SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

24-25: Integrating Climate Change Predictions into Hydrologic and Hydraulic Design

PROBLEM SUMMARY

Transportation infrastructure professionals require effective tools to account for the impacts of global climate change on hydrologic and coastal design practices. However, current design procedures rely on historical data to predict future conditions, which may not be a reliable assumption with climate change. Recognizing the complexity and potential need to incorporate climate change data into design, ODOT invested in a small research project to pilot the use of the recently published guidance document: "*NCHRP 15-61- Applying Climate Change Information to Hydrologic and Coastal Design of Transportation Infrastructure.*" The outcome of this effort indicated that more research and guidance are needed to implement incorporation of climate change into design. To bridge this gap to implementation, efficient and effective design tools, decision matrices, and a data strategy to identify and incorporate the best available datasets are needed.

ODOT OBJECTIVES

The goal of this research is to produce actionable deliverables for more confident and efficient incorporation of climate change into hydrologic and hydraulic design for our practitioners. ODOT objectives include:

- Develop a decision-making framework and flowchart for designers that navigates when and how to incorporate climate change input
- Develop user-friendly GIS tools for assessing and incorporating needed climate datasets and tools
- Develop criteria and tools for assessing quality and limitation of project analysis
- Implement data strategy for cataloging progress and build library of case studies for future work
- Develop an assessment and implementation process for a potential programmatic approach by hydrologic geographic regions
- Provide guidance documents and workshops to practitioners

BENEFITS

Climate change is likely to introduce new hydrologic risks, such as sea level rise, changes in snowmelt, and changes in precipitation intensity, duration, and frequency. Failing to consider these changing risks compromises the performance and sustainability of existing and future transportation infrastructure. Incorporation of climate change considerations into the planning and design of transportation infrastructure will likely mitigate these potential risks and ensure that transportation infrastructure can continue to operate safely and effectively, even in a changing climate. This research will provide implementable guidance for when and how to incorporate climate change into design, including estimates on hours needed and level of effort recommended by location. Further, this research also addresses the OTC and ODOT Strategic Business Plan to "ready our system for growing communities, increased commerce and the effects of climate change."

SCHEDULE, BUDGET AND AGENCY SUPPORT
Estimated Project Length: 36 months.
Estimated Project Budget: $395,000
ODOT Support: Paul R. Wirfs, Lu Saechao, Wesley Nickerman, Robert Trevis, Paris Edwards

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/24-25.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2024

PROBLEM NUMBER AND TITLE
24-25: Integrating Climate Change Predictions into Hydrologic and Hydraulic Design

RESEARCH PROBLEM STATEMENT
Transportation infrastructure professionals require effective tools to account for the impacts of global climate change on hydrologic and hydraulic design practices. However, current design procedures rely on historical data to predict future conditions, which may not be a reliable assumption with climate change. Recognizing the complexity and potential need to incorporate climate change data into hydrologic design, ODOT invested in a small research project to pilot the use of the recently published guidance document: "*NCHRP 15-61- Applying Climate Change Information to Hydrologic and Coastal Design of Transportation Infrastructure*." This pilot was part of a larger group effort with 8 other state DOTs that also piloted this new NCHRP manual. For ODOT, the findings from this larger effort included 1) more research, tools, and guidance are needed for full implementation, 2) the level of effort and resources needed will likely vary by project and might be high for more complex sites, and 3) a programmatic approach by corridor has precedent with other state DOTs and may be appropriate for ODOT given potential budget and resource constraints.

In parallel to this pilot effort, the ODOT Climate Office recently developed a statewide climate hazard and risk mapping tool that can be used at the corridor level (Figure 1). This map tool was designed to simplify the decision-making process for climate change adaptation at ODOT by highlighting priority areas where investment would most likely improve system resilience. Users can overlay historical and future climate data with information on past flood/high water events, landslides, structural conditions, and social disparities. While ODOT's Climate Hazard Risk Map has utility for planning, it does not yet have the coverage and data needed for statewide hydrologic/hydraulic project design or programmatic decision making. This proposed research will identify and address critical data gaps, develop a framework for organizing hydrology data by geographic regions, and integrate this information with the Climate Hazard Risk Map as an updated WebGIS design tool for navigating the recommendation provided in the recent NCHRP 15-61 report. This tool will also assist with assessing the potential for a programmatic approach for incorporation of climate change input for hydrologic design.

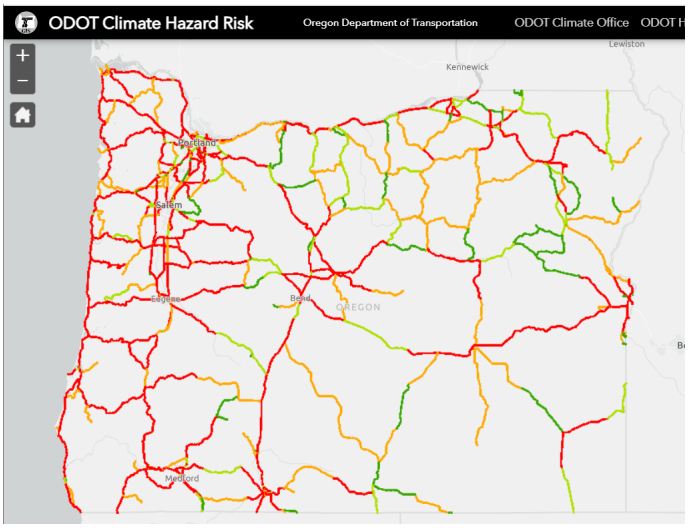

Figure 1: *ODOT Climate Hazard Risk Map. Risk for inland flooding. Red indicates highest risk, green lowest predicted risk.*

