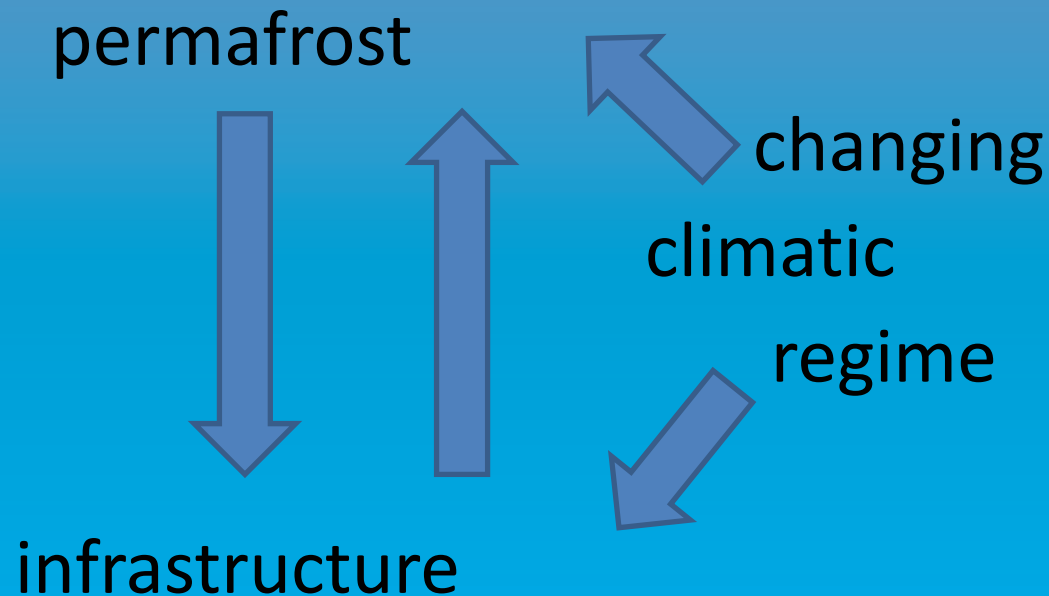




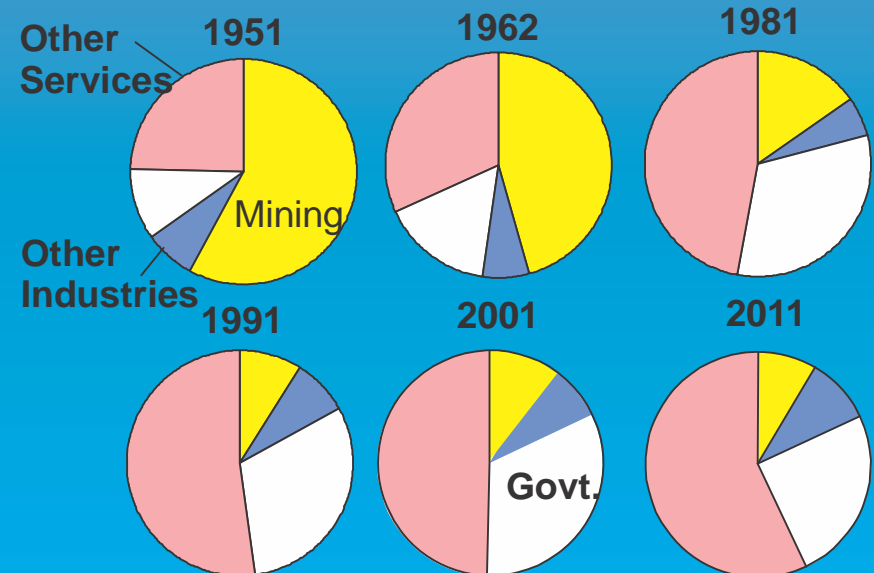
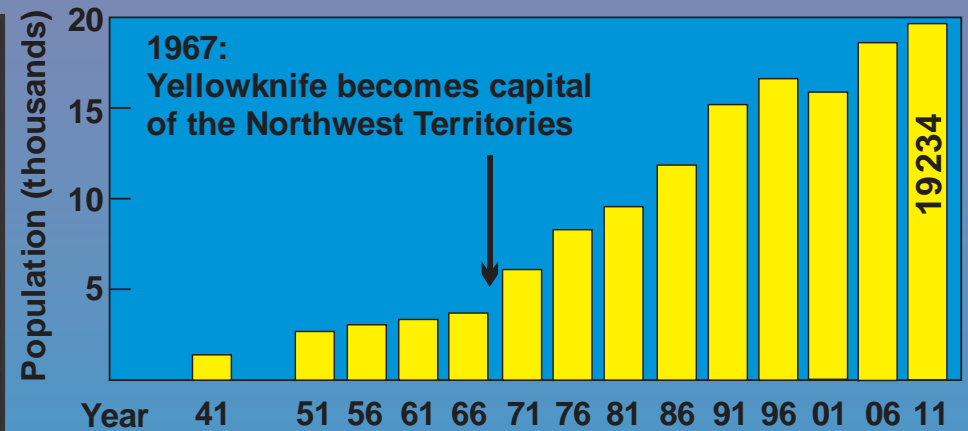
Living with Thawing Ground

Science Priorities for Risk Assessment and Adaptation Solutions

- Thermal state of permafrost
- Physical state of permafrost
- Assessing:



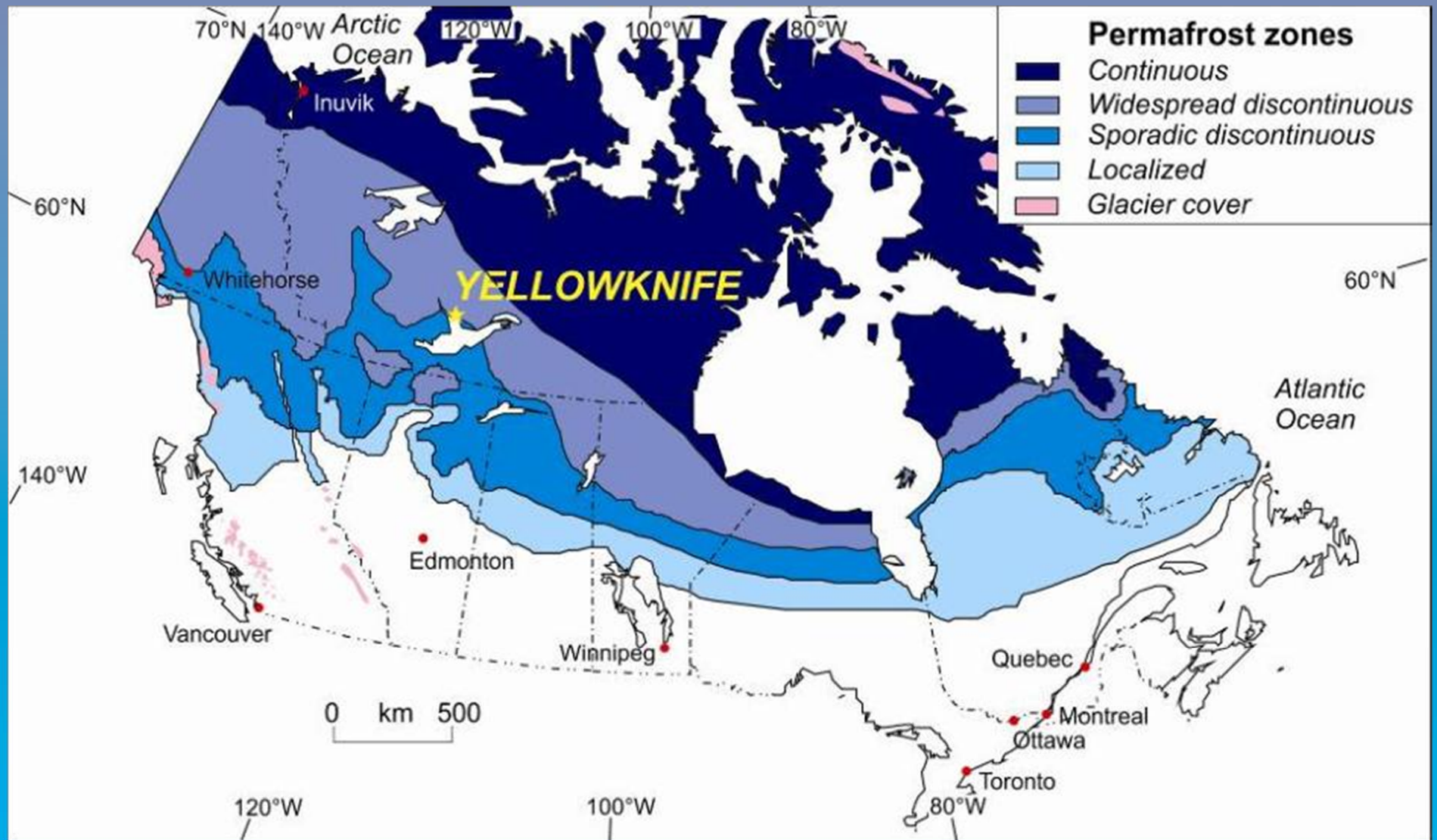
The City



“the gold is paved with streets”

“Diamond Capital of North America”

