

SPR RESEARCH PROGRAM

SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

26-63 Develop Guidance on the Safety Performance of Edge Line Pavement Markers and Guardrail Delineations on Rural Oregon Roads

PROBLEM SUMMARY

Despite Oregon's efforts to reduce fatalities and serious injuries, crashes along curves (statewide) continue to be high-risk locations, particularly those involving roadway departures. Contributing factors such as speed, visibility, pavement quality, limited delineation, and adverse weather conditions exacerbate these risks. While Oregon incorporates edge line pavement markers and guardrail delineations, there is limited research on their safety performance on Oregon specific rural roads. It will also investigate whether combining edge line pavement markers with guardrail and barrier delineations as part of a systemic safety countermeasure strategy provides greater safety benefits than applying treatments individually.

ODOT OBJECTIVES

This research will produce a guidance document outlining recommendations for the use of edge line pavement markers and guardrail delineations on rural curves. The document will provide:

- criteria for identifying high-risk curves where these treatments will be most effective, considering factors such as crash history, speed, curve geometry, and environmental conditions;
- guidance on combining edge line pavement markers with guardrail and barrier delineations as a systemic safety countermeasure strategy to achieve greater safety benefits;
- scalable solutions tailored to rural curves that address Oregon's unique roadway environments and crash patterns; and
- performance evaluation framework for ongoing assessment and monitoring of these countermeasures.

BENEFITS

This study will help guide ODOT to incorporate edge line pavement markers and guardrail delineations to achieve the most safety benefit with cost efficiency. If not studied, ODOT staff will make case-by-case decisions based on engineering judgement, but without the benefit of empirical findings on their effectiveness.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 18 months.

Estimated Project Budget: \$180,000

ODOT Support:

- Eric Finney, Engineering Manager, eric.finney@odot.oregon.gov

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:

<https://www.oregon.gov/odot/Programs/ResearchDocuments/26-63>

SPR RESEARCH PROGRAM

SECOND-STAGE PROBLEM STATEMENT

FY 2025

PROBLEM NUMBER AND TITLE

26-63 Develop Guidance on the Safety Performance of Edge Line Pavement Markers and Guardrail Delineations on Rural Oregon Roads

RESEARCH PROBLEM STATEMENT

Despite Oregon's efforts to reduce fatalities and serious injuries, crashes along curves (statewide) continue to be high-risk locations, particularly those involving roadway departures. Contributing factors such as speed, visibility, pavement quality, limited delineation, and adverse weather conditions exacerbate these risks. While Oregon incorporates edge line pavement markers and guardrail delineations, there is limited research on their safety performance on Oregon specific rural roads. It will also investigate whether combining edge line pavement markers with guardrail and barrier delineations as part of a systemic safety countermeasure strategy provides greater safety benefits than applying treatments individually. By addressing this through a Safe System Approach lens, the study will develop recommendations that support one of Oregon's rural safety challenges and may be incorporated into existing design and guidance manuals. Previous research provides a strong basis for improvements in Oregon through this study. Driving simulator research shows the combination of median markings and horizontal warning signs impact driver behavior differently, which may be useful in guiding the combination of methods in the present problem statement (Babić and Brijs, 2021). Large-scale, naturalistic driving data shows the importance of curve infrastructure design on safety, but does not address the specific issues needed by this problem statement (Claros, et al., 2024). Guardrail height may significantly effect driver behavior, especially the lateral placement of a vehicle in curves (Lioi, et al., 2022). The only related study in Oregon provides evidence supporting construction practices that could support edge delineation (Dixon and Xie, 2012). This cursory review of related research supports further analysis of the problem of rural curve delineation for safety in Oregon.

RESEARCH OBJECTIVES

This research will produce a guidance document outlining recommendations for the use of edge line pavement markers and guardrail delineations on rural curves. The document will provide:

- Criteria for identifying high-risk curves where these treatments will be most effective, considering factors such as crash history, speed, curve geometry, and environmental conditions.
- Guidance on combining edge line pavement markers with guardrail and barrier delineations as a systemic safety countermeasure strategy to achieve greater safety benefits.
- Cost-effective, scalable solutions tailored to rural curves that address Oregon's unique roadway environments and crash patterns.
- Additionally, the research will include a performance evaluation framework for ongoing assessment and monitoring of these countermeasures.
- Findings could potentially be integrated into Oregon's Highway Design Manual and other applicable guidance to ensure alignment with the Safe System Approach and statewide safety goals. The deliverables will also support local and state agencies in prioritizing investments in proven safety countermeasures that reduce roadway departure crashes on high-risk curves.

WORK TASKS, COST ESTIMATE AND DURATION

Task 1: TAC Meeting #1 will bring the TAC and research team together to identify agency needs on the use of

edge line pavement markers and guardrail delineations on rural curves, including review of planned project tasks and timeline.

Task 2: Draft Literature Review will address peer-reviewed research on safety effectiveness of edge line pavement markers and guardrail delineations, in addition to state DOT design, construction, maintenance and operation practices along rural curves.

