


ARQULUK program

Preservation of Canada's northern transportation infrastructures

Pan-Territorial Permafrost Workshop
Yellowknife, November 5-7th




*In Inuktitut language,
"Arquluk" means
"Bumpy road"*



Arquluk is a Cooperation Research and Development Program,
financed (1 320 000\$) by NSERC
and 12 partners from public and private sectors

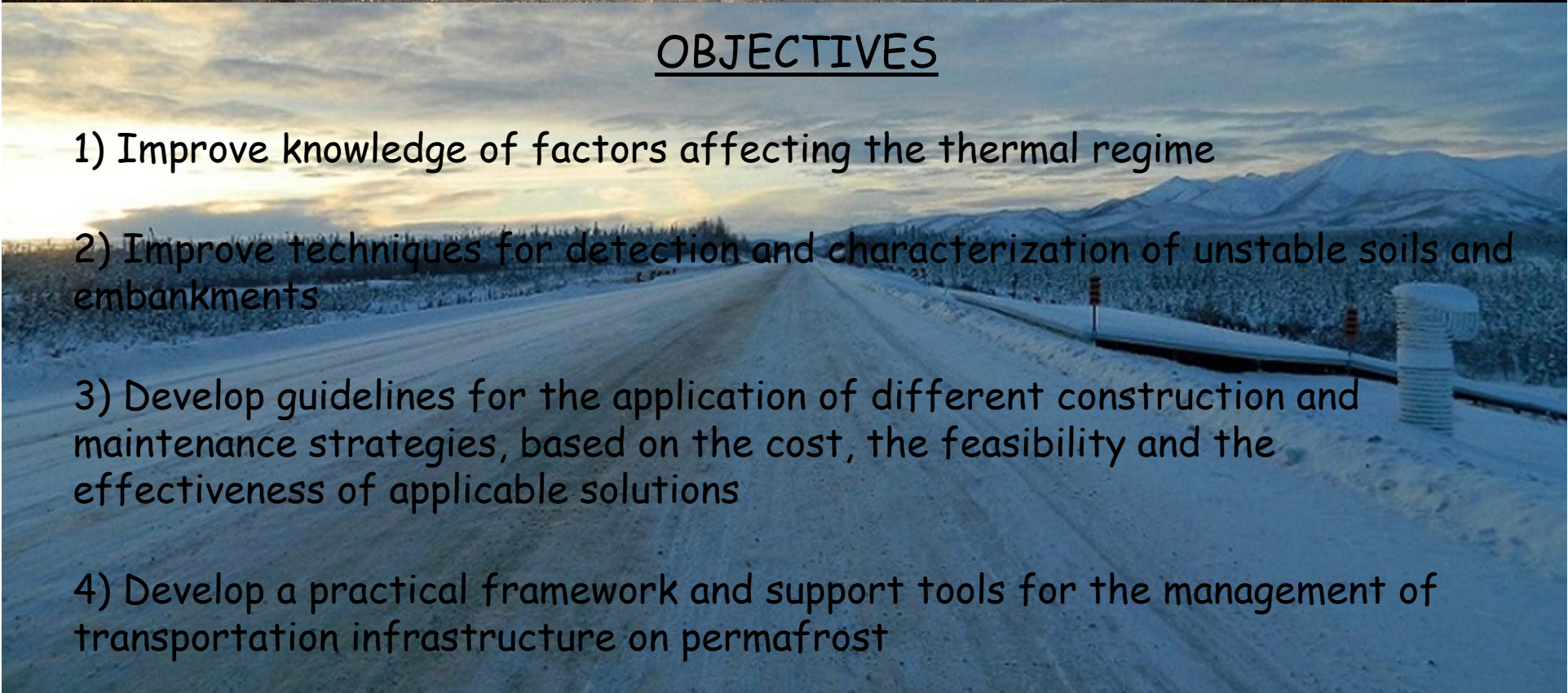
GOAL

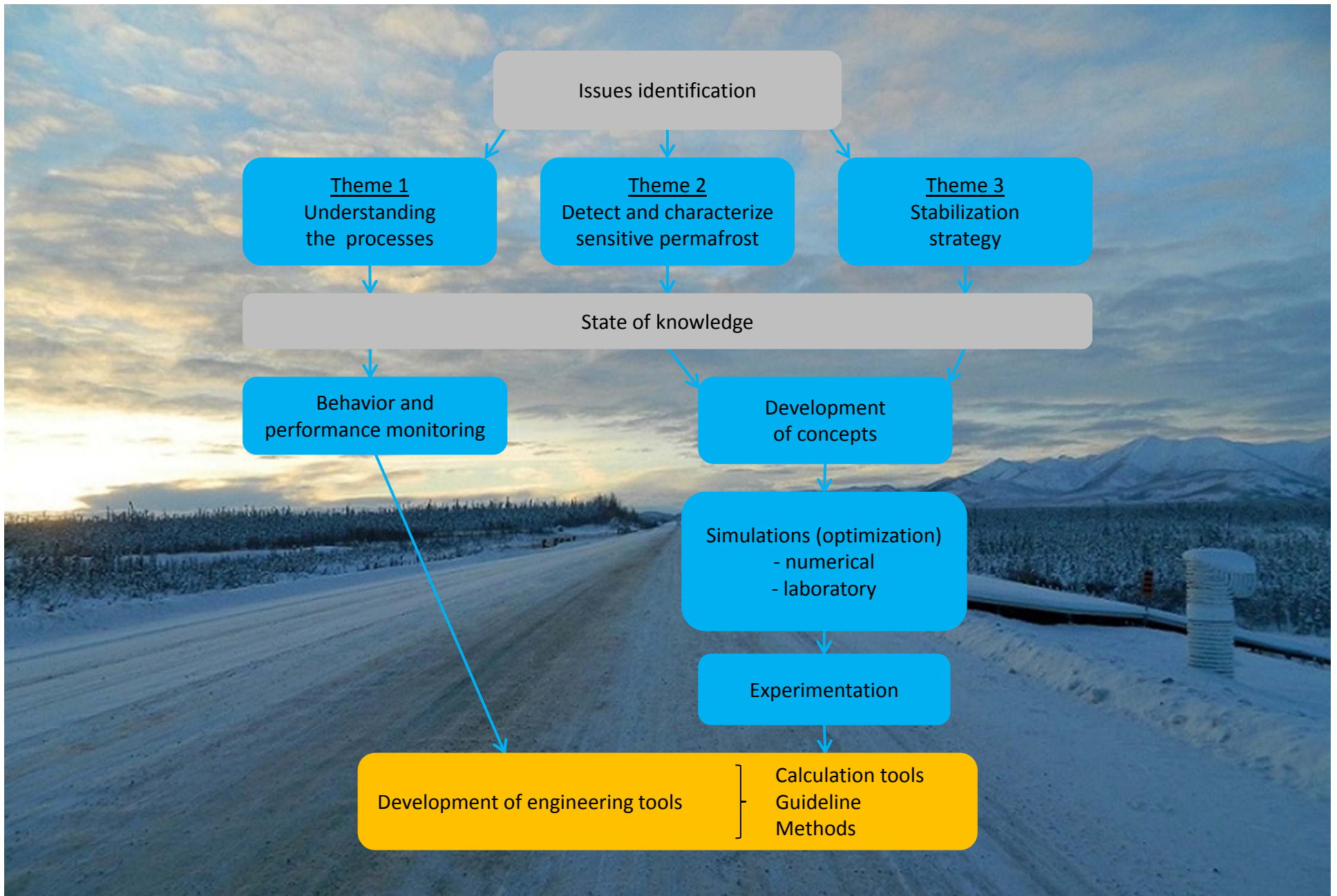
Improve current adaptive methods beneath transportation infrastructure, by developing expertise for mitigating permafrost instability.