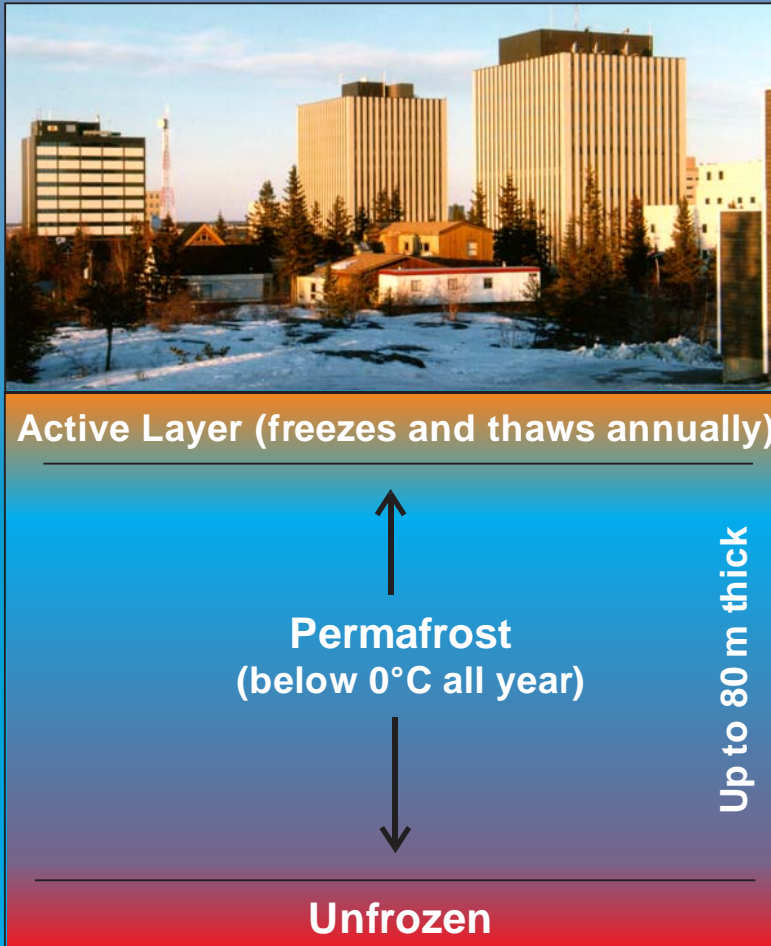
Permafrost in Canada



Permafrost is:

A ground temperature condition:

Defined as soil or rock that remains at or below 0°C throughout the year



Permafrost is:

A ground temperature condition:



Active Layer (freezes and thaws annually)

↑
Permafrost
(below 0°C all year)
↓

Up to 80 m thick

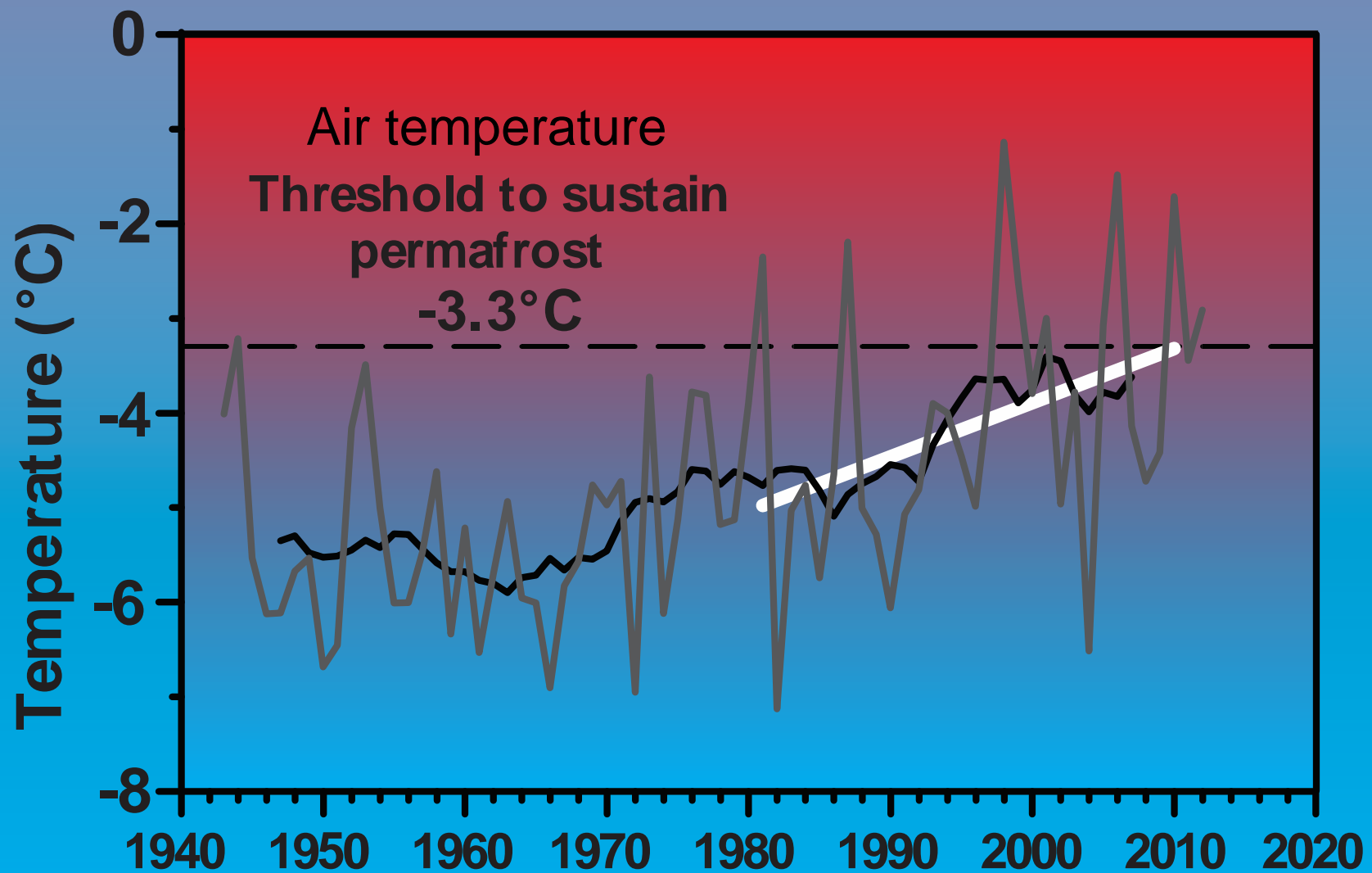
Unfrozen

Defined as soil or rock that remains at or below 0°C throughout the year

potentially unstable material containing ice, that is sensitive to impacts caused by:

