

***Pan-Territorial Permafrost
Workshop. Nov. 4-7, 2011
Yellowknife, NWT***



Permafrost – Infrastructure Research: Great Slave Region, NWT



www.nrcan.gc.ca

S.A. Wolfe



Natural Resources
Canada

Ressources naturelles
Canada

Canada

Thanks to:

Geological Survey of Canada: Dan Riseborough, Caroline Duchesne, Mark Ednie, Wendy Sladen, Greg Oldenborger, Peter Morse, Chris Stevens (SRK)

Canada Centre for Remote Sensing: Rob Fraser, Ian Olthof, Naomi Short, Yu Zhang, Joost van der Sanden

GNWT Northwest Territories Geoscience Office: Steve Kokelj

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Rio-Tinto: Ron Near

Nuna-logistics: Tim Tattrie

BGC Engineering Inc: Lukas Arenson

EBA Engineering: Ed Hoeve

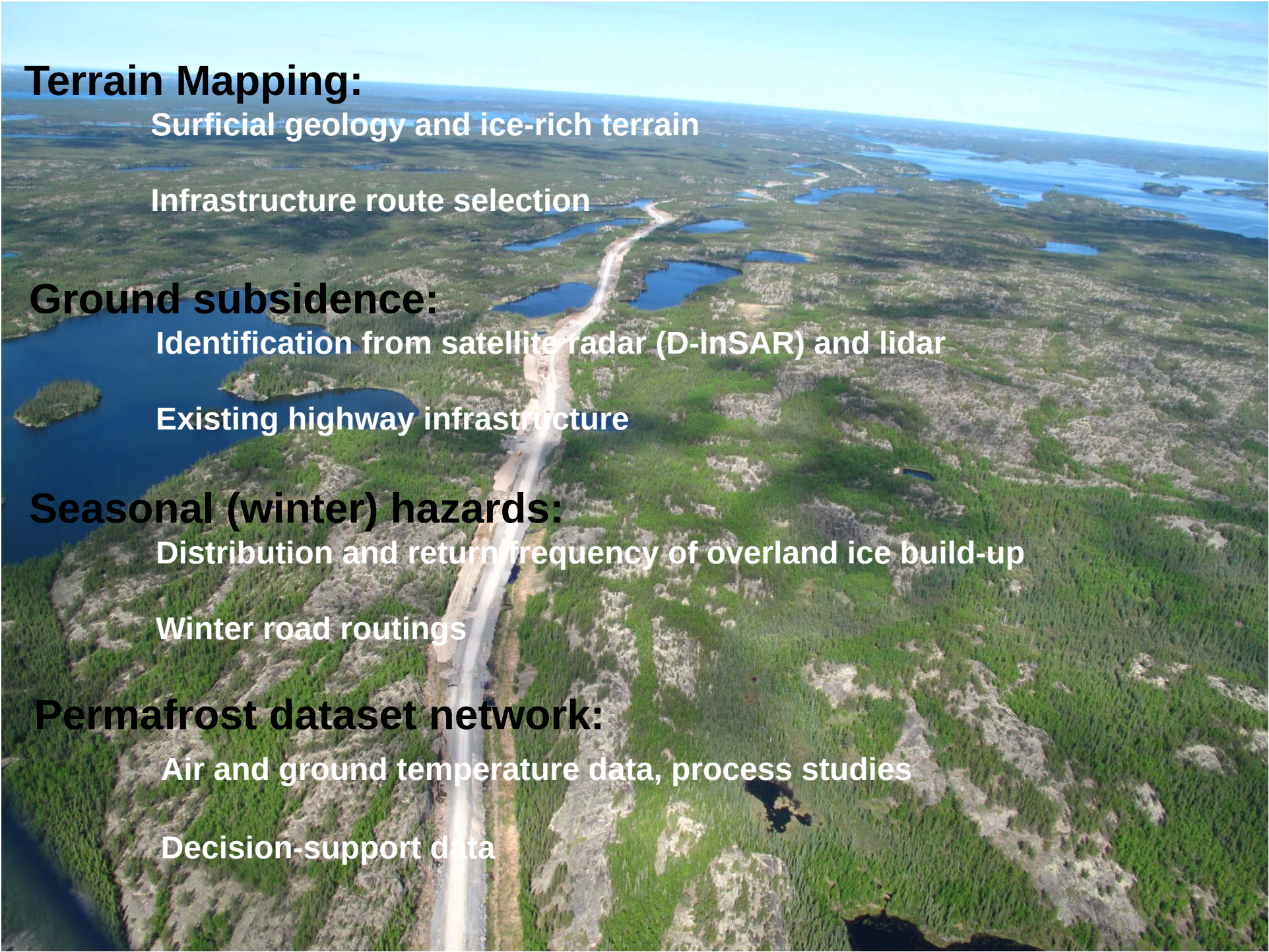
Carleton University: Chris Burn

Community and industry infrastructure are expanding throughout the extensive discontinuous permafrost zone of the Great Slave Region

But relatively little is known about climatically-sensitive permafrost in this region

This network provides essential information on permafrost conditions in this region for infrastructure, and to understanding permafrost changes in a warming climate.





Terrain Mapping:

Surficial geology and ice-rich terrain

Infrastructure route selection

Ground subsidence:

Identification from satellite radar (D-InSAR) and lidar

Existing highway infrastructure

Seasonal (winter) hazards:

Distribution and return frequency of overland ice build-up

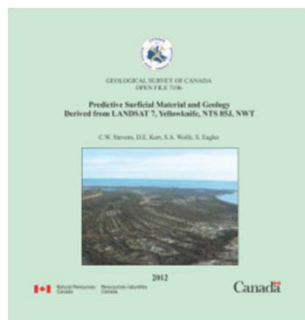
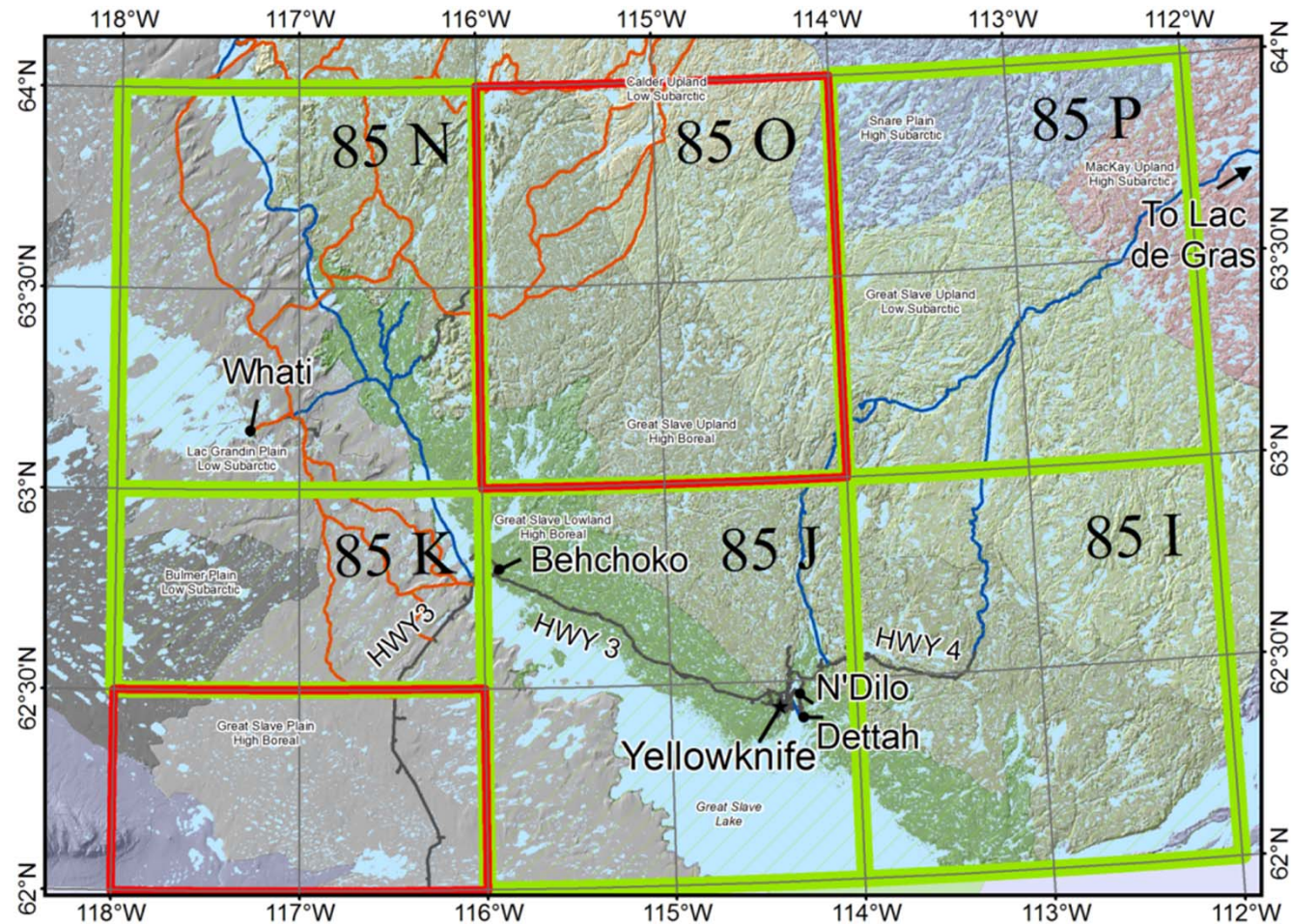
Winter road routings

Permafrost dataset network:

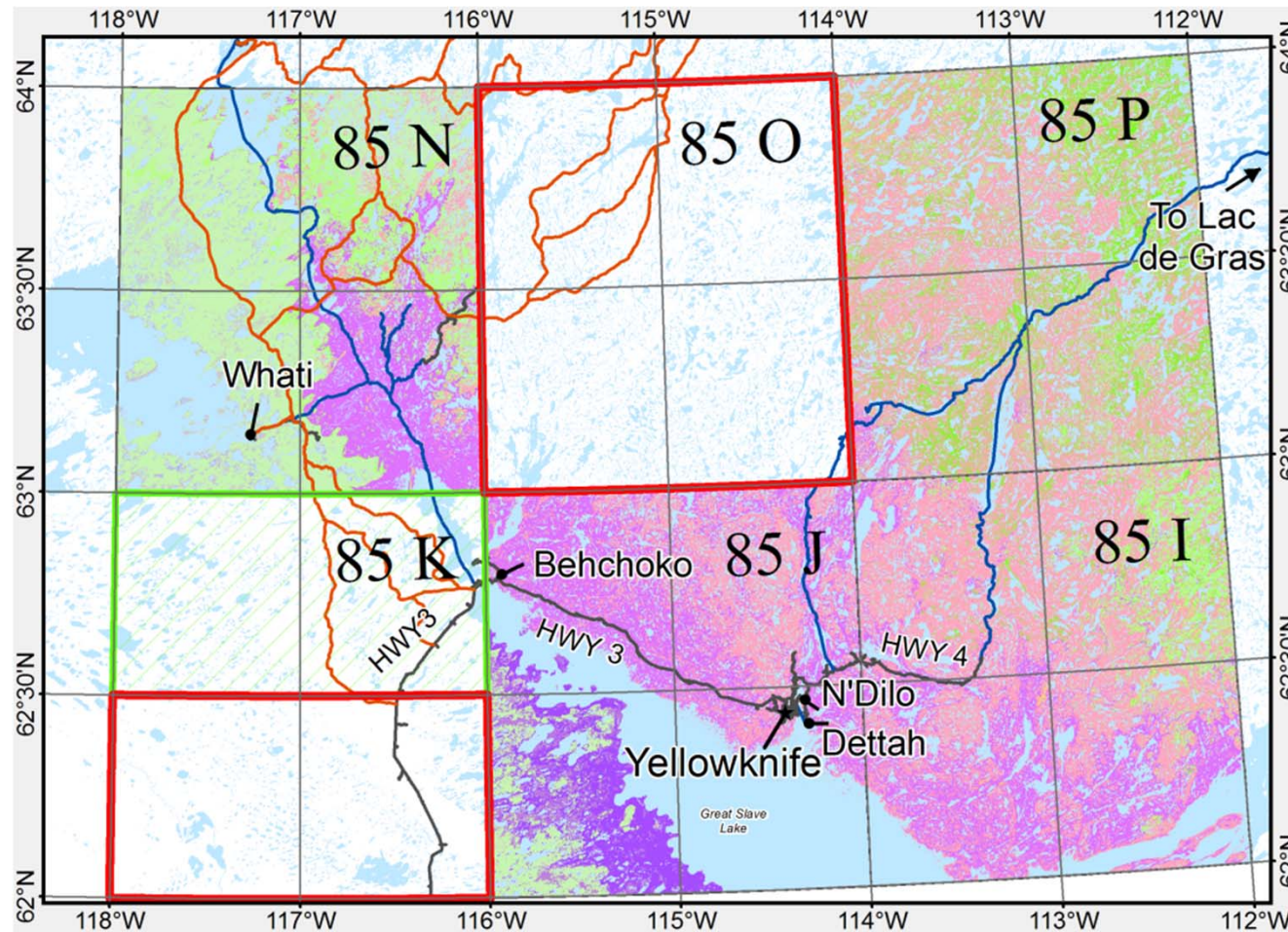
Air and ground temperature data, process studies

Decision-support data

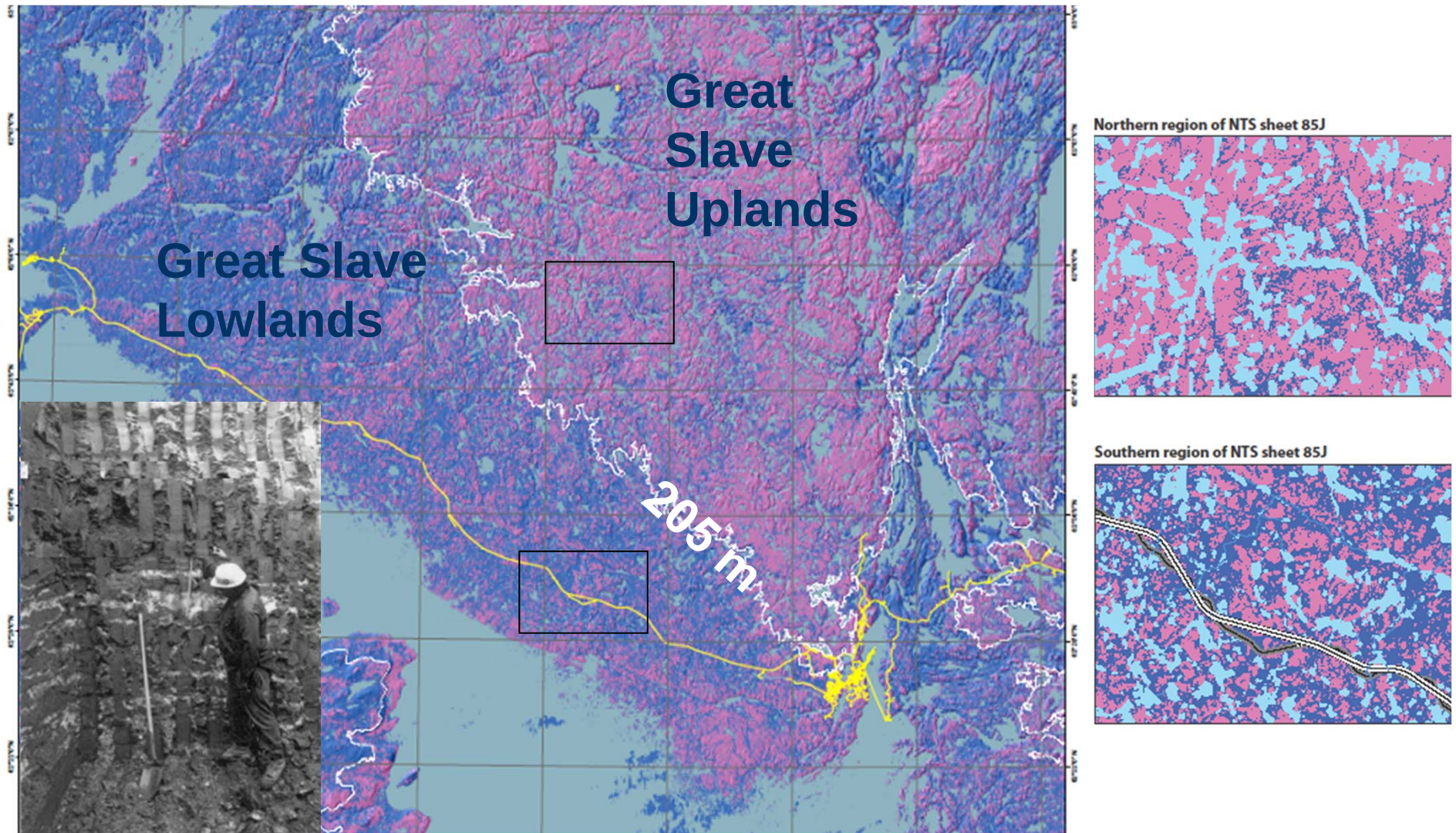
Terrain Mapping: Surficial geology for infrastructure route selection