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OBJECTIVES

- 1) Improve knowledge of factors affecting the thermal regime
 - 2) Improve techniques for detection and characterization of unstable soils and embankments
 - 3) Develop guidelines for the application of different construction and maintenance strategies, based on the cost, the feasibility and the effectiveness of applicable solutions
 - 4) Develop a practical framework and support tools for the management of transportation infrastructure on permafrost
- 



Program time table

program started in April 2012

Research theme / Activity	2012	2013	2014	2015	2016	2017
1. Improvement of knowledge						
- Experimental test site monitoring (Beaver Creek, Tasiujaq)						
- Engineering parameters development						
2. Identification and characterization						
Geophysical and thermal methods						
Profile analysis						
Oedometric testing						
Mechanical behavior of marginally frozen soils						
3. Development of adaptation techniques						
- Laboratory and numerical modeling						
- Maintenance material and techniques						
- Guidelines and strategies (risk management)						
Reports (P: progress; F: Final)						

Development of a design procedure for low-impact drainage design system

Julie Malenfant-Lepage (PhD)

also financed by ADAPT (CRSNG-Discovery Frontiers)

ongoing project

related to
theme 1 and 3

1. Soil temperature as a function of water flow
2. Thermal modeling and laboratory testing
3. Development of criteria for allowable convective heat transfer
4. Development of mechanistic index and transfer functions to convert water flow to heat transfer potential
5. Development of a practical engineering method for low impact drainage systems



Thermal regime around culvert

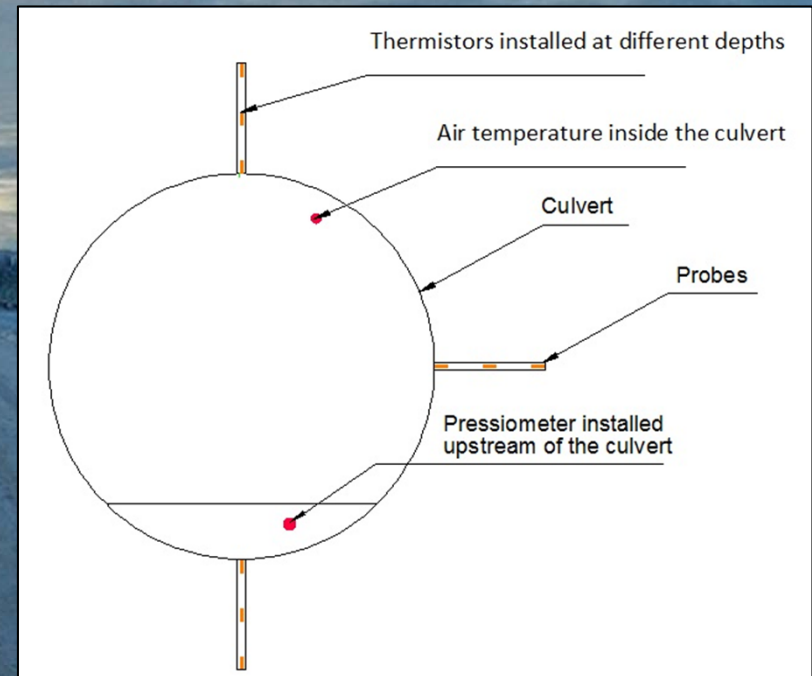
Loriane Perier (MSc)

financed by Transport Canada

associated project

related to theme 1

1. Identify key factors for an optimal drainage design
2. Quantify the effects of several parameters
 - Culvert diameter
 - Embankment height
 - Insulation
 - Water flow
 - Air temperature
3. Document thermal regime around culverts as function of water flow and air temperature