- Natural Processes
- Human impacts
- Climate change

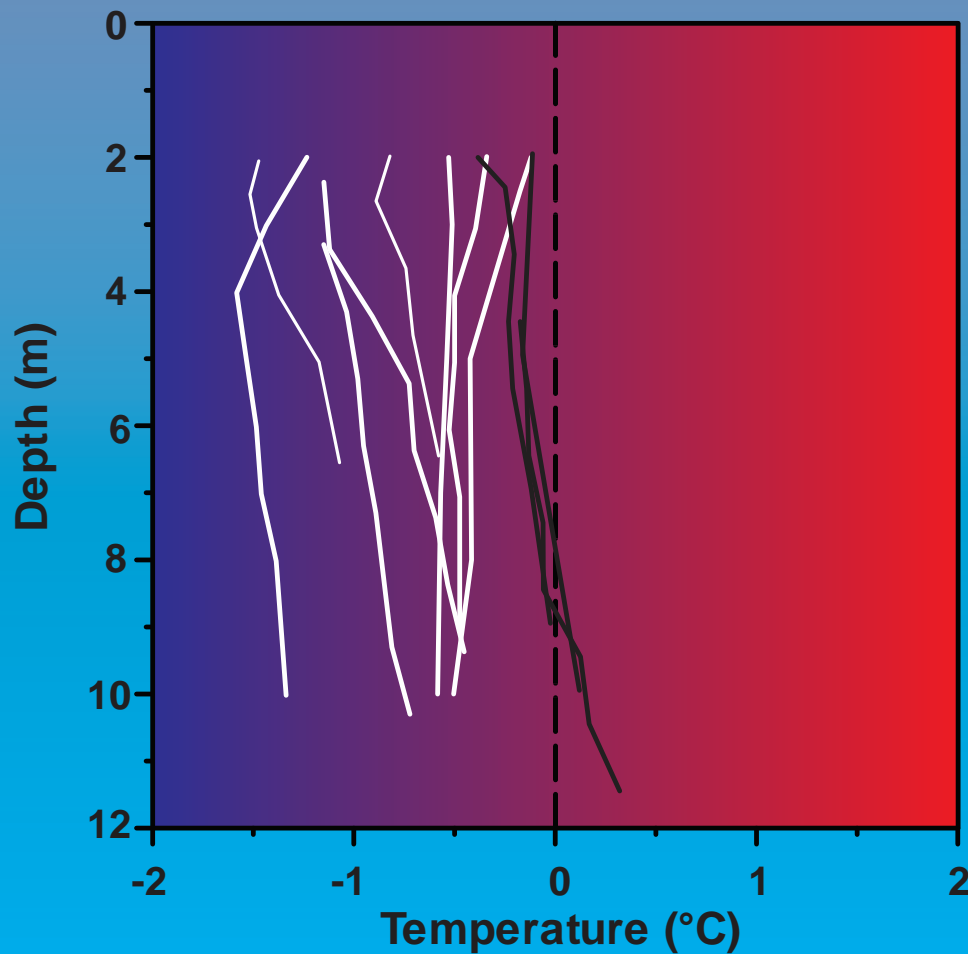
Air Temperatures in Yellowknife



Ground Temperatures in Yellowknife

undeveloped terrain

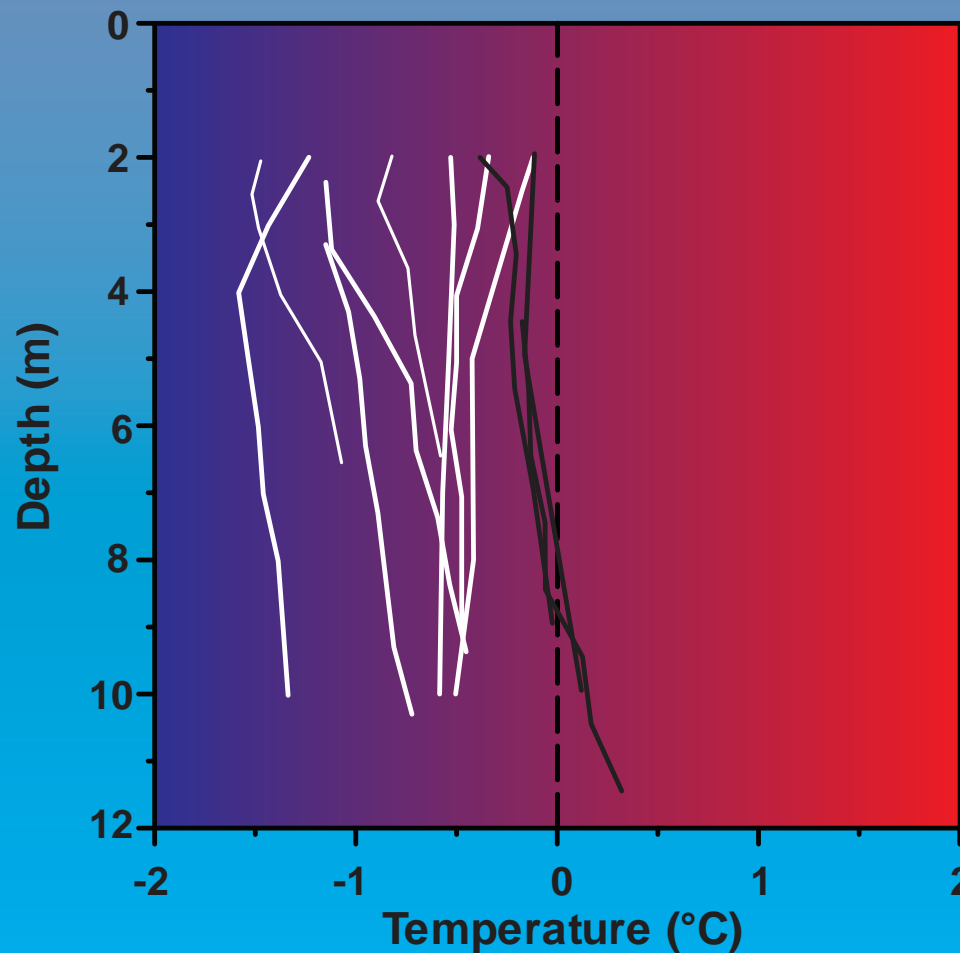
- Peatlands
- Spruce forests
- Birch forests



Ground Temperatures in Yellowknife

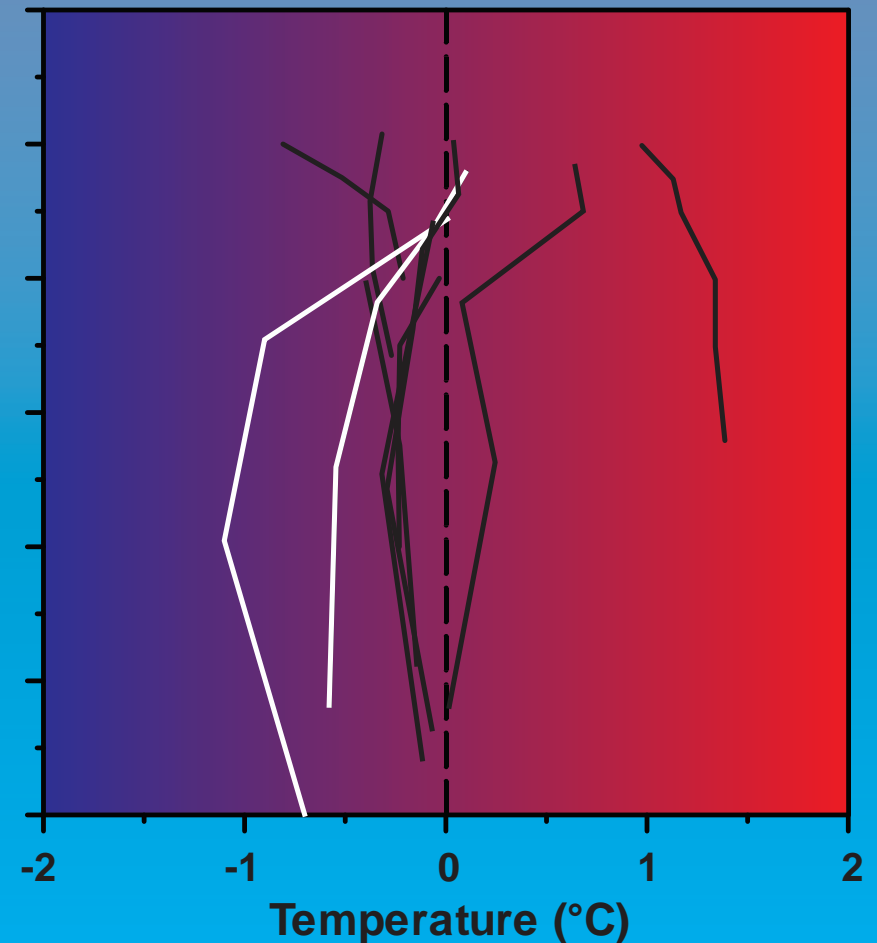
undeveloped terrain

- Peatlands
- Spruce forests
- Birch forests



developed terrain

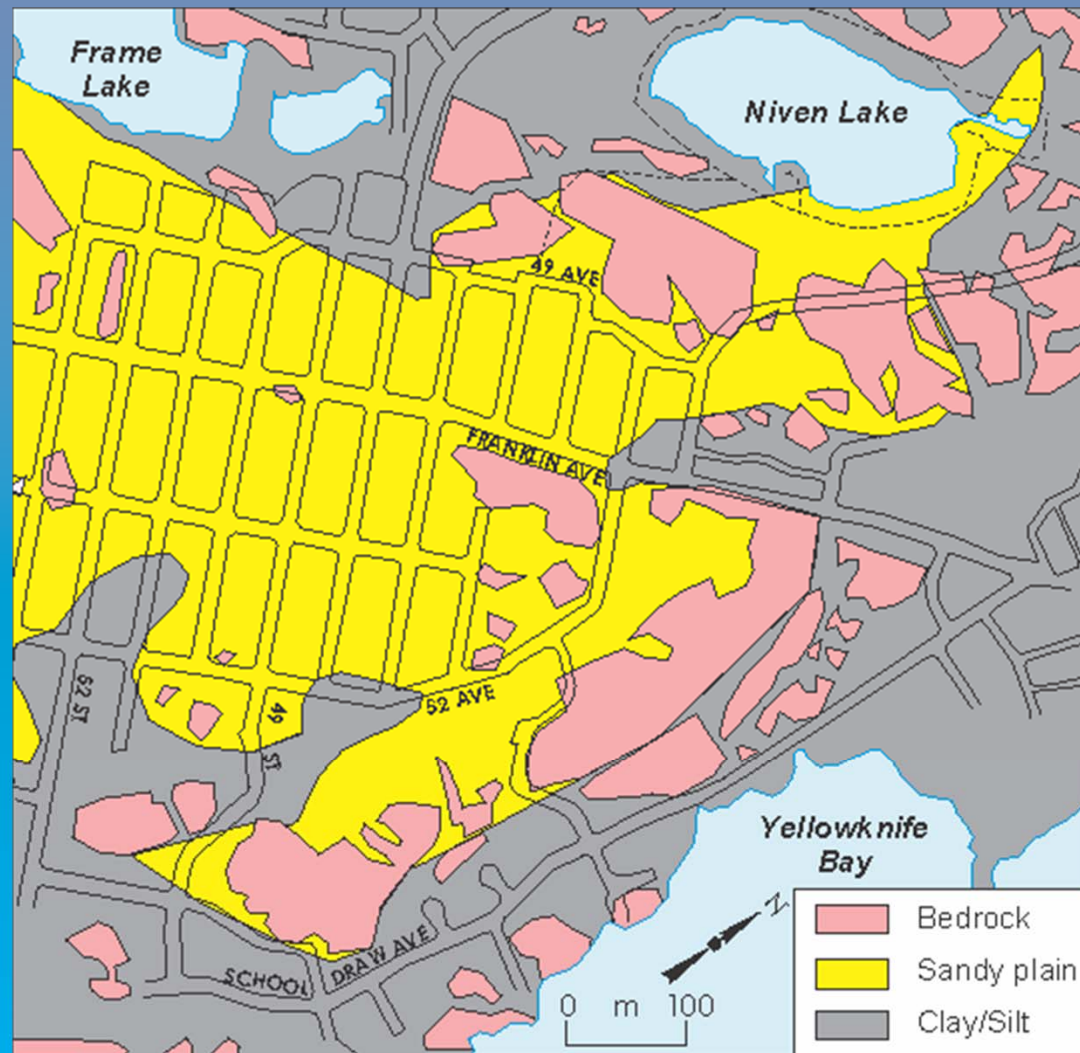
- Walkways
- Roadways
- Highway shoulders