Terrain Mapping: Surficial geology for infrastructure route selection



Great Slave Lowlands: Glaciolacustrine silts and clays



Terrain Mapping: Surficial geology for infrastructure route selection



Terrain Mapping: Ice-rich terrain in discontinuous permafrost

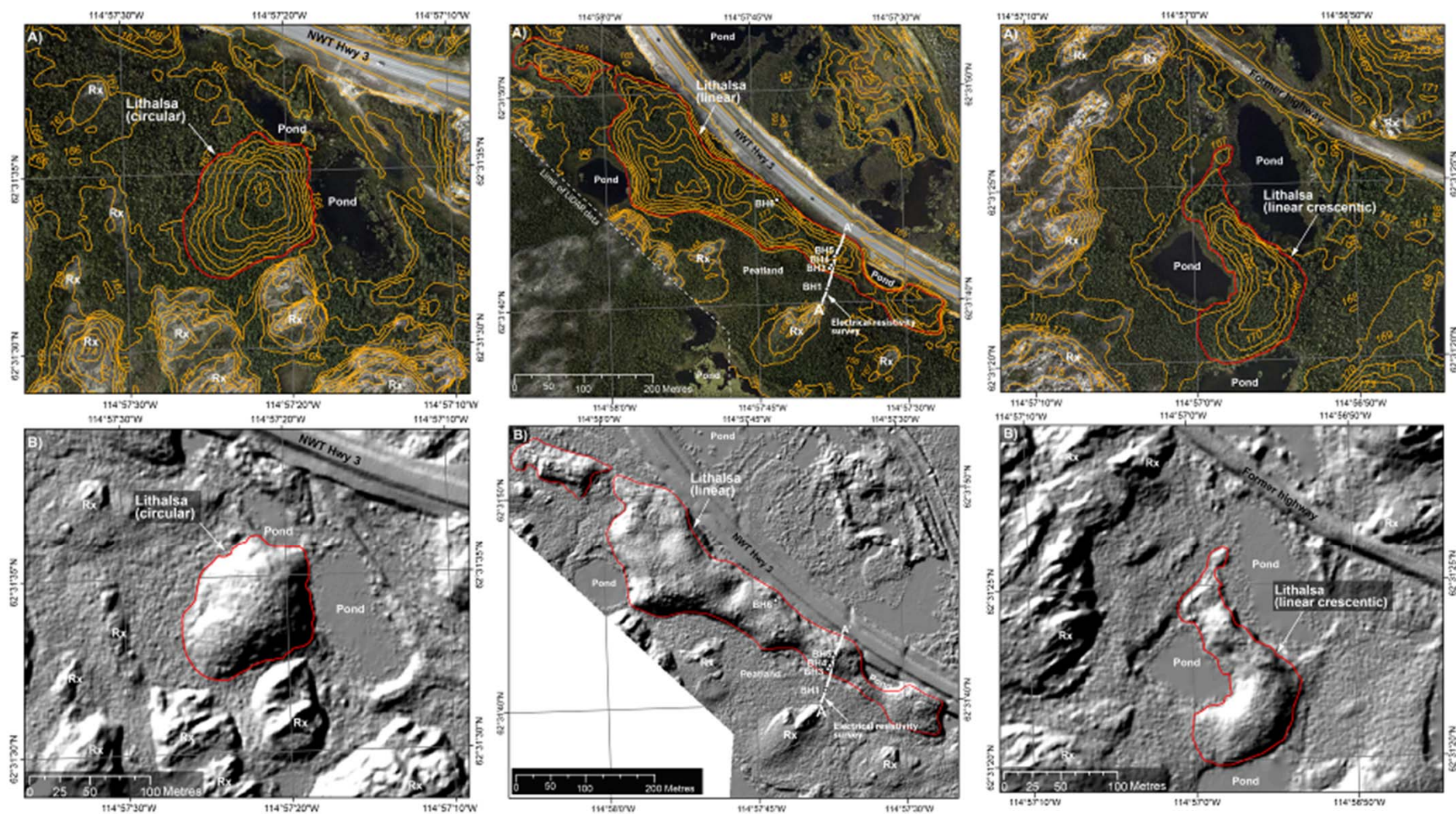


Terrain Mapping: Ice-rich terrain in discontinuous permafrost



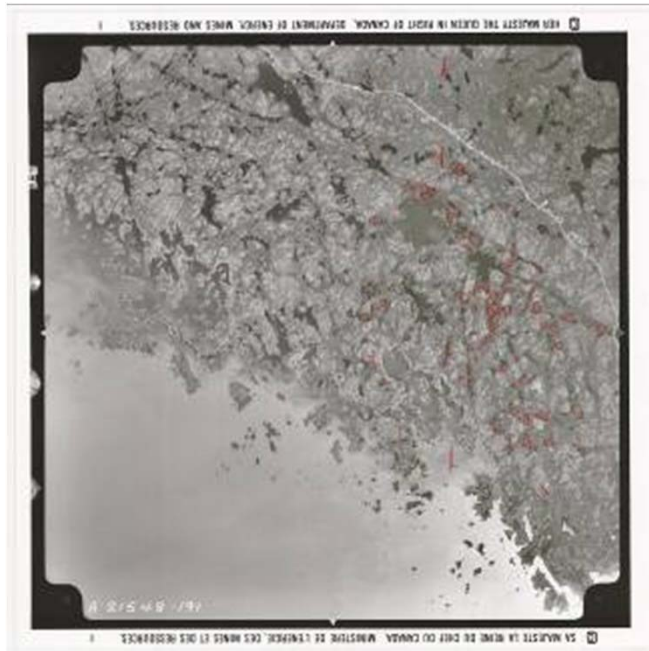
Ice-rich terrain:

Recognition using LiDAR (light detection and ranging)



Ice-rich terrain in the Great Slave Lowlands:

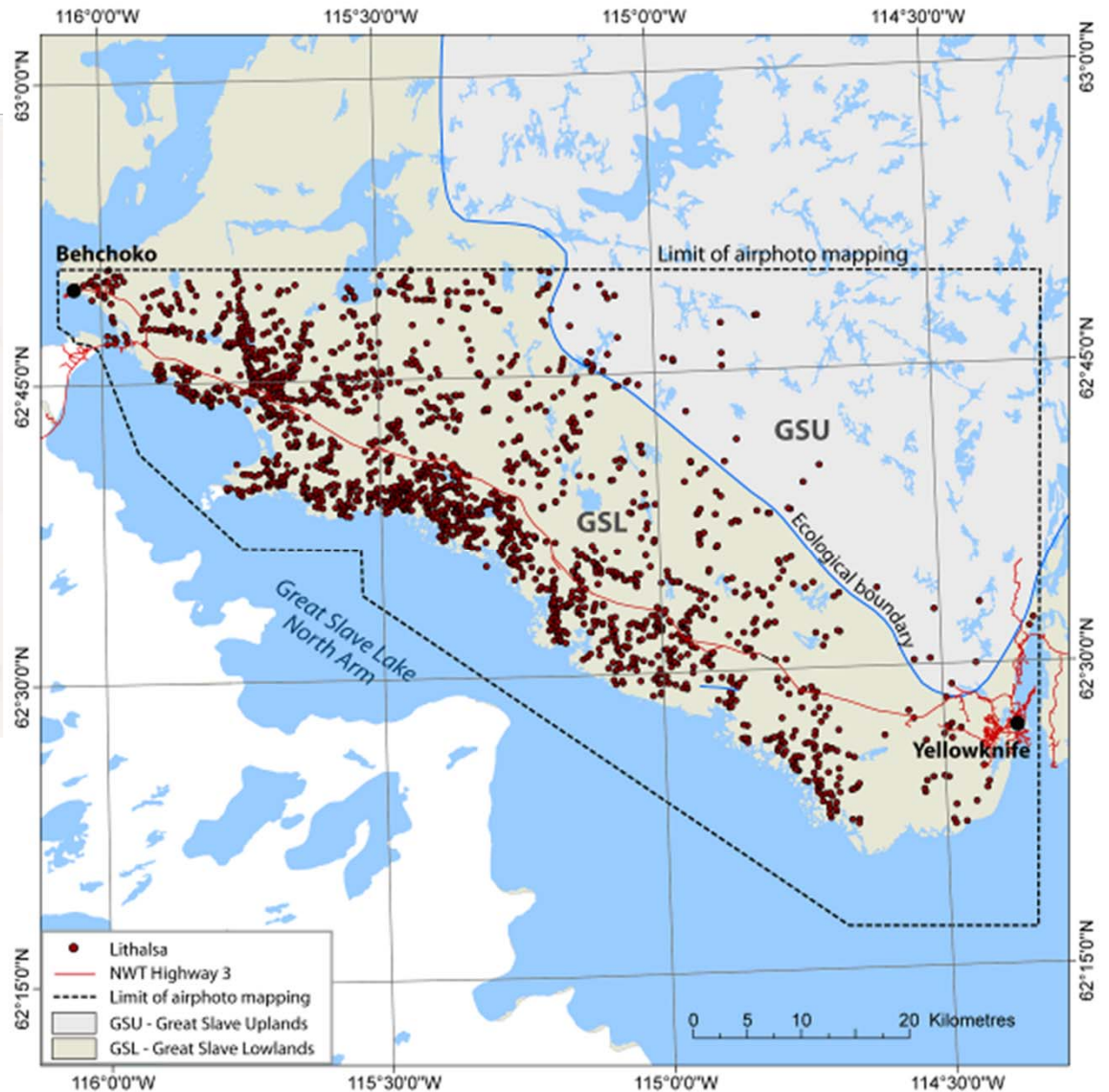
Airphoto mapping



Regional distribution

1,777 features in 3,680 km²

97.7% in the Lowlands
2.3% in the Uplands

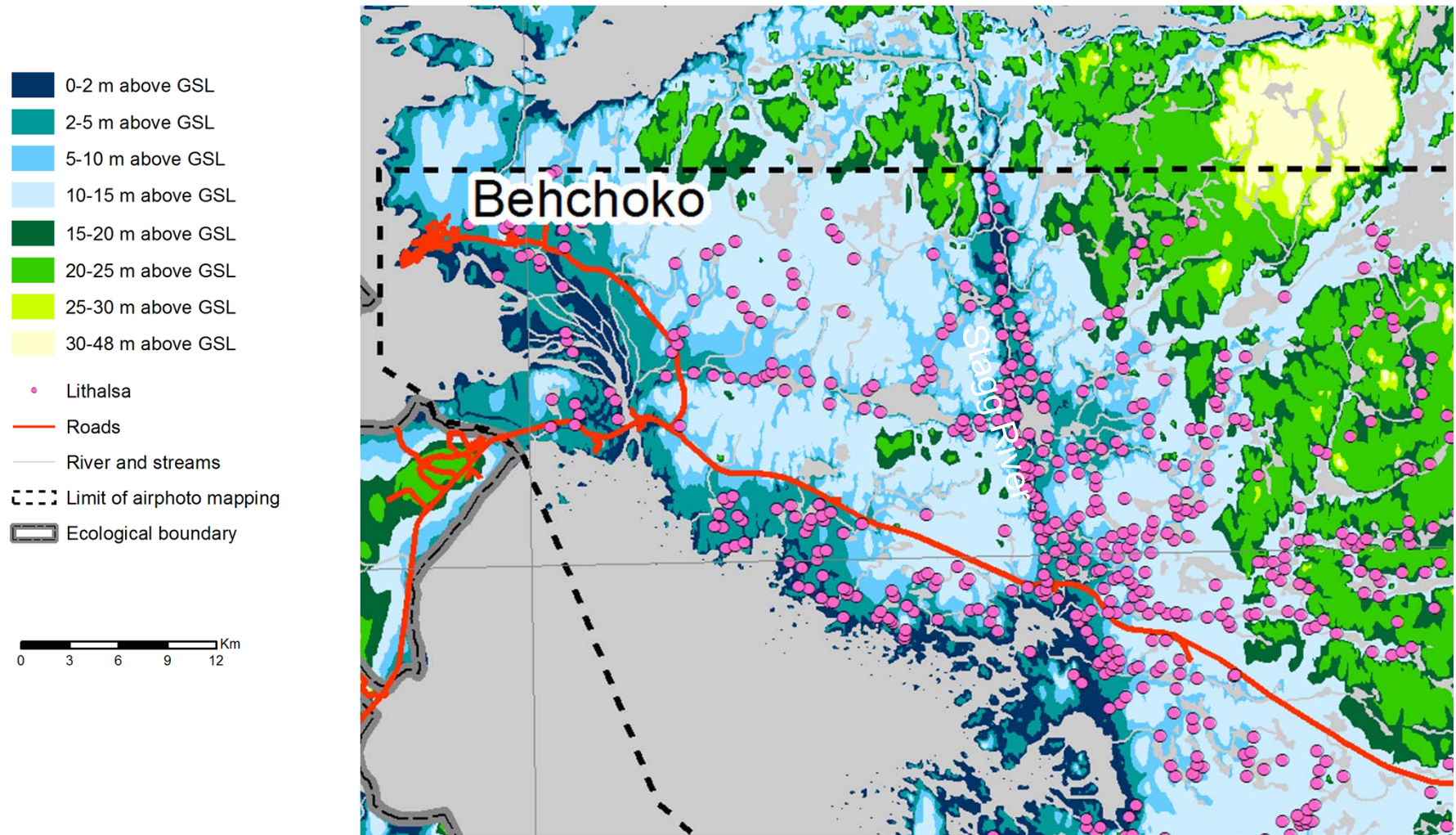


Ice-rich terrain in the Great Slave Lowlands:

Elevation

Concentrated:

- Within 10 m above Great Slave Lake
- Within valleys (e.g. Stagg River area)



GSC Open File 7255

Ground subsidence

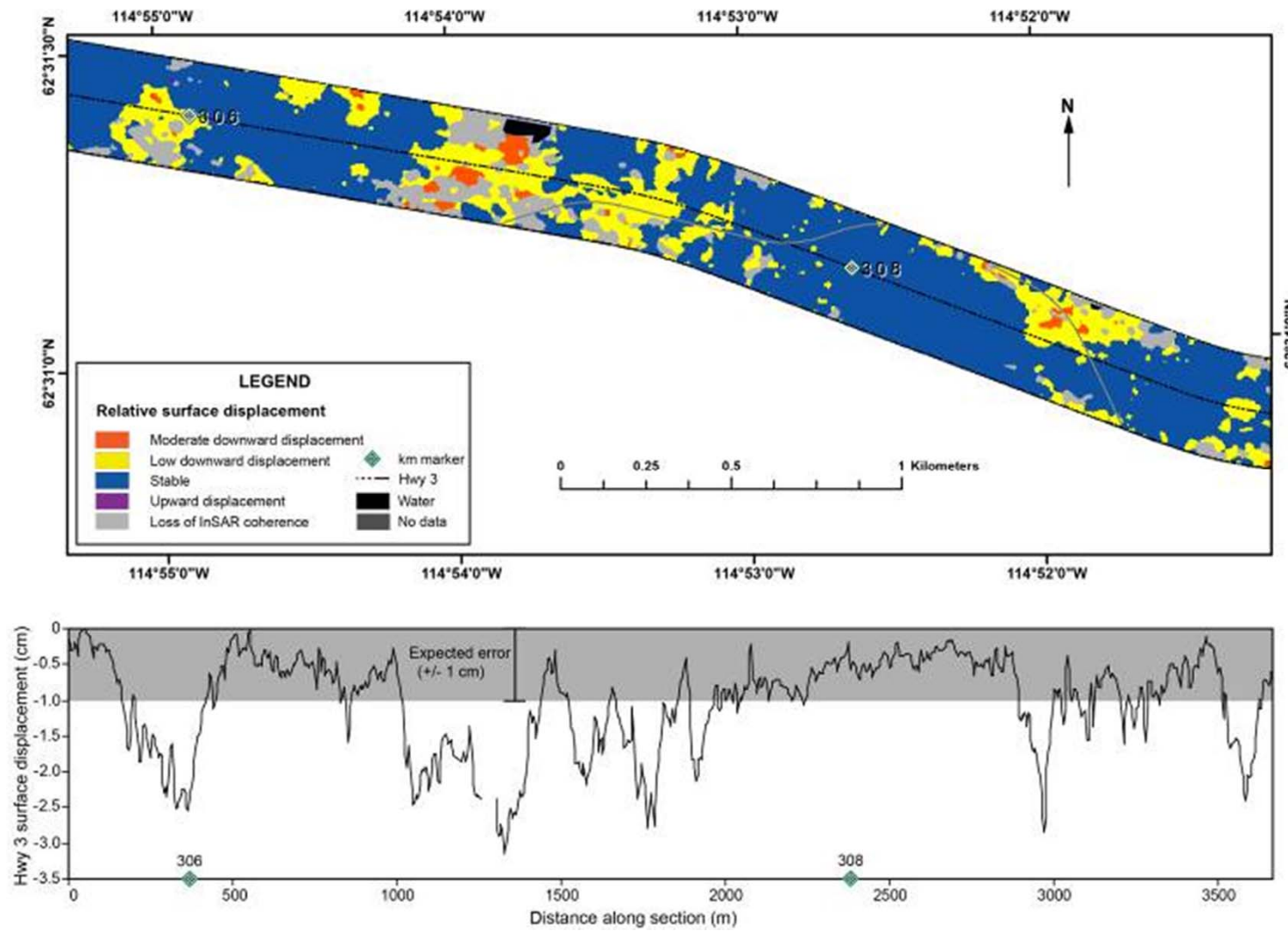
Identification with satellite radar (D-InSAR) and lidar

Existing highway infrastructure

Settlement and rotations observed on Highway 3 between Behchoko and Yellowknife



Surface displacement Highway 3



Seasonal surface displacement along NWT Highway 3 corridor

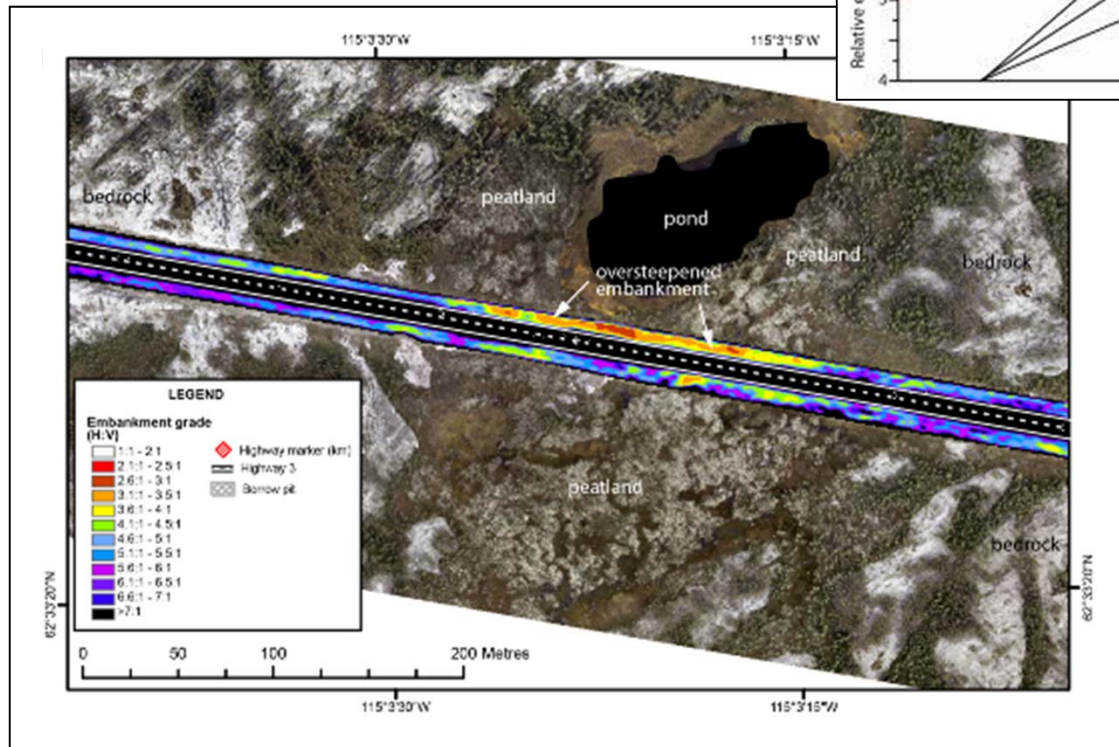
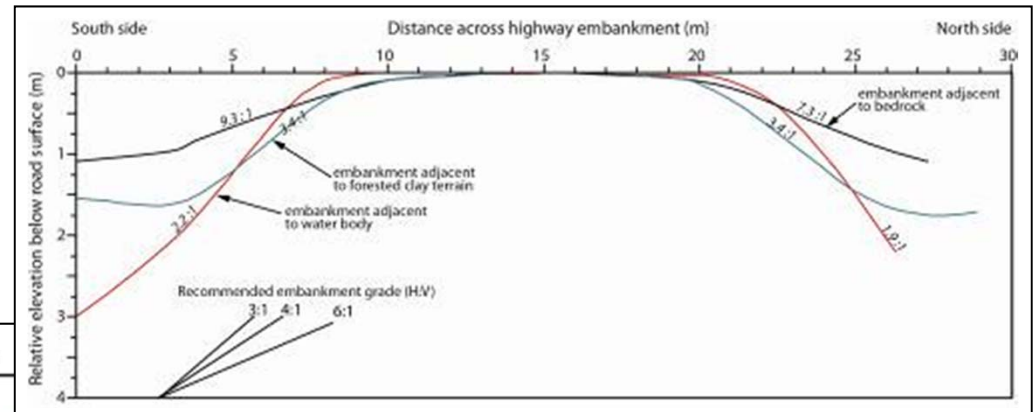
Embankment stability

