

# AN APPROACH FOR QUALITATIVE EVALUATION OF PERMAFROST THAW-SETTLEMENT POTENTIAL



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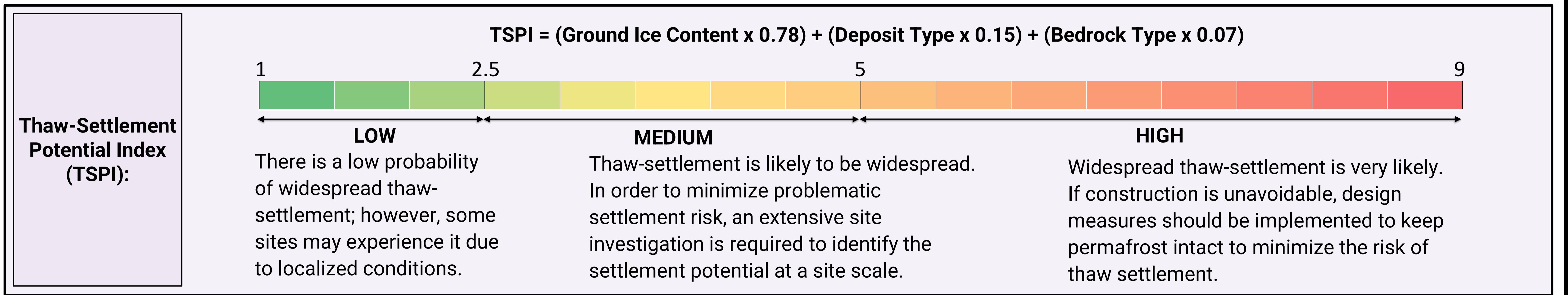
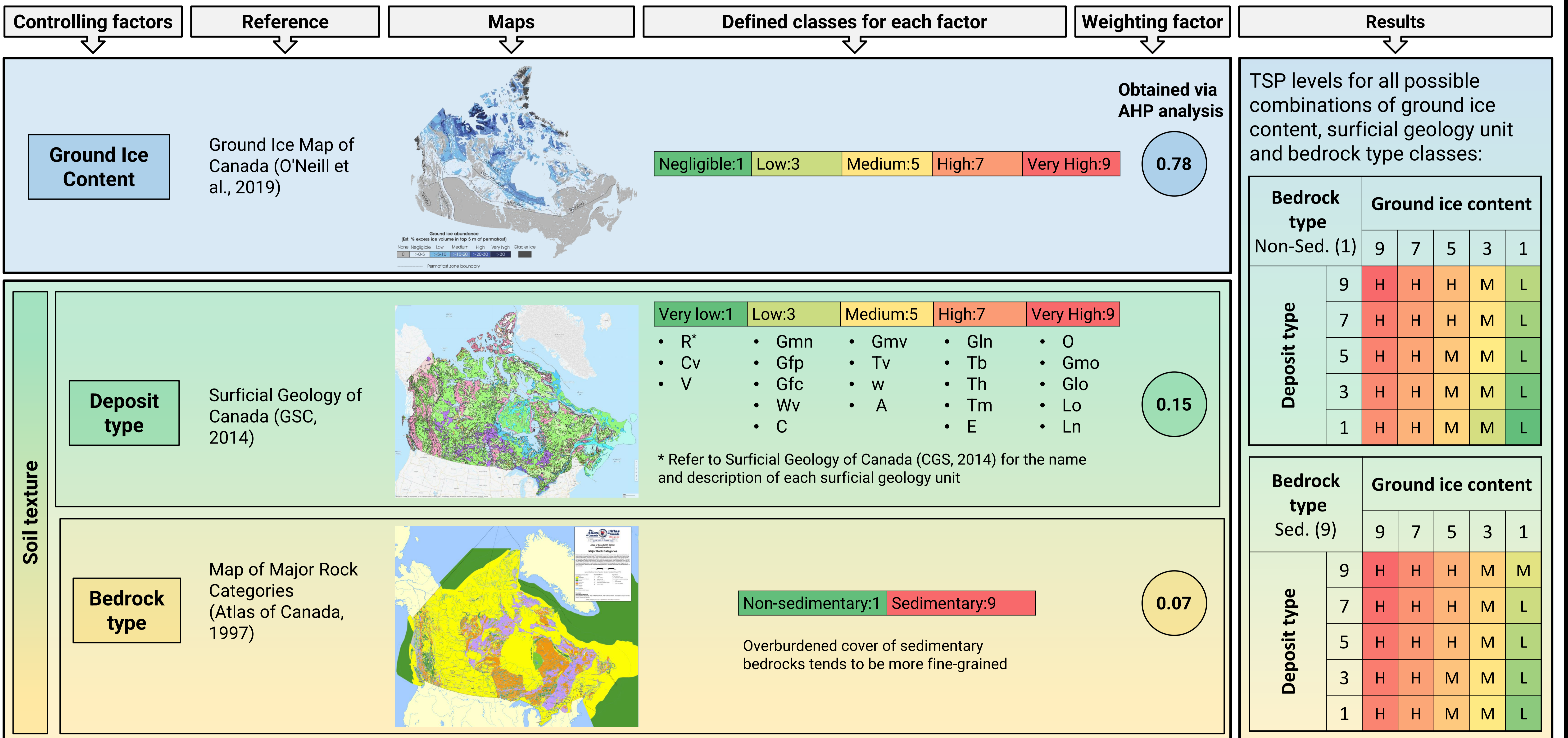
## INTRODUCTION & BACKGROUND