Task 3: Draft Research Methodology will include an in-depth analysis of rural curves in Oregon to identify segments with high crash rates, and those with and without edge line pavement markers and guardrail delineations. The research method will address causal approaches, such as difference-in-difference regression, that may isolate the relative protective impacts of edge line pavement markers and guardrail delineations, while controlling for speed, visibility, roadway conditions, and weather. The methodology will also include development and testing of practice-ready analysis methods for potential incorporation in ODOT standards.

Task 4: TAC Meeting #2 is intended to set the course for the completion of the project by reviewing the draft research methodology, and informing the research team of necessary changes.

Task 5: Data Collection includes the time and resources necessary to follow the Draft Research Methodology, using input from the TAC in Task 4.

Task 6: Data Analysis follows the Draft Research Methodology to provide a statistical review of results on safety in rural curves, and leverage insights from the TAC and ODOT practitioners to ensure methods are transferable to practice.

Task 7: Draft Final Report will include development of a Publication ready Draft Final Report in the prescribed ODOT report format that emphasizes practice-ready findings from the study to support implementation, and also sufficiently describes the research process and analysis to support replication of the study.

Task 8: TAC Meeting #3 will include a review of the Draft Final Report, and Draft Research Note prior to the TAC meeting.

Task 9: Final Report involves editing the Draft Final Report to incorporate edits identified by the ODOT research coordinator following TAC Meeting #3.

Key Deliverables: *The final report for this project will include a guidance document outlining recommendations for the use of edge line pavement markers and guardrail delineations on rural curves.*

Estimated Project Length: 18 months.

Estimated Project Budget: \$180,000

IMPLEMENTATION

Close engagement of the project technical advisory committee (TAC) will be key for implementation of the project, including guidance for practical design solutions on rural curves. A Research Note will be a main product for broad dissemination of findings, which could benefit other state DOTs as well. As additional of edge line pavement markers and guardrail delineations are implemented, findings from this study may be updated using a Quick Hit approach, led by the ODOT Research Unit, possibly including calculation and publication of crash modification factors in the FHWA CMF Clearinghouse.

POTENTIAL BENEFITS

The main benefit of this study will be knowledge that could lead to improved safety outcomes—a chief strategic direction in the Oregon Research Advisory Committee Priorities. Additionally, the empirical guidance could help save the agency money, by using the guidance to implement edge line pavement markers and guardrail delineations only on the rural curves where the greatest safety impact may be

realized. Conversely, not completing this study will require ODOT staff to make case-by-case decisions based on engineering judgement, but without the benefit of empirical findings on their effectiveness—potentially decreasing safety benefits and increasing costs.

PEOPLE

ODOT champion(s):

- Eric Finney, ODOT Region 3 Engineering Manager, eric.FINNEY@odot.oregon.gov

Problem Statement Contributors:

- Greg Griffin, Principal Research Analyst, greg.GRIFFIN@odot.oregon.gov
- Eric Finney, ODOT Region 3 Engineering Manager, eric.FINNEY@odot.oregon.gov

REFERENCES

Babić, D., & Brijs, T. (2021). Low-cost road marking measures for increasing safety in horizontal curves: A driving simulator study. *Accident Analysis & Prevention*, 153(0). <https://trid.trb.org/View/1769336>

Claros, B., Chitturi, M., Vorhes, G., Bill, A., & Noyce, D. A. (2024). Horizontal Curve Safety Performance Evaluation Based on Naturalistic Vehicle Lane Position Data. *Transportation Research Record: Journal of the Transportation Research Board*, 2678(10). <https://trid.trb.org/View/2362029>

Dixon, K. K., & Xie, F. (2012). Evaluation of the Safety Edge SM Application in Oregon (No. FHWA-OR-RD-12-11). Article FHWA-OR-RD-12-11. <https://trid.trb.org/View/1138332>

Lioi, A., Hazoor, A., Castro, M., & Bassani, M. (2022). Impact on driver behaviour of guardrails of different height in horizontal-vertical coordinated road scenarios with a limited available sight distance. *Transportation Research Part F: Traffic Psychology and Behaviour*, 84(0). <https://trid.trb.org/View/1899931>

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

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

Safety: This study will contribute to safety both by using the best available technologies and strategic investment. Edge line pavement markers and barrier delineations represent an ongoing part of the state's investment in safety infrastructure with new and reconstruction projects, and with maintenance. Knowing the impact of these features on rural road safety can inform the agency's use of differing technologies that could have higher or lower safety outcomes in rural areas of the state. Strategically, this study supports targeted investments by focusing on the locations with the highest potential impact, ensuing efficient investments to reduce and mitigate the costs of crashes along rural curves in Oregon.

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.
 - All ODOT Regional Traffic Sections
 - ODOT Engineering and Technical Services
- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns.
 - The Traffic Safety and Human Factors Expert Task Group found this topic to be implementable, but spatial accuracy of crash data drives analysis quality. Therefore, the research team should evaluate the spatial sensitivity of a sample of crash data to be used in this study.