Recommended embankment side slope grade

6:1 (H:V) adjacent to water bodies

4:1 over forested glaciolacustrine terrain/wet bogs

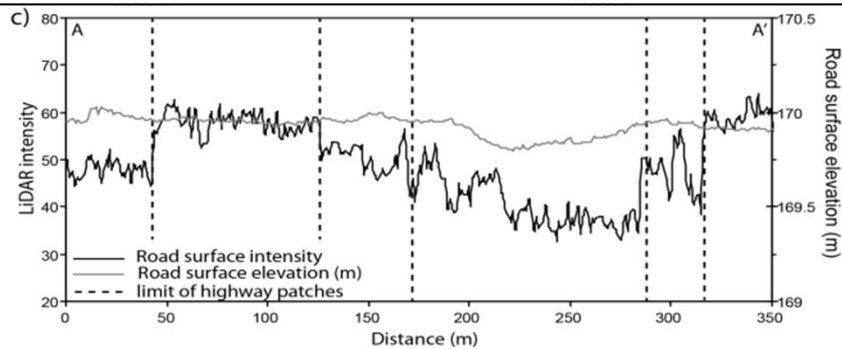
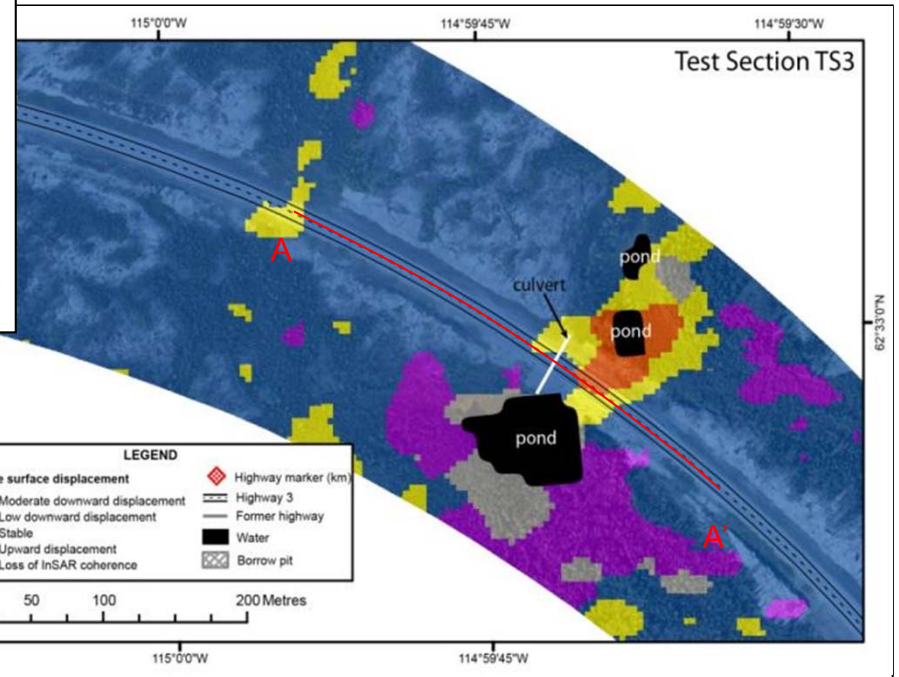
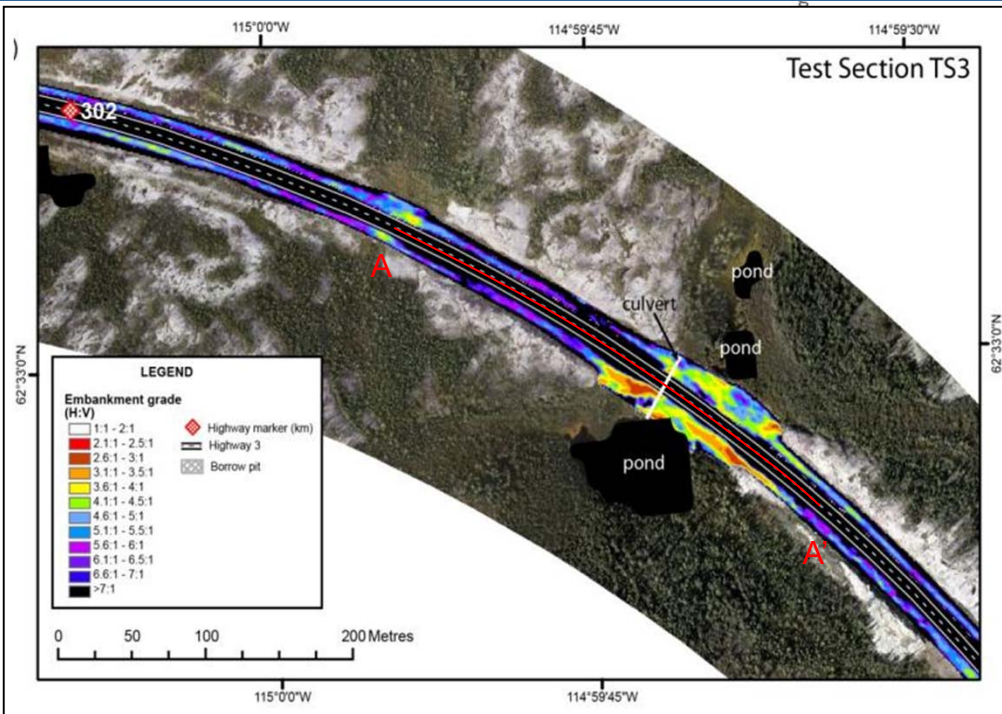
3:1 over bedrock



Embankment Side
Slope Grade

Integrated highway assessment

Remediation test section TS3
(km 302 to 302.7)



Seasonal (winter) hazards:

Distribution and return frequency of overland ice build-up

Winter road routings

Spring

Icing (a.k.a. aufeis, “*glaciation*”, kwqōq)

- Winter overland flow of water
- Accumulation of ice sheets

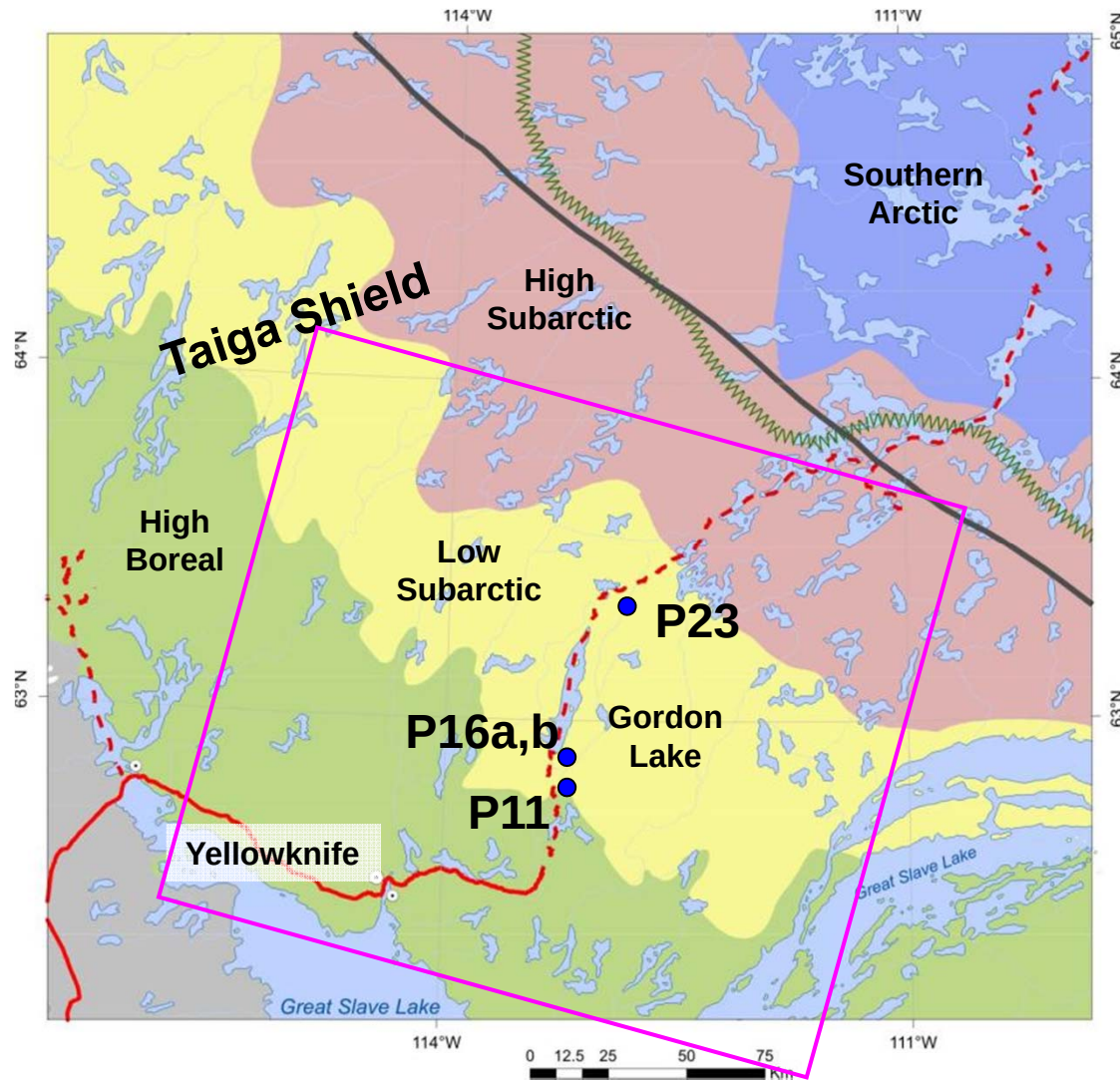
Transportation Hazard



Denali National Park, AK

(photo: National Park Service)