Thaw unstable sediments



Glacial Lake McConnell

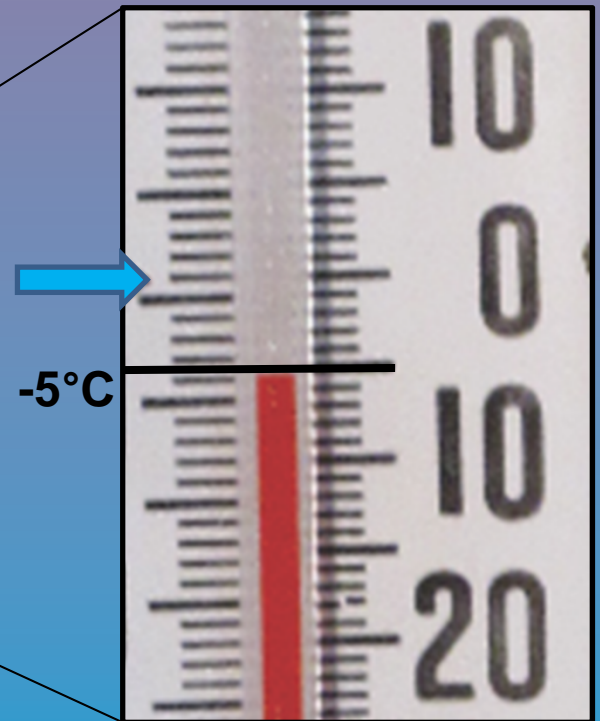


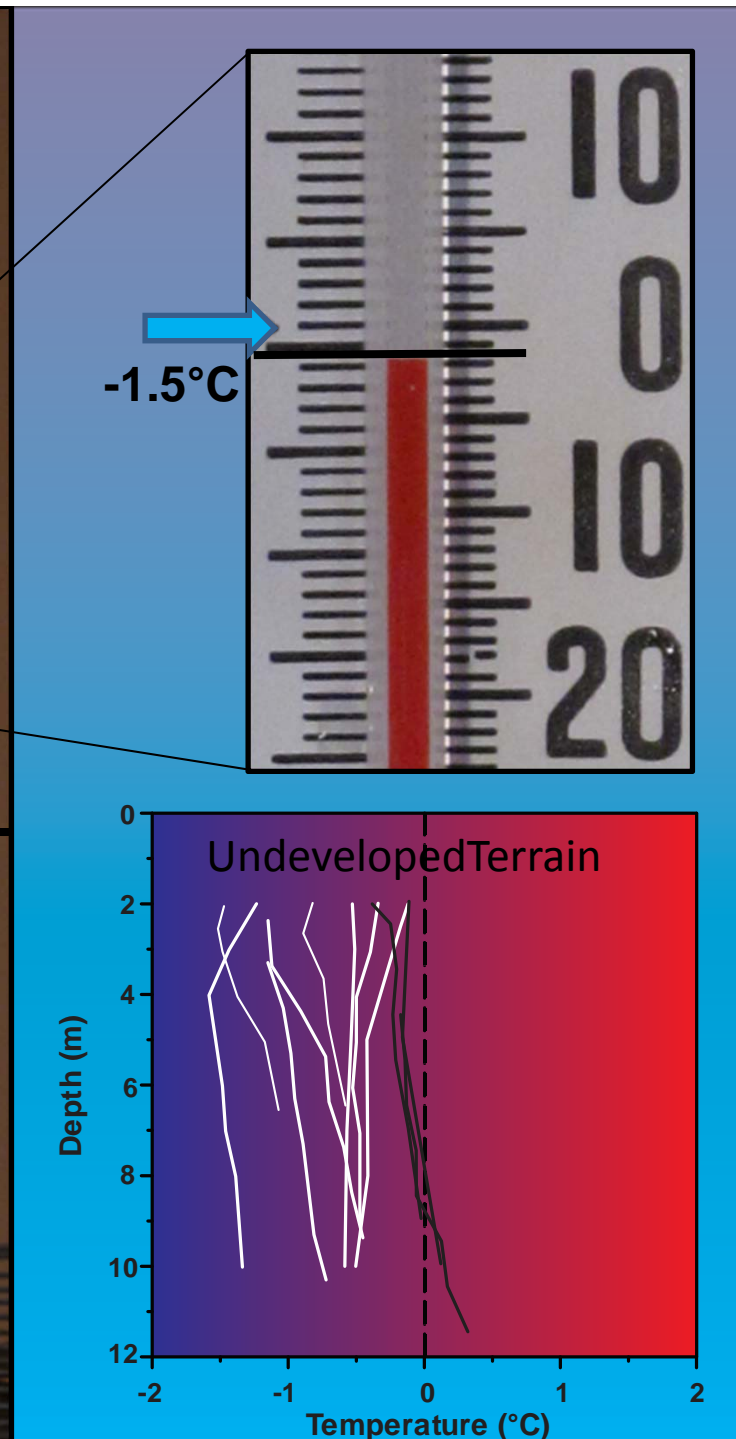
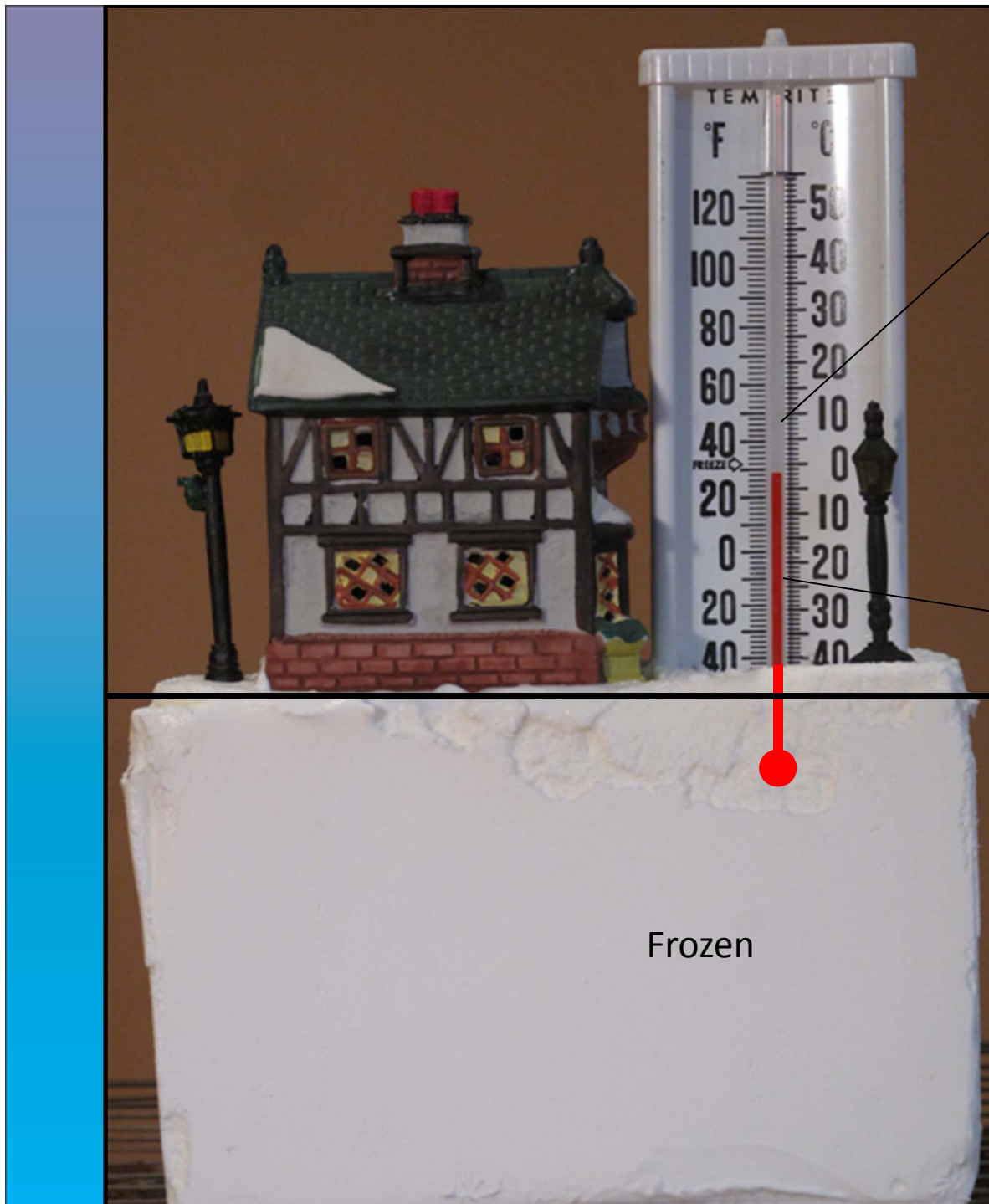