Detection and characterization of massive ice

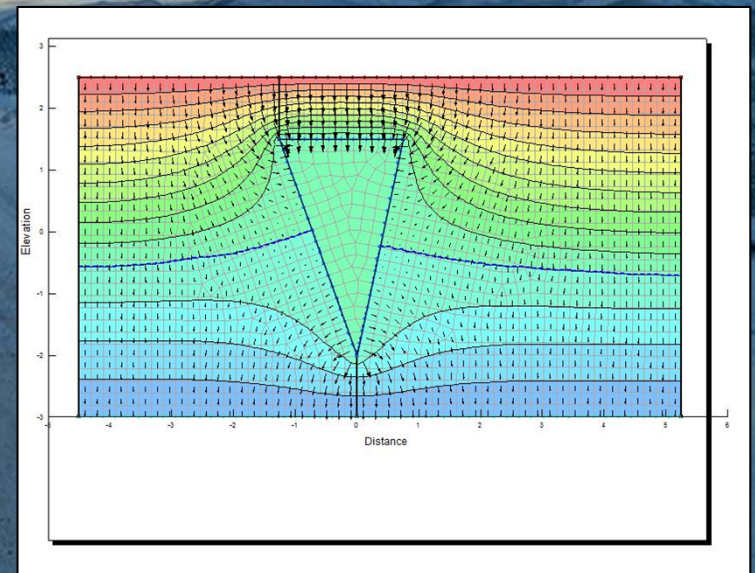
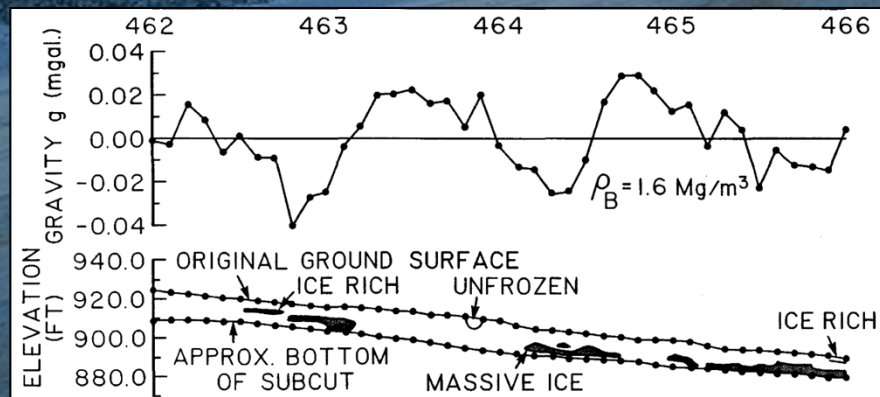
Benoît Loranger (MSc)

ongoing project
theme 2

Numerical simulations using existing models to generate significant soil density anomalies representing massive ice.

