 ODOT Pavement Condition Report shows paving lane miles have declined since 2015 due to budget constraints, while chip sealed lane miles continue to increase and are projected to grow over the next decade. As chip seals become a larger share of Oregon's preservation strategy, their design and construction must be optimized to maximize cost-effectiveness, durability, and sustainability.

Incorporating recycled asphalt pavement (RAP) aggregates into chip seals can reduce virgin asphalt binder use, lower material costs, and decrease greenhouse gas (GHG) emissions. Findings from SPR858, which included only a limited laboratory assessment, demonstrated improved adhesion and potential binder reduction. However, feasible binder reduction limits and long-term performance impacts have not been fully validated. A systematic, performance based investigation supported by laboratory testing, life cycle assessment (LCA), life cycle cost analysis (LCCA), and field validation is required to optimize binder content, avoid chip loss or bleeding, and enable statewide implementation.

ODOT OBJECTIVES

- Develop performance based design and construction guidelines for RAP-based chip seals.
- Determine optimum RAP types, emulsion contents, and maximum feasible binder reduction levels.
- Validate laboratory findings through field pilot sections and long-term performance monitoring.
- Quantify environmental and economic impacts using LCA and LCCA.
- Improve RAP management, production practices, and implementation strategies statewide.

BENEFITS

This research supports RAC priorities and the OTP by improving cost efficiency, advancing sustainable materials, strengthening stewardship of public resources, and enhancing performance.

Key benefits include reduced preservation costs and measurable GHG emission reductions through lower virgin binder use; extended chip seal service life through performance based design; improved investment decision making using LCA and LCCA; better utilization of existing RAP stockpiles; and greater preservation coverage under constrained budgets. By enabling more roadway miles to remain in "fair or better" condition, the project supports lower network-level roughness, reduced fuel consumption, and lower road user-related emissions while helping manage rising paving costs.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 36 months.

Estimated Project Budget: $365,000

ODOT Support:

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FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/27-25.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2027

PROBLEM NUMBER AND TITLE

27-25 Using Recycled Asphalt Pavements (RAP) for Pavement Preservation to Reduce Material Costs and Environmental Impact

RESEARCH PROBLEM STATEMENT

With the rising costs of asphalt concrete paving, more affordable pavement preservation options, such as chip seals, are becoming increasingly essential. The 2024 ODOT Pavement Condition Report shows that the number of lane miles paved annually has declined since 2015, largely due to rising paving costs and reduced budgets. Despite this decline, chip sealed lane miles have been gradually increasing and are projected to continue growing over the next decade. As chip seals become a larger component of Oregon's pavement preservation strategy, it is critical to optimize their design and construction to maximize cost-effectiveness, durability, and sustainability.

Chip seals offer a high benefit to cost ratio and are particularly effective at sealing surface cracks and enhancing pavement conditions by adding a protective layer. This process often improves ride quality, reduces roadway roughness, and enhances user comfort. Modifications to the current chip seal process and specifications that allow for the incorporation of recycled asphalt pavement (RAP) aggregates could lead to significant cost savings and reductions in greenhouse gas (GHG) emissions. However, while preliminary findings from previous Oregon research studies indicate that RAP aggregates may improve adhesion and allow reductions in virgin asphalt binder content, these findings were based on limited laboratory evaluations and have not been validated through comprehensive testing and field performance monitoring.

Therefore, building on the findings from ODOT Research Project SPR858, there is a need for a systematic and comprehensive investigation to determine the optimum RAP types, emulsion contents, and design parameters that will allow successful implementation of RAP-based chip seals in Oregon without compromising performance. SPR858 demonstrated that RAP aggregates can improve adhesion and potentially allow reductions in virgin asphalt binder content, however, the extent of binder and emulsion reduction and the associated performance implications have not been fully quantified. Reducing virgin binder content in chip seal emulsions has the potential to generate significant cost savings and meaningful reductions in GHG emissions, but these benefits must be achieved without increasing the risk of chip loss (due to low binder content and poor adhesion between the aggregates and the binder) or bleeding (due to excessive binder content). Since the aged binder around RAP aggregates can gradually blend into the thin emulsion layer under traffic and climatic effects, the virgin binder content must be carefully selected to balance durability and constructability. Implementing performance based guidelines supported by laboratory testing, life-cycle assessments, and field validation is required to allow specification revisions and statewide implementation.