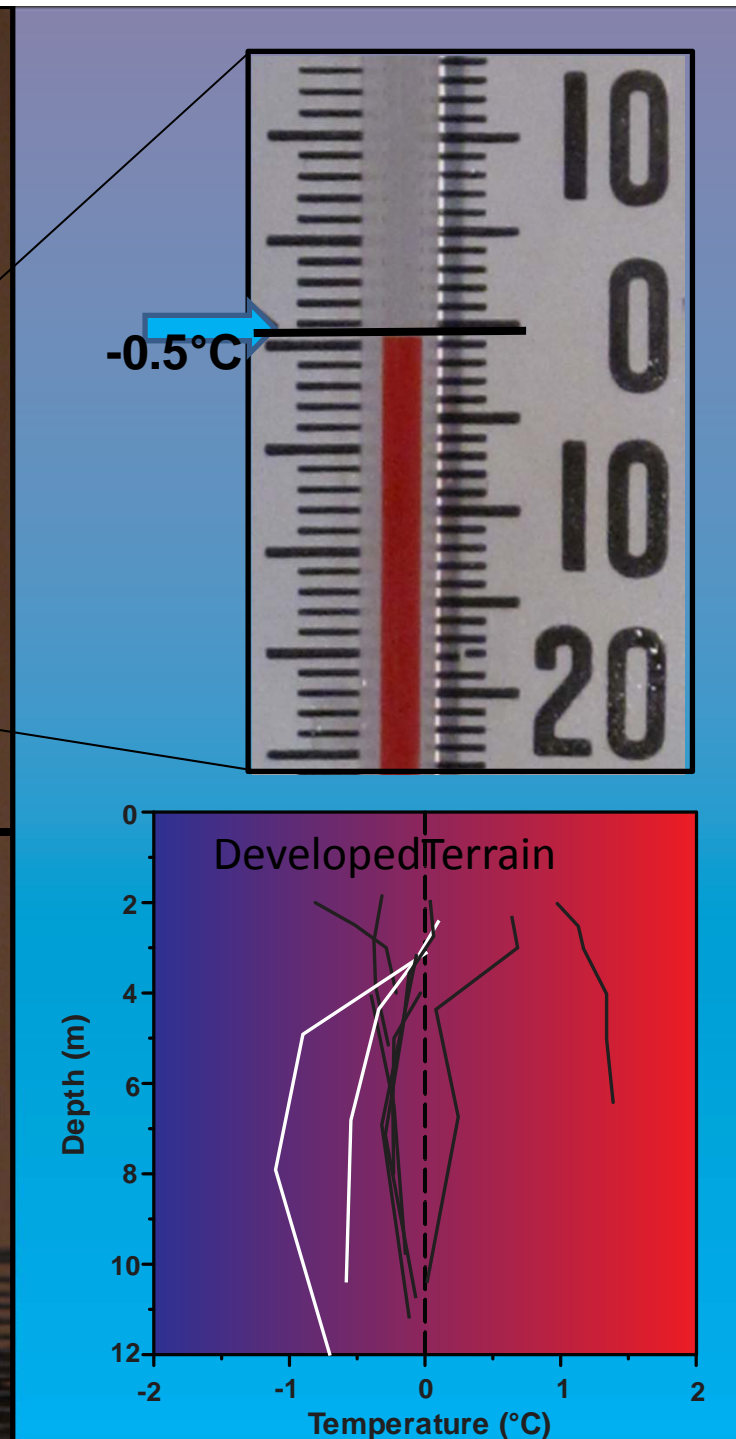
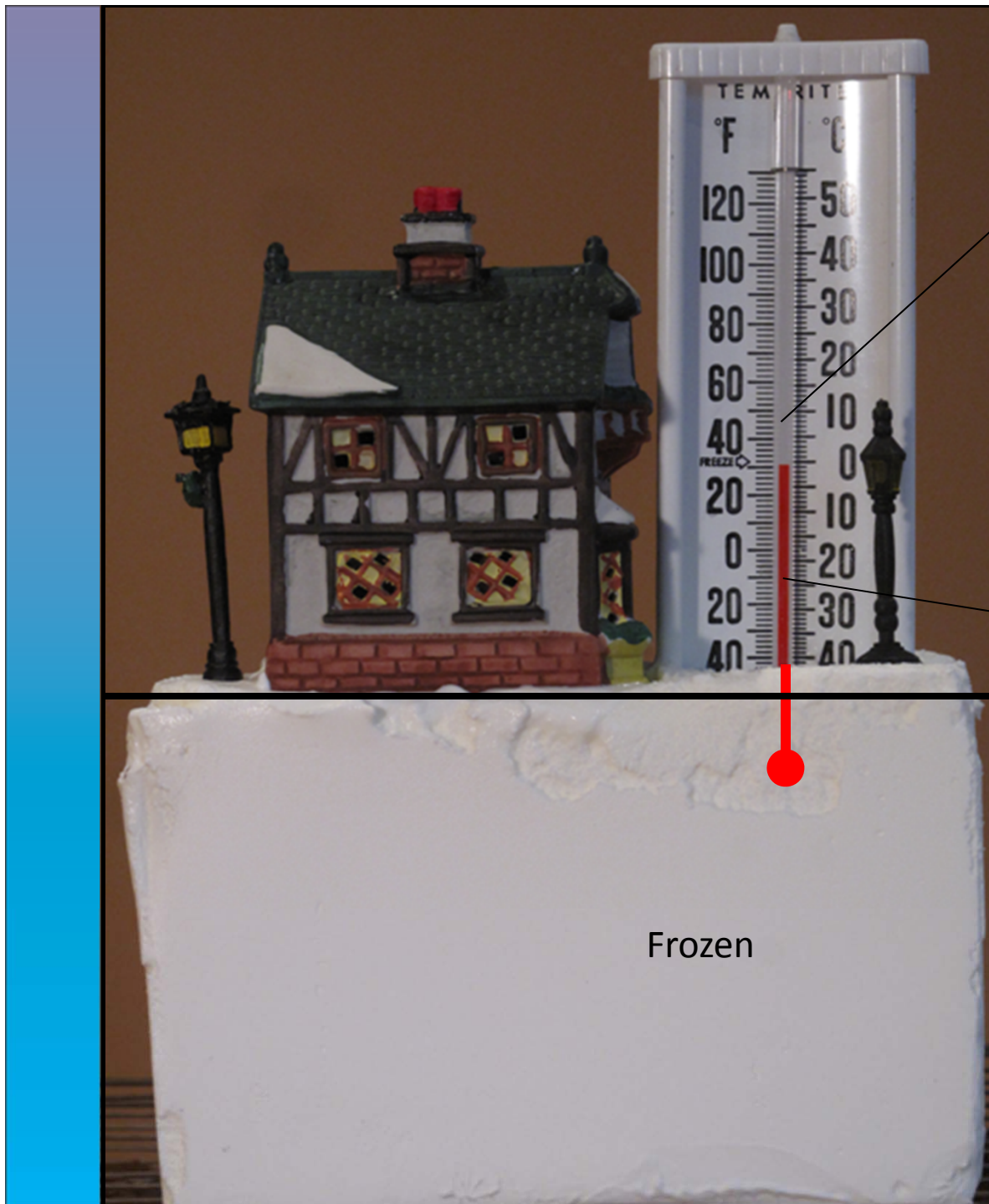
*Thaw
unstable
permafrost
is like
ice cream*