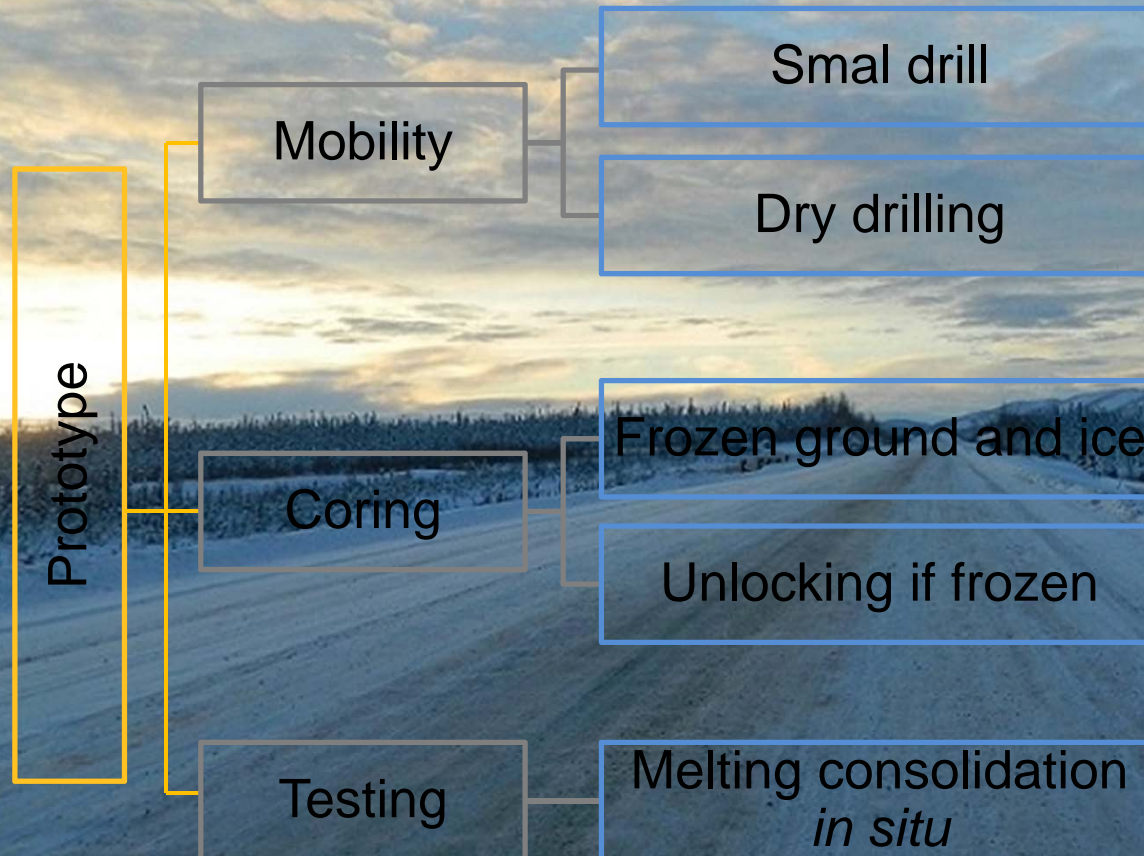
Field measurements using:

1. High precision gravimeter
2. Thermal profiling



In situ thaw settlement measurement of permafrost

Cédric Flécheux (MSc)



Thermal stabilization of transportation infrastructure using high albedo surface

Simon Dumais (MSc)

ongoing project
theme 3

Heat absorbed by dark paved surfaces

Technical issues with high albedo surfaces:

- Poor durability -> High cost
- Low skid resistance
- Dazzling surfaces

Approach the problem from a material specifications point of view instead of only considering the color of the surface