RESEARCH OBJECTIVES

The primary objective of this proposed research project is to develop performance based design and construction guidelines for the successful implementation of RAP-based chip seals in Oregon. Building on the findings from SPR858, the study will evaluate RAP aggregates in combination with different emulsion types and application rates to determine the optimum design parameters that will minimize chip loss and bleeding while maintaining long-term performance.

A second objective is to determine the maximum feasible binder and emulsion reduction levels without compromising constructability and durability, using RAP aggregates. Laboratory findings will be validated through field pilot sections.

Another objective is to quantify the environmental and economic impacts of RAP-based chip seals through pavement life cycle assessment (LCA) and life cycle cost analysis (LCCA) conducted based on the final optimal designs identified in the laboratory phase. This component will quantify GHG emission reductions, long-term cost benefits, and compare the environmental impacts of producing RAP chips versus leaving RAP piles unused.

The study will also determine how RAP piles are managed across the state, including differences in ownership and availability. The impacts of alternative centralized RAP deposit strategies will be assessed at statewide and regional levels, with focus on Regions expected to rely more heavily on chip sealing. In addition, practical production considerations such as optimal crushing methods, number of screening stages, management of top and bottom byproducts, and potential contractor incentive mechanisms will be investigated. The final objective is to validate the selected strategies through long-term monitoring of pilot sections and translate the findings into specification revisions and implementation guidance.

WORK TASKS, COST ESTIMATE AND DURATION

Task 1: Literature Review and Synthesis of Previous ODOT Research: A comprehensive review of national and international literature on RAP-based chip seals will be conducted, along with a synthesis of findings from SPR858 and other ODOT studies. Knowledge gaps related to adhesion, binder reduction limits, RAP processing, constructability, and environmental impacts will be identified to guide the experimental program.

Task 2: Statewide RAP Management and Production Feasibility Assessment: Current RAP pile management practices across Oregon will be documented, including variations in ownership, stockpiling, processing, and regional availability. The impacts of alternative centralized RAP deposit strategies will be evaluated at statewide and regional levels, particularly in Regions expected to rely more heavily on chip sealing. Practical production considerations for RAP chip manufacturing will also be assessed, including crushing methods, number of screening stages, gradation control, management of top and bottom byproducts, and the influence of processing on material quality. Potential contractor incentive mechanisms to encourage RAP chip production will also be examined.

Task 3: Laboratory Evaluation of RAP-Based Chip Seal Designs: A comprehensive laboratory investigation will be conducted to determine optimum RAP types, crushing and screening configurations, emulsion types, and application rates. Pull-off testing developed in SPR858 will be performed to assess adhesion and chip retention. The Hamburg Wheel Tracking Test (HWTT) will be used to evaluate bleeding and chip loss under moisture and traffic loading. The laser-based texture scanning system developed in SPR858 by OSU-AMaP will monitor chip embedment and surface texture changes during the HWTT. Maximum feasible reductions in virgin binder and emulsion content will be determined without compromising durability or constructability.

Task 4: Field Pilot Sections and Implementation: Field pilot sections will be constructed using the most promising RAP-based chip seal designs identified based on laboratory results. Construction practices, material variability, and short term performance will be documented to validate laboratory findings under actual traffic and climatic conditions.

Task 5: Life-Cycle Assessment (LCA) and Life-Cycle Cost Analysis (LCCA): Pavement LCA and LCCA will be conducted based on the final optimal designs validated through laboratory and field evaluations. GHG emission reductions and long-term cost benefits will be quantified and the environmental impacts of producing RAP chips will be compared to leaving RAP piles unused.