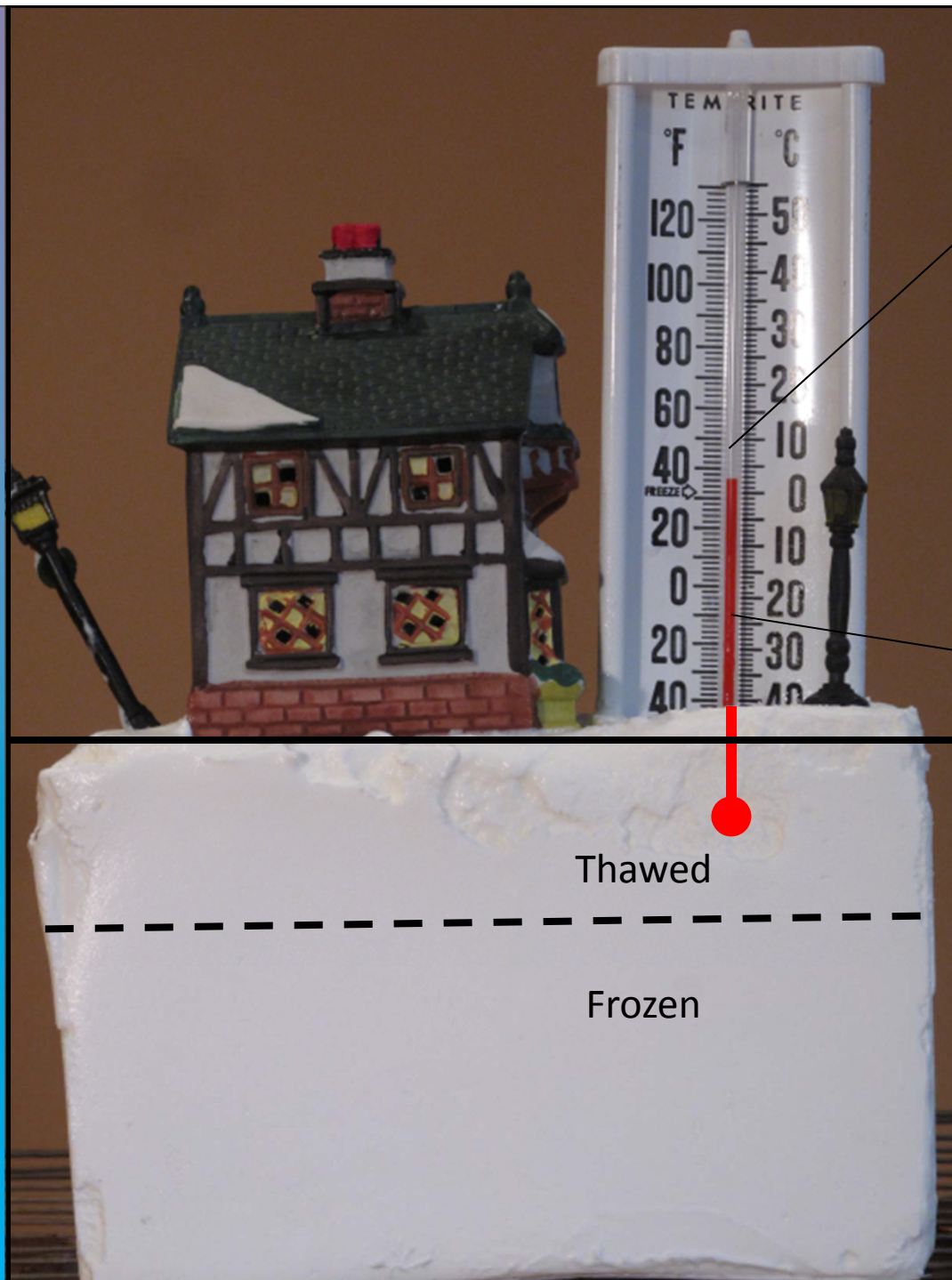


Well
Frozen

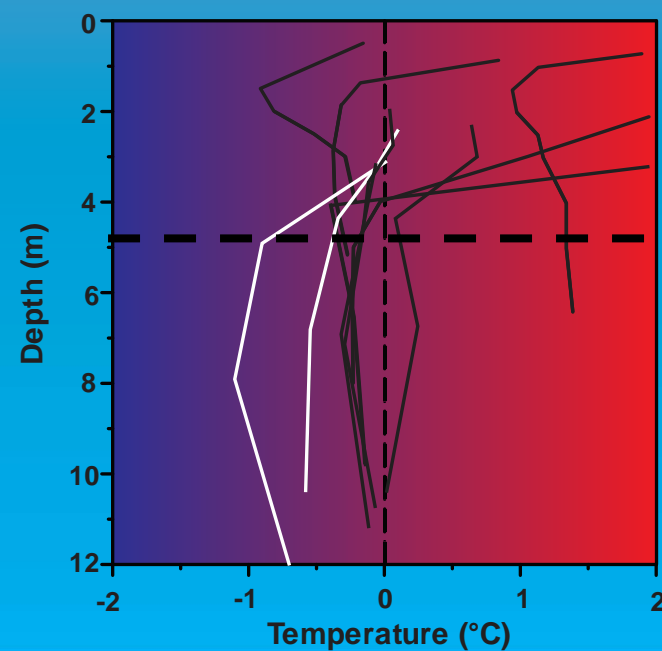


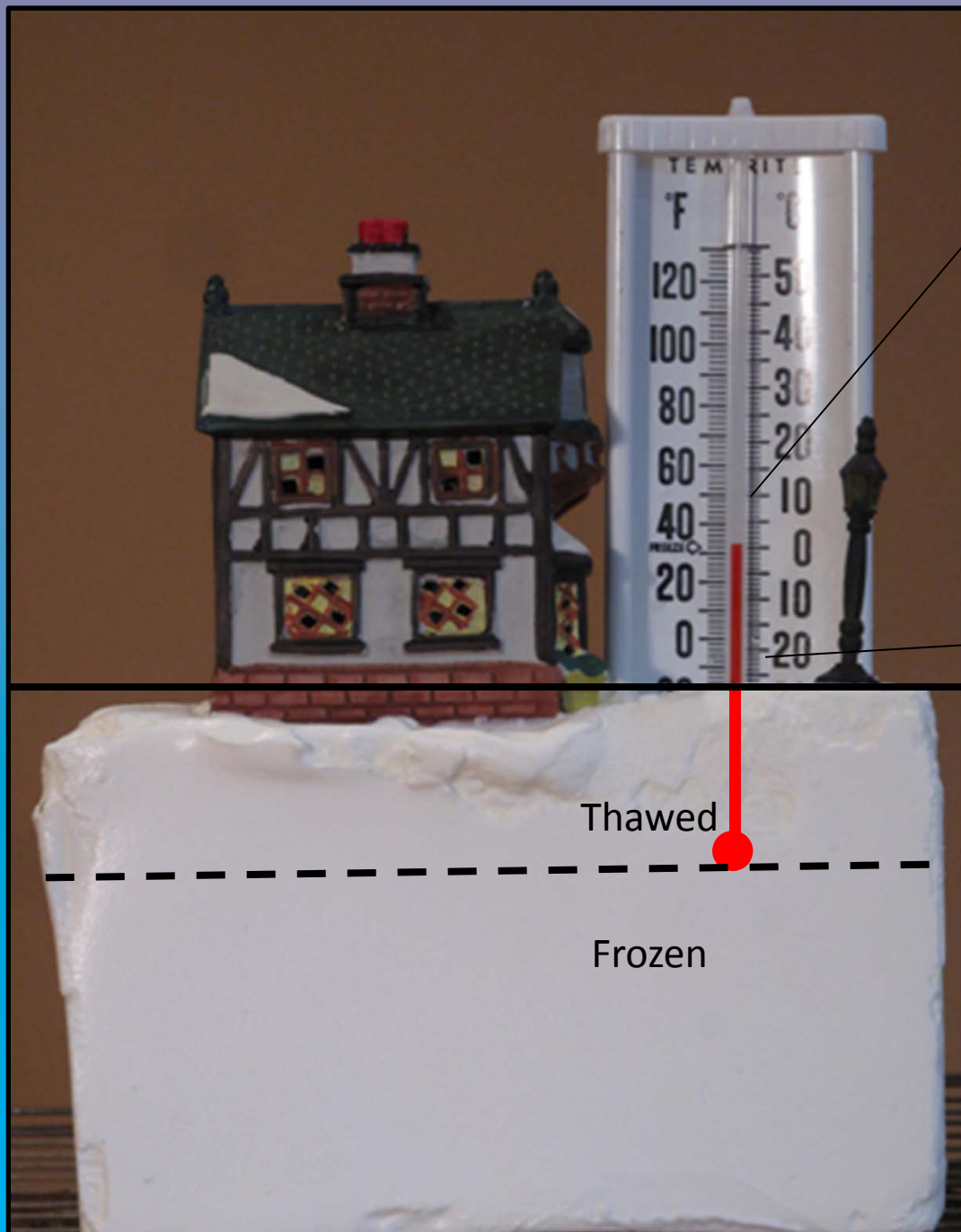




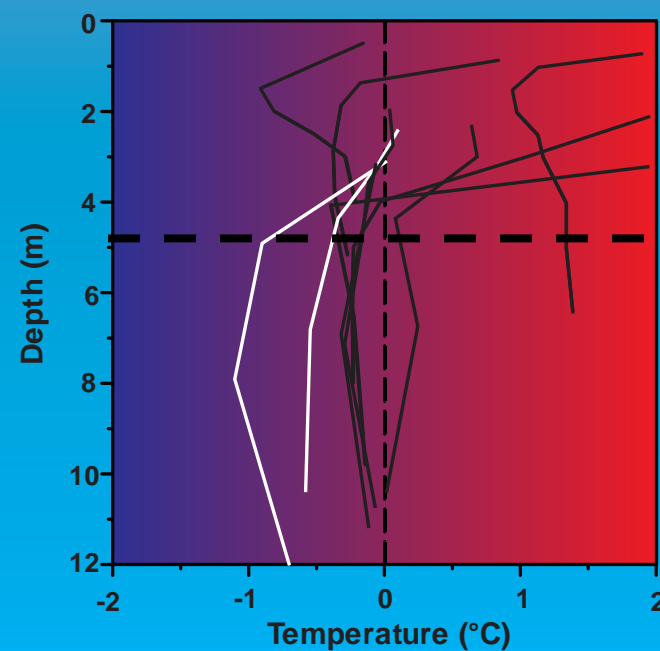


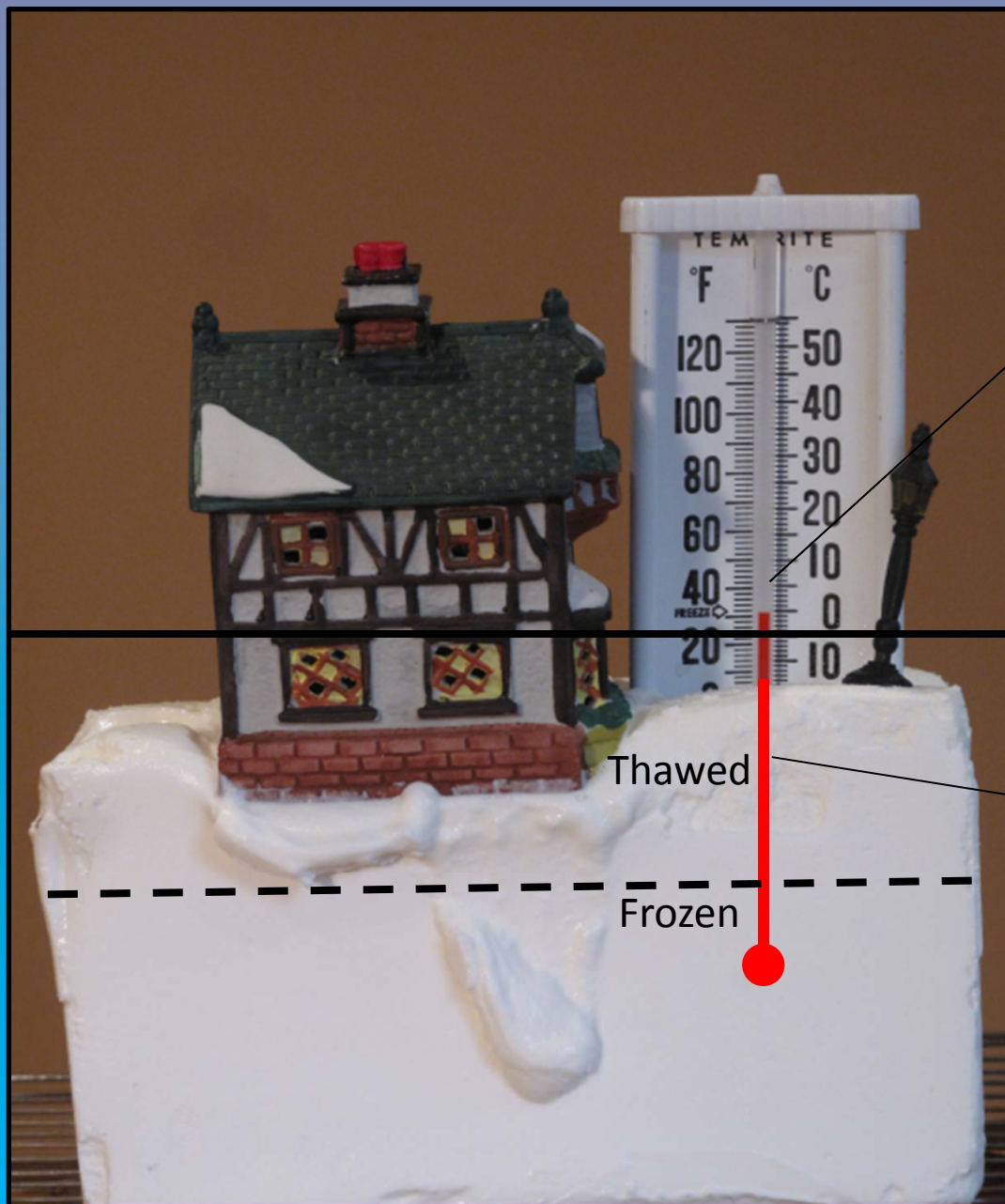
+2.5°C





+2.5°C

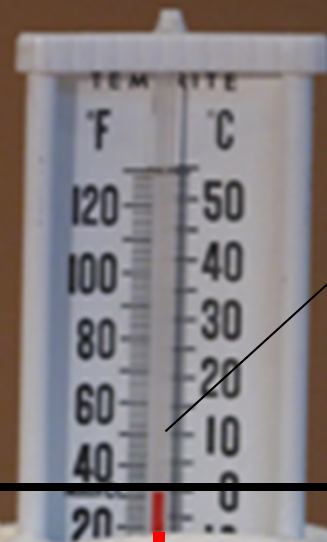




-0.2°C