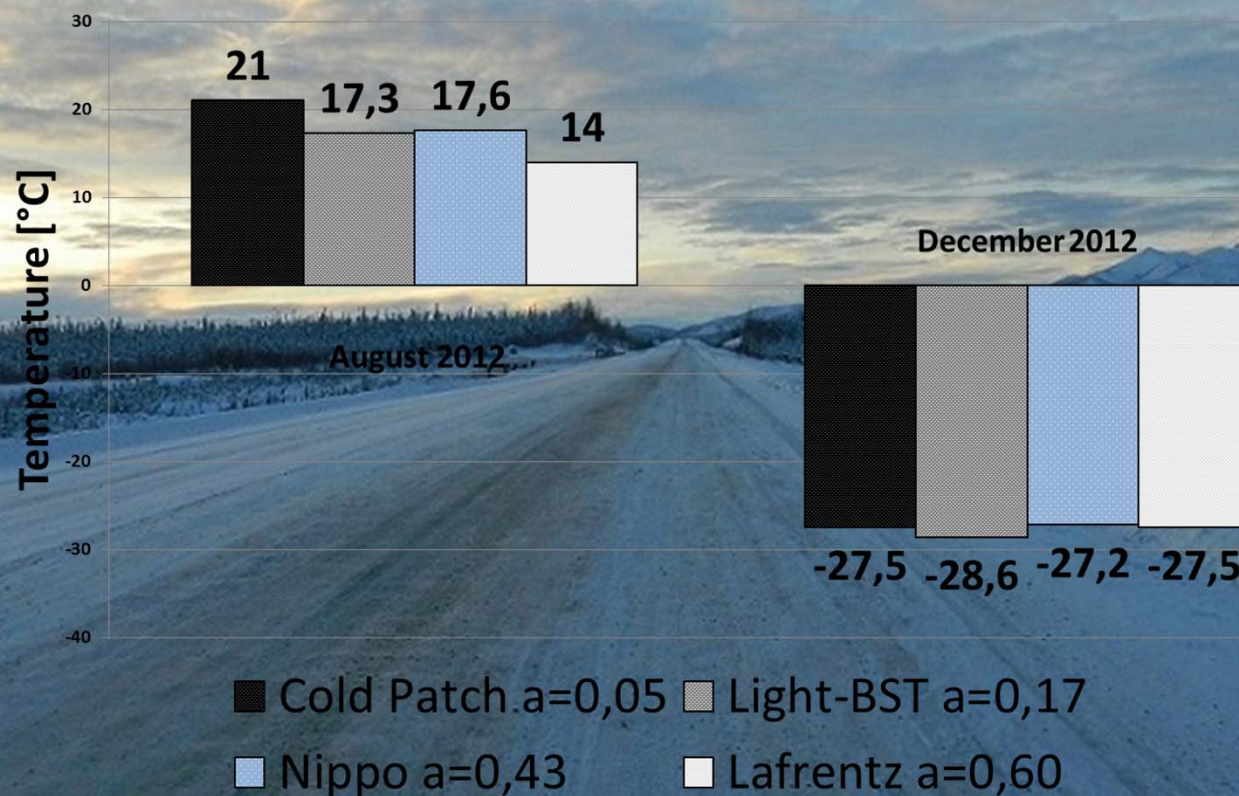


Thermal stabilization of transportation infrastructure using high albedo surface

Simon Dumais (MSc)

ongoing project
theme 3

Preliminary results, Beaver Creek, Yukon, 2012



Monitoring of thermal and mechanical behavior of the access road to Salluit airport, Nunavik

Dejan Grabundzija (MSc)

financed by Transport Québec

associated project

related to theme 3

Thermal drain

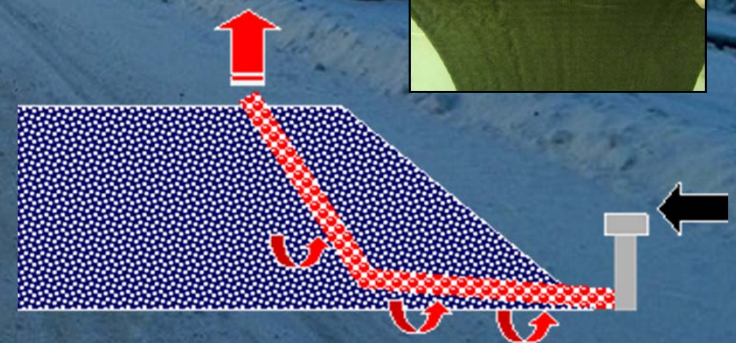
Geomembrane allowing air circulation
under the embankment

Thermal monitoring

Vertical and horizontal thermistors
Thermistors inside the thermal drain

Mechanical monitoring

Vertical and horizontal inclinometers



Projects starting in 2014

Theme 1. Development of engineering parameters.
starting in January 2014
Florence Lanouette (MSc)

Theme 2. Analysis of longitudinal profiles of existing pavements.
starting in May 2014
Laurie-Anne Grégoire (MSc)

Theme 3. Risk management: guidelines and strategies.
starting in January 2014
Heather Brooks (PhD)

Projects to be assigned

Theme 2. Mechanical behavior of marginally frozen soils
(MSc.)



www.arquluk.gci.ulaval.ca

Thank you to
our partners and
collaborators

Advanced course on permafrost engineering applied to transportation infrastructure

Yukon College, May 2014

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