Task 6: Long Term Performance Monitoring and Specification Development: Long term performance of pilot sections will be monitored by ODOT using Automated Pavement Condition

Surveys (APCS) and the laser-based texture evaluation procedures developed in SPR858. The research team will analyze the collected data to determine the benefits and issues of RAP-based chip seals. The findings will be translated into performance-based design recommendations, specification revisions, and implementation guidance for statewide adoption.

Key Deliverables:

1. Performance based design guidelines and specification revisions for statewide implementation.
2. Validated lab test methods for adhesion, bleeding, chip loss, and embedment.
3. Field validated pilot section performance data under Oregon's traffic and climate conditions.
4. LCA and LCCA results quantifying GHG reductions and long term cost impacts.
5. Evaluation of RAP pile management strategies, including centralized deposit scenarios and contractor incentive considerations.
6. Practical guidance for RAP chip production, including crushing, screening, and management.
7. Final implementation focused research report with recommendations for ODOT.

Estimated Project Length: **36 months.**
Estimated Project Budget: **$365,000**

EXPECTED ODOT IMPLEMENTATION ACTIONS

ODOT is expected to implement the findings of this research through revisions to chip seal specifications to allow the use of RAP aggregates and performance-based binder and emulsion reduction limits. The validated laboratory procedures and field performance data will be incorporated into quality assurance and project selection practices. The LCA and LCCA results will support sustainability reporting and long-term investment decisions. In addition, evaluating and revising RAP pile management strategies and contractor incentive mechanisms based on the findings of this research study will inform material management policies and preservation planning across the state.

POTENTIAL BENEFITS

This proposed research study directly supports ODOT Research Advisory Committee (RAC) priorities and key objectives of the Oregon Transportation Plan by improving cost efficiency, advancing sustainable materials use, improving system performance, and strengthening stewardship of public resources. The specific benefits are:

1. Reduced preservation costs and measurable GHG emissions through lower virgin binder use and improved material efficiency supporting ODOT's climate and sustainability goals.
2. Extended chip seal service life and reduced chip loss through performance based design.
3. Improved preservation decision making using LCA and LCCA supported investment strategies.
4. Better utilization of existing RAP stockpiles, reducing waste and long term storage liabilities.
5. Enhanced contractor guidance and incentives to improve RAP chip production and use.
6. Greater preservation coverage under constrained budgets by optimizing chip seal performance and reducing cost.
7. Reduced risk of rising paving costs and missed sustainability targets.

PEOPLE

ODOT champion(s):

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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: Chip seals are low-cost pavement preservation options that are especially important in this low-paving-budget environment. As paving costs continue to increase and the number of lane miles paved each year declines, cost effective treatments such as chip seals allow ODOT to maintain a larger portion of the roadway network in "fair-or-better" condition. Incorporating RAP aggregates and reducing virgin binder content can further lower material costs and improve efficiency, enabling broader preservation coverage under limited budgets.

Maintaining more roadway miles in good condition helps reduce network-level roughness, which directly affects fuel consumption and vehicle emissions. A previous ODOT/FHWA research study (Coleri et al., 2025) conducted by the OSU-AMaP research group showed that reducing pavement roughness can result in substantial fuel savings and associated reductions in GHG emissions for road users. Therefore, improving the cost-effectiveness and sustainability of chip seals through RAP utilization not only reduces material production-related emissions, but also supports smoother pavement surfaces and lower user-related emissions across the transportation system.

Equity: This research is not focused on equity and will not include analysis of equity.

Safety: This study is not specifically focused on safety analysis; however, improved chip seal design that reduces chip loss and bleeding can provide indirect safety benefits. Reducing chip loss helps minimize windshield damage caused by dislodged aggregates, while controlling asphalt binder bleeding helps maintain pavement surface texture and skid resistance, particularly during wet conditions. In addition, reduced treatment costs can allow broader chip seal application across the network, improving overall pavement surface conditions and skid resistance, which may contribute to reduced crash potential. Therefore, although safety is not the primary focus, improved performance and expanded preservation coverage resulting from this research can indirectly enhance roadway safety for users.

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.
    - Pavement Services Unit
    - Maintenance Unit

- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns.
    - None