Site Abandonment

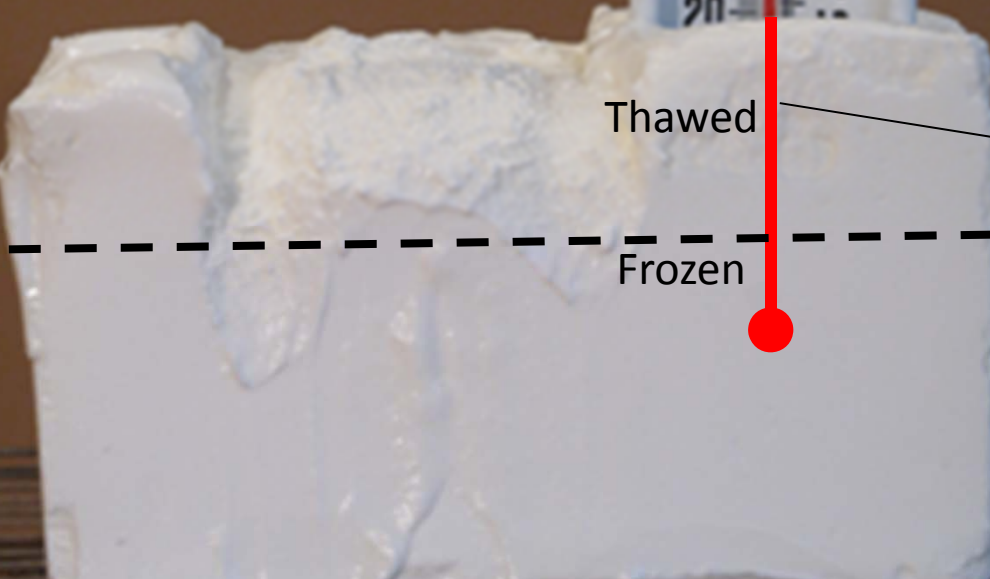


-0.2°C



Thawed

Frozen

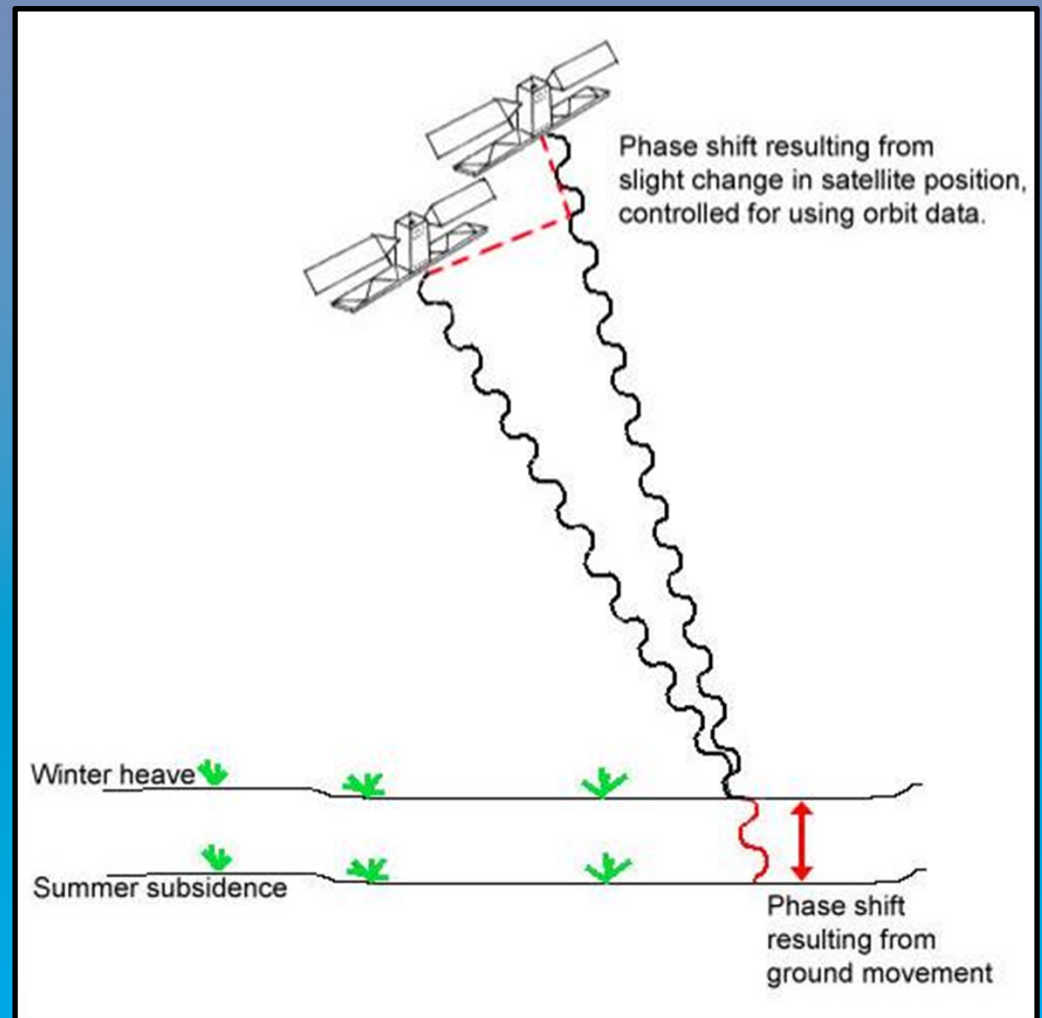




D-InSAR

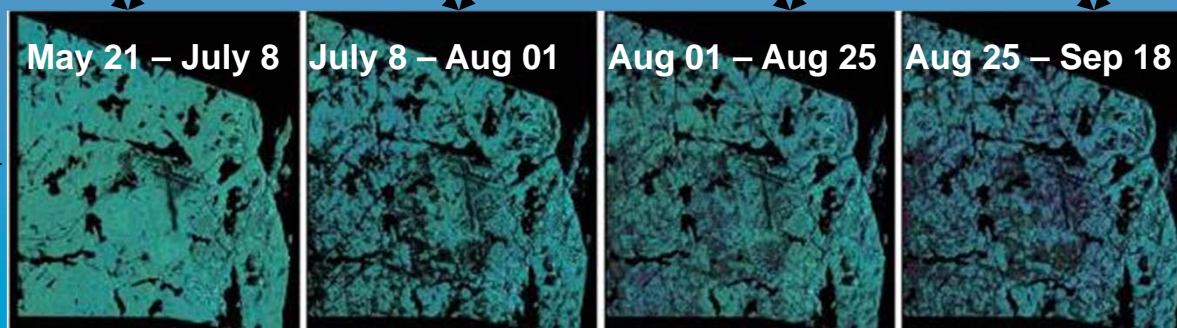
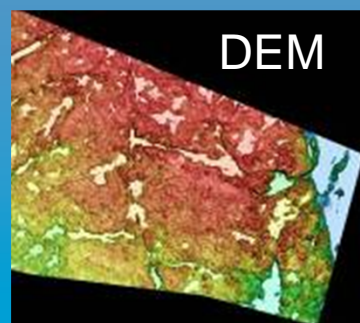
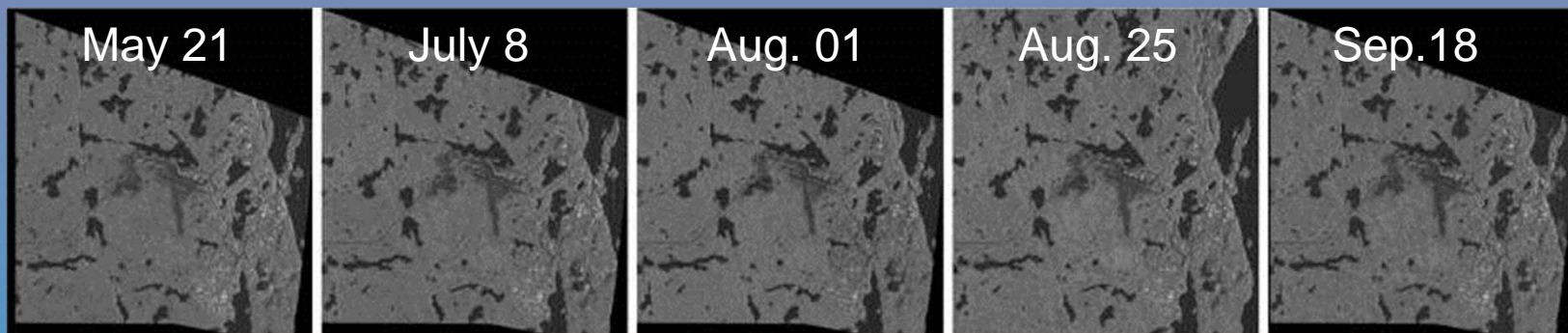
Differential
Interferometric
Synthetic Aperture
Radar