Tibbitt to Contwoyto Winter Road



Portage 11



Portage 23



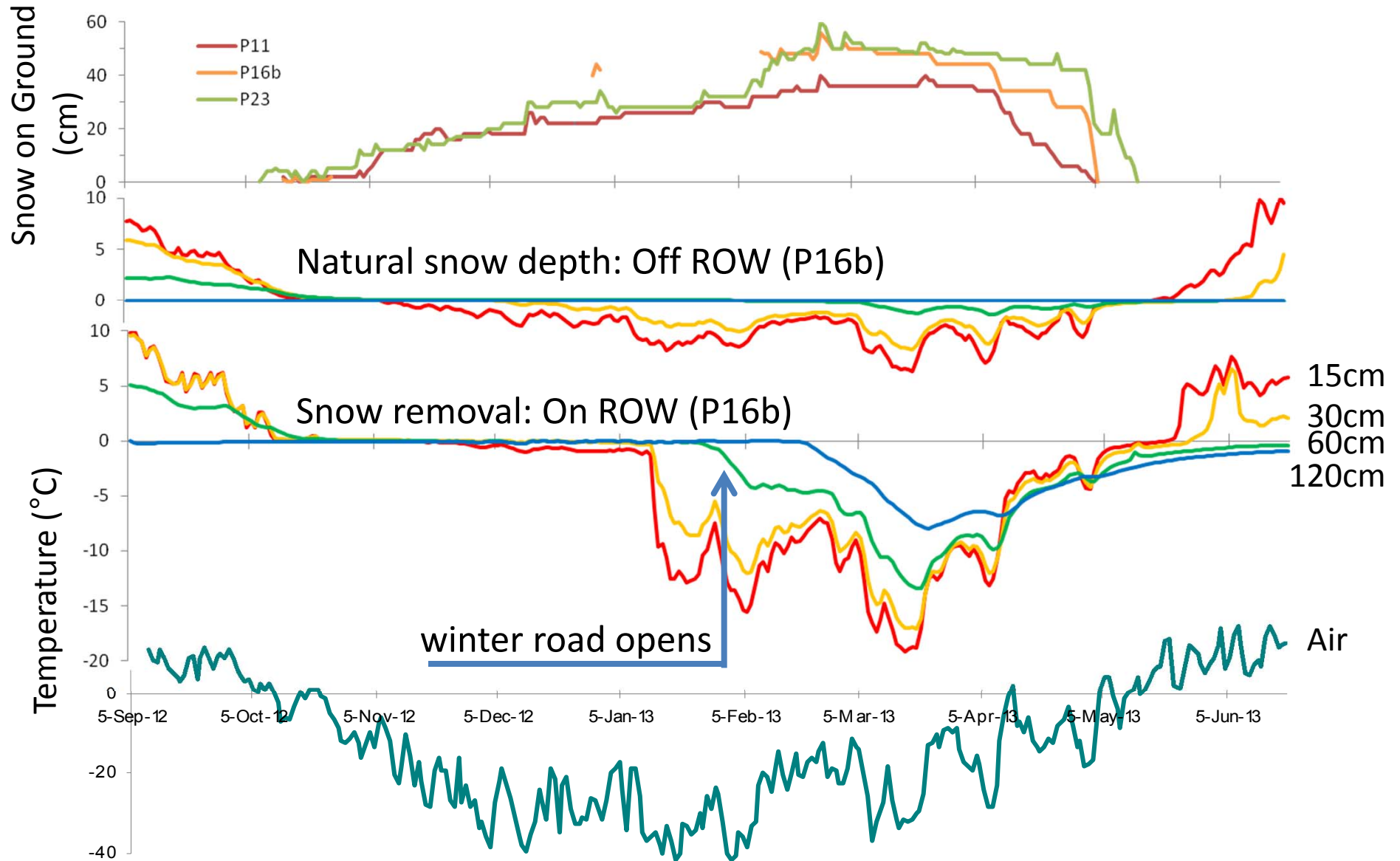
Portage 16a



Portage 16b



Snow removal significantly increases freezing



2012-12-04 13:00:00

T

● -20°C

Portage 23



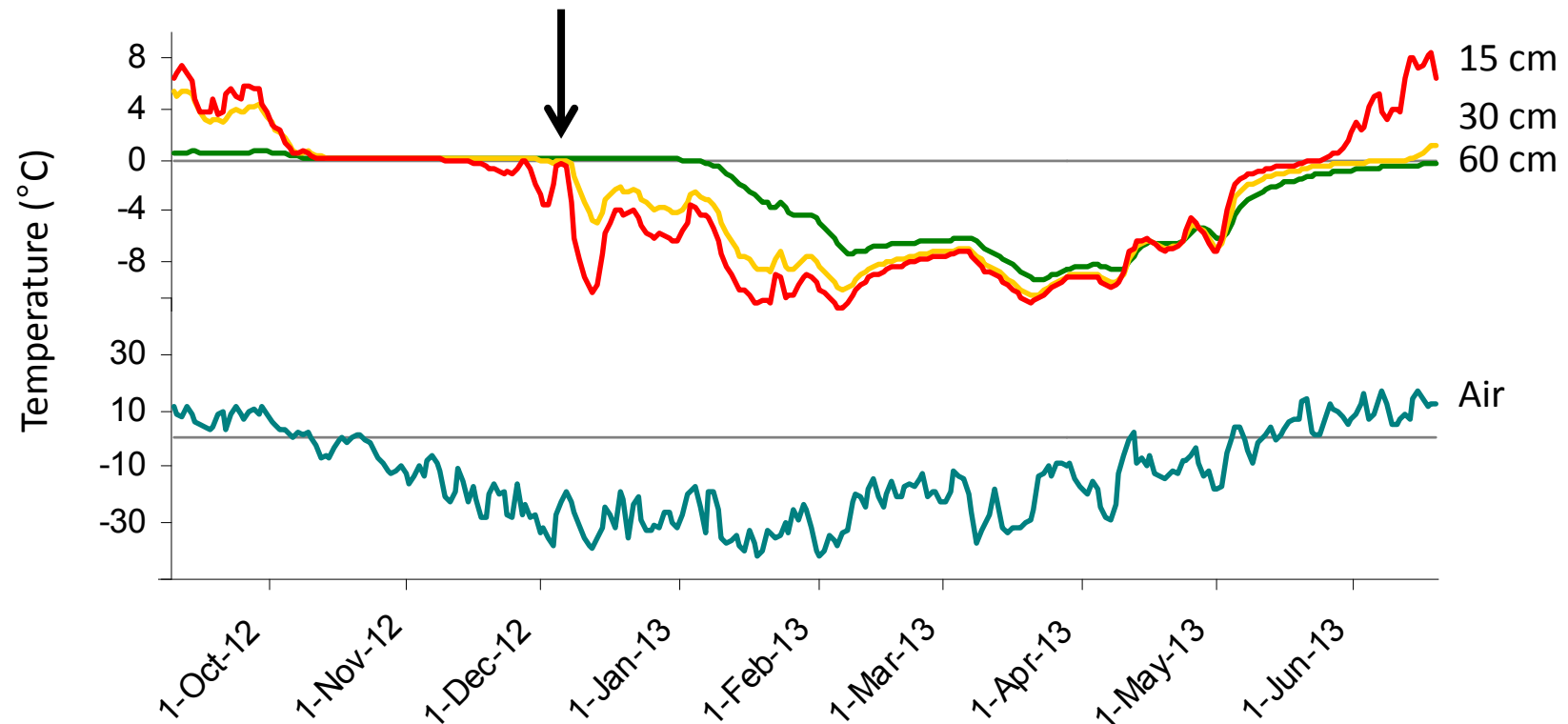
INAC BARCODE 7543

RECONYX