RESEARCH OBJECTIVES
Climate change effects on existing assets as well as for new designs may need to be considered to ensure long-term performance and safety. To bridge this current implementation gap for climate change incorporation in hydrologic and hydraulic design, efficient and effective design tools, decision matrices, and a data strategy to identify and incorporate the best available datasets are needed. The goal of this research is to produce actionable deliverables for more confident and efficient incorporation of climate change into hydrologic design for our practitioners. ODOT objectives include:

- Develop a decision-making framework and flowchart for designers that navigates when and how to

incorporate climate change input
- Develop user-friendly GIS tools for assessing and incorporating needed climate datasets and tools
- Develop criteria and tools for assessing quality and limitation of project analysis
- Implement data strategy for cataloging progress and build library of case studies for future work
- Develop an assessment and implementation process for a potential programmatic approach by hydrologic geographic regions
- Provide guidance documents and workshops to practitioners

WORK TASKS, COST ESTIMATE AND DURATION

Task 1: *Form Technical Advisory Committee (TAC).* For this project a subset of the TAC will also form a working group consisting of hydraulic engineers, water resource professionals, climate analysts and scientists, and academic partners. The working group will meet quarterly to discuss progress.

Task 2: Assessment of Data. Applicable, current climate data, databases, references (and limitations) will be identified, sorted, and a storage and retrieval protocol will be developed. Data gaps will also be identified.

Task 3: Case Studies. At least 4 case studies representative of inland and coastal hydrology will be performed to supplement ODOT's Millport Slough Bridge pilot of NCHRP 15-61. These locations may represent coastal, cascade, the Willamette valley, and eastern Oregon watersheds. The purpose of this effort will be to identify data gaps, establish processes, estimate level of effort needed, and identify potential steps for standardization.

Task 4: Data Needs. In addition to available data, additional site specific or site type data will likely be needed. This task will cover this data acquisition (ex. geomorphological analysis of watershed).

Task 6: Tool Development. Based on findings and needs from Task 2 and Task 3, develop automated tools for data retrieval, processing, analysis, and storage. Tools will likely include GIS based tools and any GUI developed will be Python or Microsoft based and not require Admin privileges for access or distribution.

Task 7: Develop decision matrix. Using NCHRP 15-61 guidelines and findings from Task 3, develop decision matrix and protocols that track with ODOT's Hydraulic Design Manual.

Task 8: Assess Programmatic approach: A peer summit will be coordinated with other state DOTs that successfully implemented climate change into their respective design processes. Following the peer summit and using the results from Tasks 2-7, assess the feasibility of a programmatic approach and deliver guidance.

Task 9: Communication of findings. In addition to a final report the findings from this research will be presented as workshop for ODOT's Regions. Relevant geospatial data will be integrated into ODOT platforms.

Key Deliverables: *Case Studies that can be leveraged to build a decision matrix, decision matrix and decision flowchart for designers based on select criteria (ex. project type, risk level, topology, etc.) informing when and how to incorporate climate change information for hydrologic design, GIS based tools for accessing climate data and project site specifics, protocols for data incorporation and interpretation, criteria for quality assessment, data strategy (including storage and retrieval), programmatic assessment, guidance document, workshop, GIS data integrated into ODOT platforms.*

Estimated Project Length: 36 months.
Estimated Project Budget: $395,000

IMPLEMENTATION

Implementation of this research will be led by ODOT's Hydraulic Engineering Section. If this research is successful, it is likely that elements of this research will be used to update ODOT's Hydraulic Manual. Vetted relevant GIS layers will be added to ODOT's Climate Hazard Risk Map and TransGIS. Workshops will be used to distribute the

findings and assist with questions and concerns from the Regions.

POTENTIAL BENEFITS

Climate change is likely to introduce new hydrologic risks, such as sea level rise, changes in snowmelt, and changes in precipitation intensity, duration, and frequency. Failing to consider these changing risks potentially compromises the performance and sustainability of existing and future transportation infrastructure. Incorporation of climate change considerations into the planning and design of transportation infrastructure will likely mitigate these potential risks and ensure that transportation infrastructure can continue to operate safely and effectively for Oregon, even in a changing climate. This research will provide implementable guidance for when and how to incorporate climate change into hydrologic and hydraulic design, including estimates on hours needed and level of effort recommended by location. To address the need identified from the OTC and ODOT Strategic Business Plan to "ready our system for growing communities, increased commerce, and the effects of climate change" products from this research are anticipated to be integrated into both the Hydraulic Manual as well as in design specifications such as temporary water management, bed material design, and scour mitigation.

PEOPLE

ODOT champion(s): Paul R. Wirfs (State Hydrualic Engineer), Lu Saechao (Stormwater Lead), Wesley Nickerman (Senior Bridge Hydraulic Engineer), Robert Trevis (Culvert Program Lead), Paris Edwards (Climate Office Analyst)
Problem Statement Contributors: Robert Trevis, Lu Saechao, Wesley Nickerman, Paris Edwards, Paul Wirfs, Kira Glover-Cutter

STAFF REVIEW PAGE

Literature Check

TRID&RIP

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

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.

Data will be incorporated in the Climate Hazard Risk Map and TransGIS. Database and any GUI developed will be Python or Microsoft based and not require Admin privileges for access or distribution. Databases that are not geospatial and Hydrologic or Hydraulic Engineering in nature will be owned and maintained by the Hydraulic Engineering Section.

Cross-agency stakeholders

- *Hydraulic Engineering Section*
- *Region Hydraulic Engineers*
- *Climate Office*
- *GIS for upload of Geospatial Data to TransGIS*