- Permafrost, which is ground that remains frozen for more than two consecutive years, is a key feature of Canada's northern lands.
- Permafrost thaw, driven by climate change and construction-induced disturbance, is damaging infrastructure.
- Thaw-induced settlement is a major contributor to high maintenance costs and compromised safety standards.
- Evaluating thaw-settlement potential at a coarse scale is critical in the early stages of projects with large footprints. This allows for:
  - Comparing and screening multiple possible routes/locations based on thaw-settlement vulnerability
  - Identifying the most vulnerable sections of a route that crosses various terrains/permafrost conditions
  - Planning more effectively for further investigation at a site scale
- **In this study, a systematic approach is proposed for qualitative evaluation of thaw settlement potential (TSP) at a regional scale due to near-surface permafrost thaw.**

## METHODOLOGY

- Ground ice content and soil texture are identified as the main factors defining the thaw-settlement magnitude.
- Soil texture is determined using surficial deposit type and bedrock type:
  - Surficial geology units are evaluated based on the possibility of having more fine-grained particles and organics, which are more thaw unstable.
  - Overburdened cover of sedimentary bedrocks tends to be more fine-grained.
- It is conservatively assumed that near-surface permafrost, if present, eventually thaws.
- Identified three variables are compared using Analytical Hierarchy Process (AHP), based on their importance in defining the thaw-settlement magnitude.
- A coefficient is obtained for each variable, and a numeric value is assigned to different categories defined for each variable.
- Using numeric classes and coefficients, Thaw-Settlement Potential Index (TSPI) is calculated.

## THAW SETTLEMENT POTENTIAL EVALUATION



## APPLICATION OF THE PROPOSED APPROACH

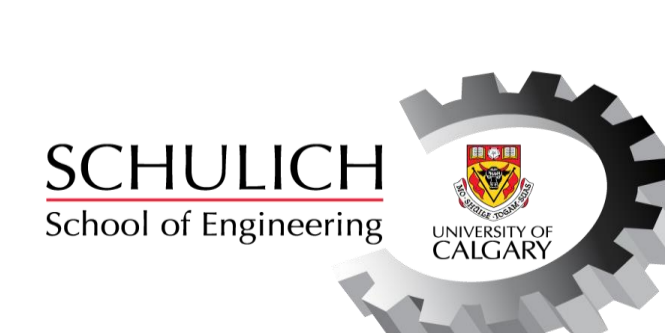
- Performing a preliminary assessment during the route or site selection process, with minimum effort, time and cost
- Guiding city planners in selecting more stable ground for future development in the North

## NEXT STEP

- To develop a Canada-wide map for the settlement potential
- To validate the approach by performing the assessment for case studies of thaw-settlement across Canada
- To enable a finer-scaled quantitative assessment using easily acquirable borehole data

## REFERENCES

1. Atlas of Canada, "Major Rock Categories, Geological Map of Canada-Map D1860A," Atlas of Canada. Natural Resources Canada, Ottawa, ON, Canada, 1997.
2. Geological Survey of Canada, "Surficial geology of Canada, Canadian Geoscience Map 195, Scale 1:5,000,000," Natural Resources Canada, Ottawa, ON, Canada., Ottawa, ON, Canada, 2014.
3. H. B. O'Neill, S. A. Wolfe, and C. Duchesne, "New ground ice maps for Canada using a paleogeographic modelling approach," The Cryosphere Discussions, pp. 1-37, 2019, DOI: 10.5194/tc-2018-200.



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