Research Problem Statement

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I. TITLE

17-050 Customized Design of Living Snow Fences for ODOT Highways

II. PROBLEM

If properly sited and designed, structural snow fences manufactured from wood, plastic, or metal are a proven technology to disrupt wind patterns, decelerate wind-blown snow, and constrain deposited snow in a designated area away from the pavement surface (Tabler 2003). They can reduce the negative impacts of blowing and drifting snow on roadway safety and mobility, while providing low-cost snow storage (Kumar 2014). For instance, snow fences along a section of I-80 in Wyoming were reported to reduce accidents during blowing snow conditions by 70 percent and reduce snow/ice control costs by more than 30 percent (Tabler and Furnish 1982). Areas protected by snow fences can be 10°F warmer than adjacent unprotected road pavement (Tabler 2004). Nonetheless, poorly performing snow fences may result in ineffective snow removal or, worst, in snow deposition on the roadway. Recently, a snow fence in Baker City, OR constructed at a cost of $435,000 was deemed ineffective by ODOT (http://www.bakercityherald.com/Local-News/Snow-fence-failure). Plans are currently underway to move the fence at a yet-to-be determined cost. Stories such as this demonstrate the importance of designing effective snow fences.

An emerging alternative to a structural snow fence is a living snow fence (LSF) comprised of strategically planted trees, shrubs, and prairie grasses (Fig. 1). Using natural, native vegetation as windbreaks can provide a long-lasting, low-maintenance and cost-effective solution to snowdrift in the highway environment Daigneault and Betters 2000; Heavey and Volk 2014; USDA 1994). In addition to high snow storage capacity, LSFs feature additional benefits in providing carbon sequestration, enhancing wildlife habitat, improving erosion control and water quality, as well as reducing flooding. Presently, design guidelines are limited and ad hoc procedures are often followed to install LSFs. The few design protocols that exist are based on semi-empirical assumptions regarding snow transport and deposition around structural barriers. These assumptions fail to represent the diverse scenarios around LSFs or guide their proper siting and design. In this context, there is a *critical need* for ODOT to develop robust design guidelines to facilitate the implementation of LSFs for natural topographies in the State of Oregon. Such research is much needed to enable ODOT in maintaining safe driving conditions during blown snow events (such as I-84 in the La Grande/Baker area) in a cost-effective, environmentally-sustainable manner.

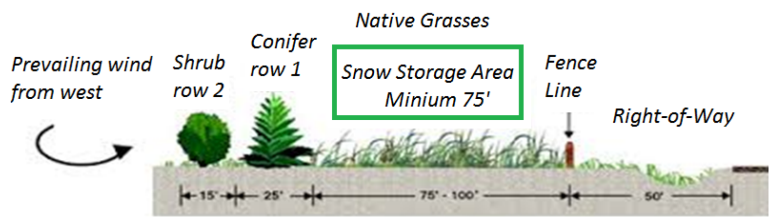

Figure 1. Schematic design of a LSF (Wyatt et al., 2012)

III. PROPOSED RESEARCH, DEVELOPMENT, OR TECHNICAL TRANSFER ACTIVITY

This research project will mainly consist of practitioner surveys and numerical investigation. It will start with a literature review and nationwide agency survey of best practices and design guidelines for LSFs with particular attention focused on vegetation species native to Oregon. The survey will also examine arrangements made by other agencies to plant the vegetation outside of the right-of-way. Subsequently, the research team will work closely with ODOT to identify the specific challenges and sites of interest in terms of implementing LSFs. Combinations of some of the identified best practices, vegetation, and representative topographies for Oregon will then be modeled numerically using computational fluid dynamics (CFD). In CFD, the equations of fluid dynamics and related processes including the transport of particles (e.g., snow) are solved for a given geometry. CFD has recently been used to model snow transport around structures and shows potential for modeling snow fences (Tominaga et al. 2011; Beyers et al. 2004). The numerical models allow fence geometry and placement to be varied to determine snow deposition for given topography and wind characteristics. In this study, the fence geometric characteristics that produce maximum snow deposition and minimize blown snow over the roadway will be identified. This process will highlight key parameters for predicting the effectiveness of an LSF. All the findings from the project will be leveraged to develop guidelines for implementing LSFs along Oregon highways.

IV. POTENTIAL BENEFITS

By identifying key design parameters for effective living snow fences, road closure will be minimized and safe driving conditions maintained with a significant reduction in snow/ice removal costs. Additionally, the increased road surface temperature resulting from snow fences is expected to reduce maintenance costs. Without this research, ODOT will continue to rely on road closures, repeated plowing, as well as chemical deicers to manage snow deposition on roadways and blown snow events. This research is urgently needed in light of recently documented failures of ODOT snow fence and the associated replacement cost and the challenge of maintain safe driving conditions with limited winter operations budgets.

V. IMPLEMENTATION

This research will guidelines to site and design living snow fences to reduce blown snow hazards in Oregon. These guidelines will enable ODOT to make informed and better choices for selecting fence placement and vegetation species to best maintain safe driving conditions. The findings will help ODOT adopt requirements for optimizing snow storage for the Snow and Ice Program.

VI. LIST OF REFERENCES *(optional)*

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VII. CONTACT INFORMATION

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