P23

4 Dec 2012

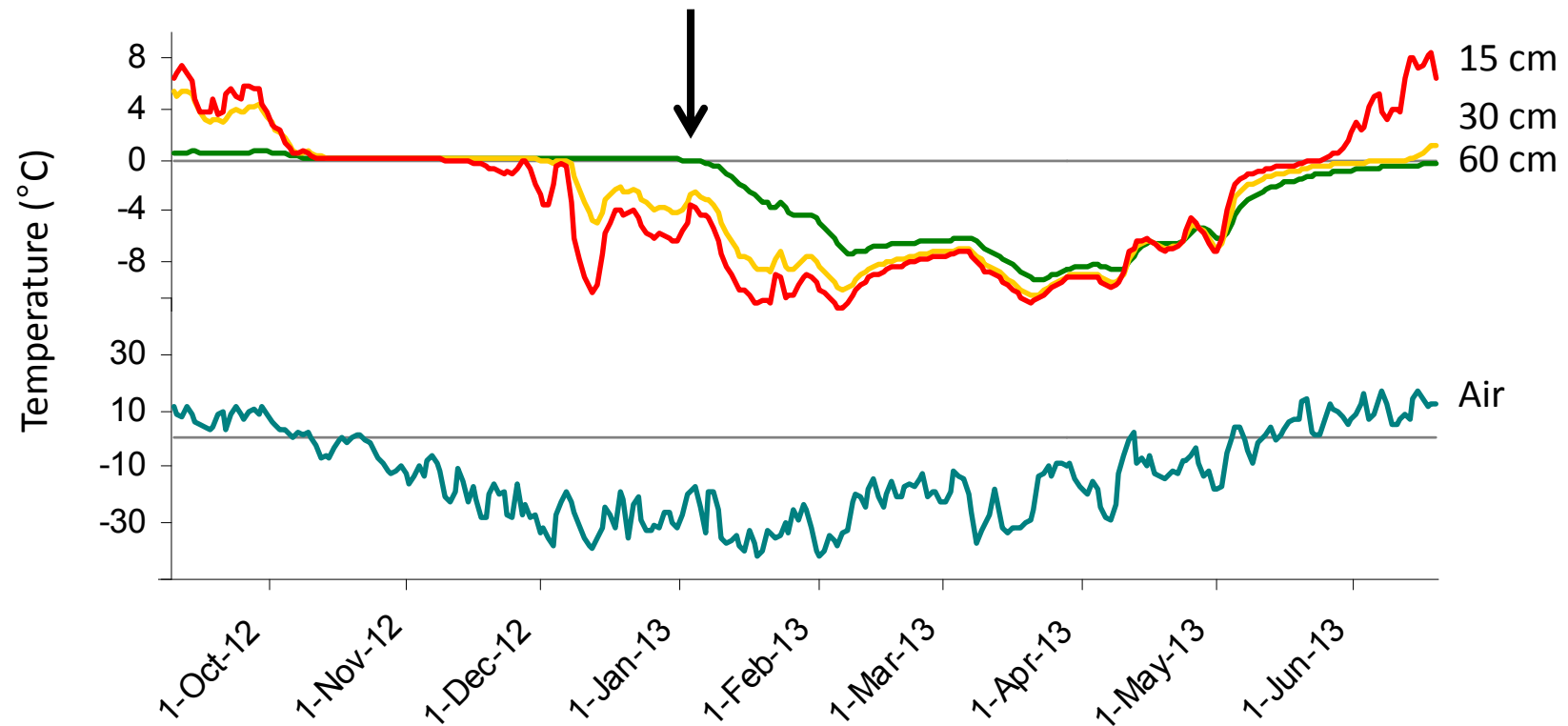
Icing flooding



P23

3 Jan 2013

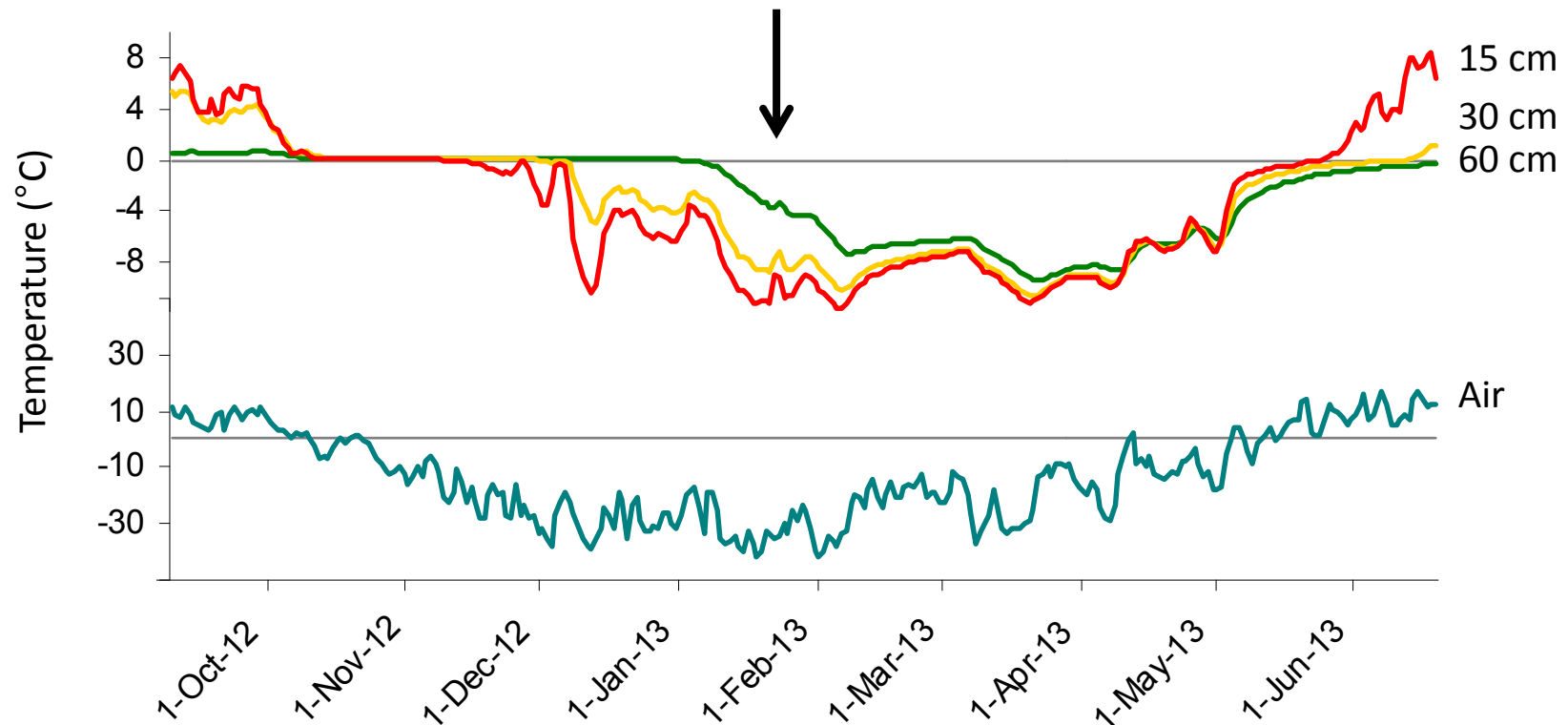
Icing flooding



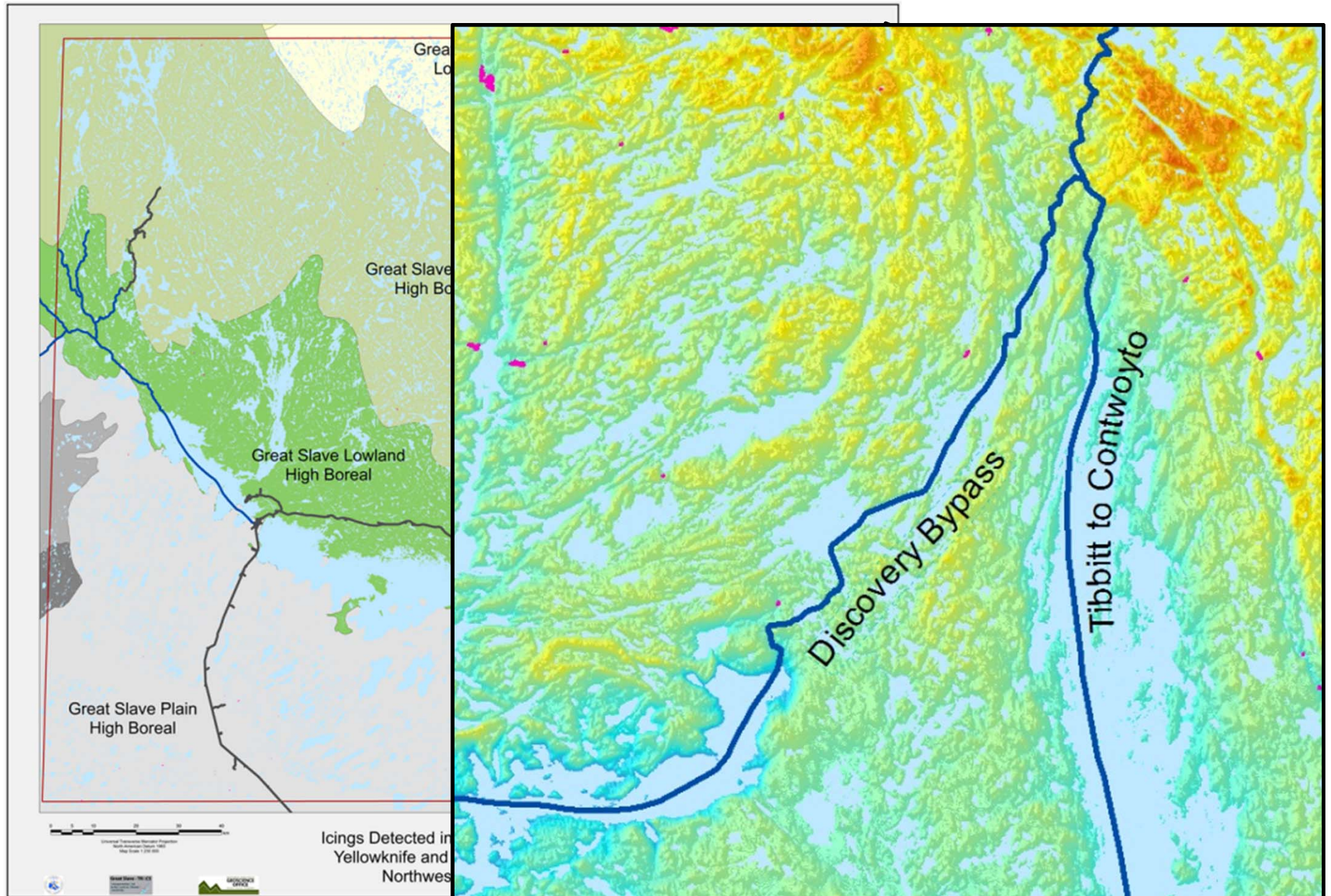
P23

21 Jan 2013

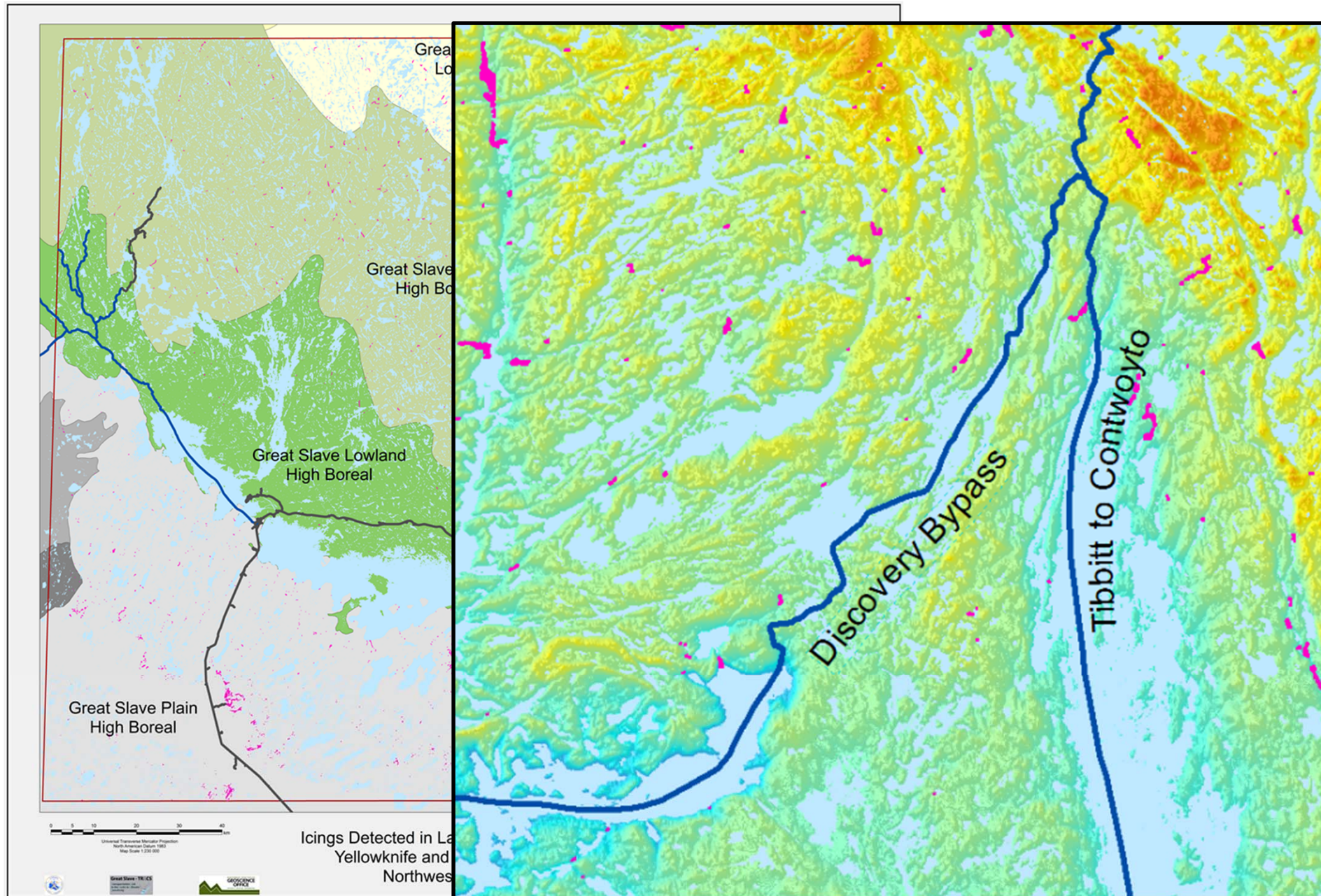
Maintenance
flooding



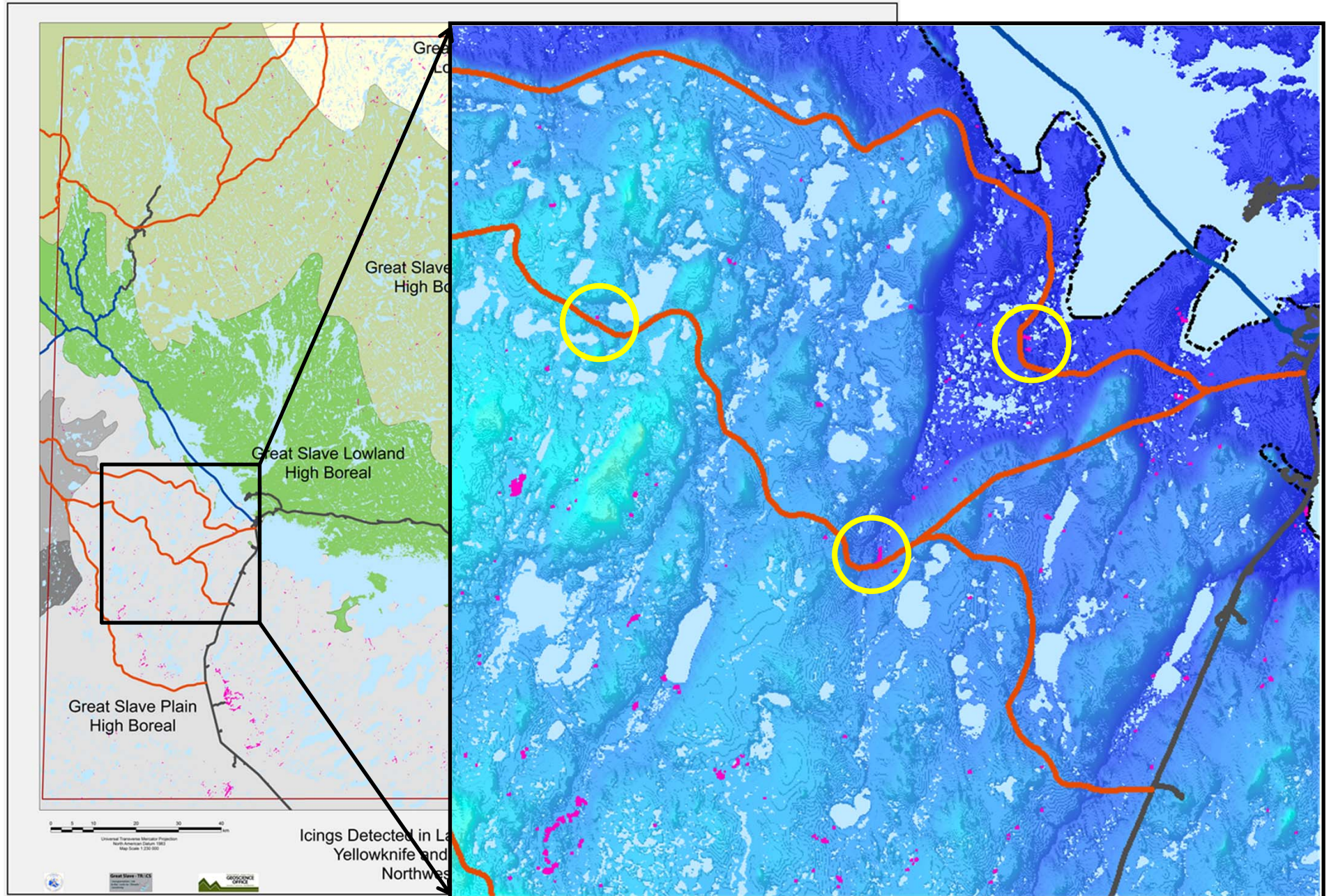
