Implications of Ice Cover Characteristics for Underwater Oil Spills in the Straits of Mackinac, Michigan

GRANT GUNN[1], KELSEY NYLAND[1], VLAD TARABARA[2], MICHELLE RUTTY[3], DOUG BESSETTE[3], AND ROBERT RICHARDSON[3]

ABSTRACT

Installed in 1953, Enbridge's oil pipeline "Line 5" transports 540,000 barrels per day of light crude oil and natural gas liquids beneath the Straits of Mackinac. American portions of Line 5 start in Superior, Wisconsin, across Michigan's Upper Peninsula, then along the lake bed in the Straits of Mackinaw before terminating in Sarnia, Ontario. Recent events have raised concerns about Line 5's safety and potential for spill potential in ice-covered conditions.

Consolidated ice cover may restrict the spread of oil by shielding the released crude from wind transport and partly immobilizing the spill. Absent turbulent conditions, crude constituents should rise to the ice-water interface and pool at the ice's underside, with laboratory and field observations indicating that oil will coalesce, form a slick, and spread while resting on the ice-water interface. As a result, the roughness of the ice-water interface is of critical importance to the potential spread of oil.

In this study, we retrieve the roughness characteristics and generate topographic features of the ice underside in the Straits of Mackinac using Ground Penetrating Radar. Observed RMS roughness features of up 4cm are used to identify how ice properties impact potential oil residency time, particularly the transport of oil with respect to periods of increased flow, as well as the potential for oil weathering by emulsification. Laboratory experiments simulate oil spills under rough ice conditions and inform agent- based modeling (ABM) research and provide recommendations for under-ice oil spill remediation policy and best practices.

[1] Department of Geography, Environment and Spatial Sciences, Michigan State University, East Lansing, MI, USA

[2] Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI, USA

[3] Department of Community Sustainability, Michigan State University, East Lansing, MI, USA