Mapping icings from Landsat remote sensing



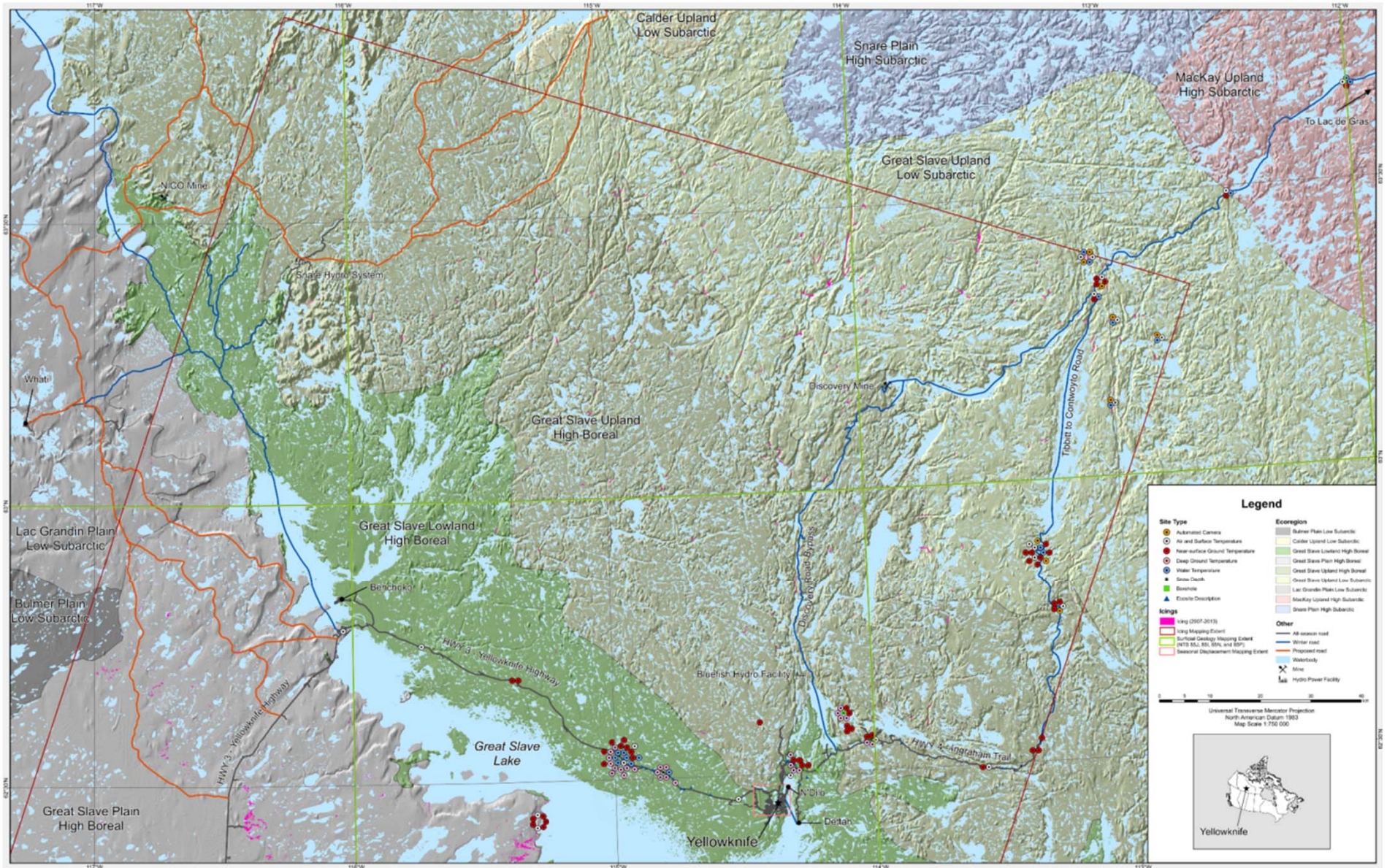
Map Areas 2007-2013



Route Planning



Permafrost dataset network: air and ground temperatures and process studies for decision-support



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