Repeat pass satellite
D-InSAR is a well
established method
for detecting ground
movement



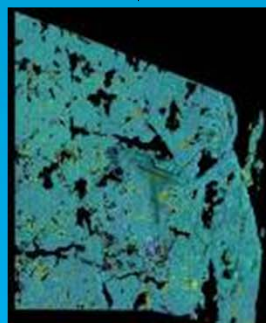
InSAR Processing Example

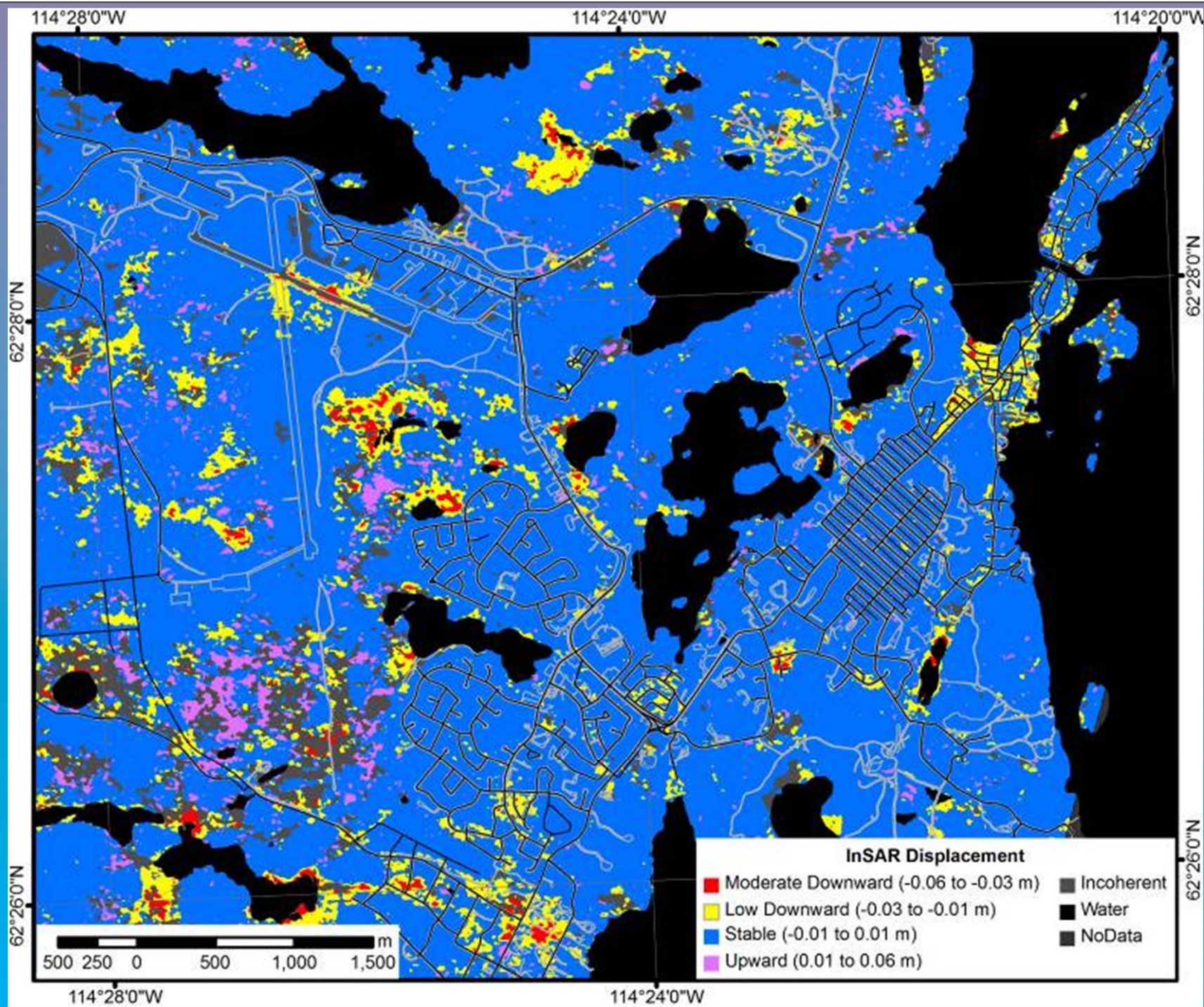
RADARSAT-2
acquisitions

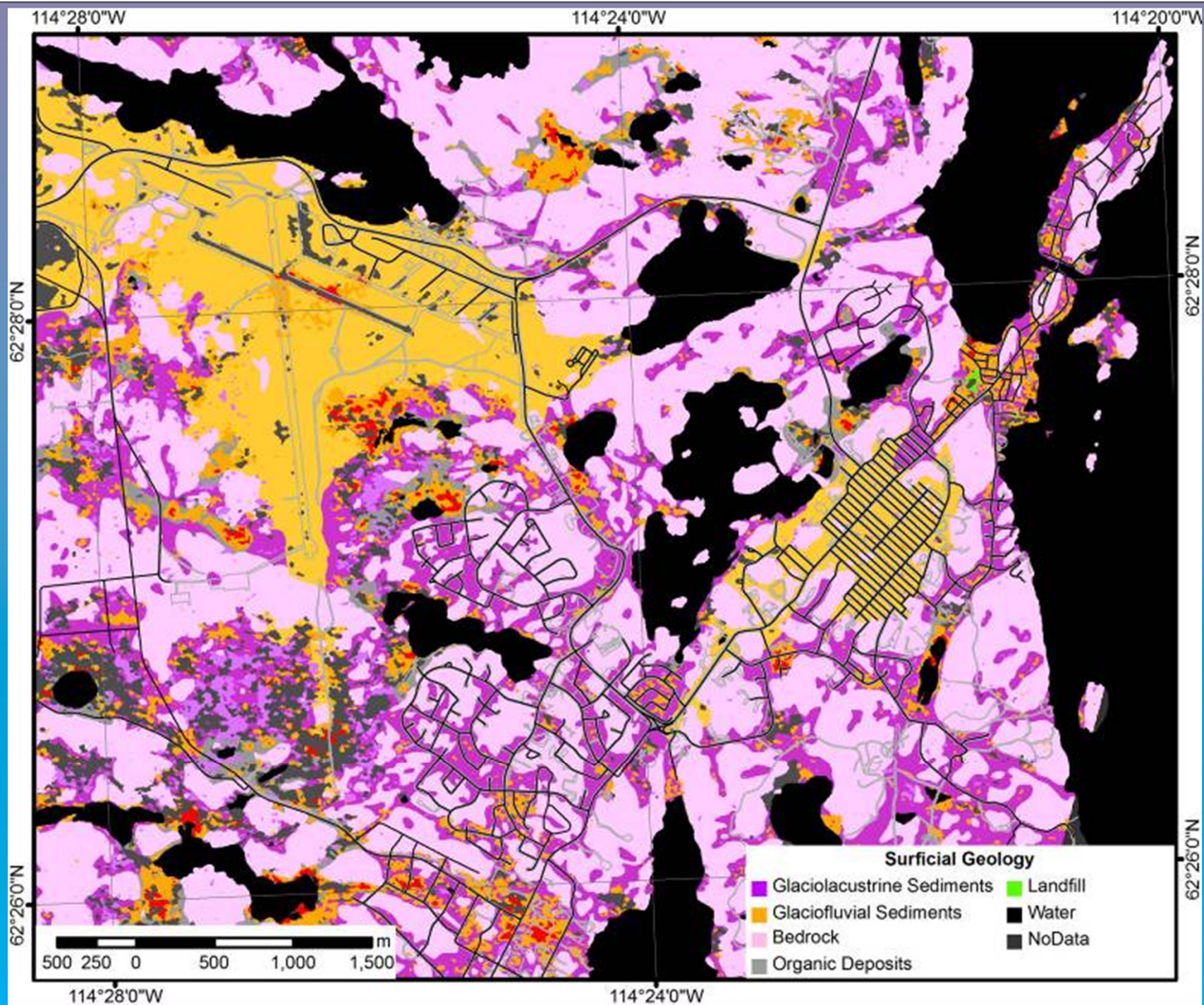


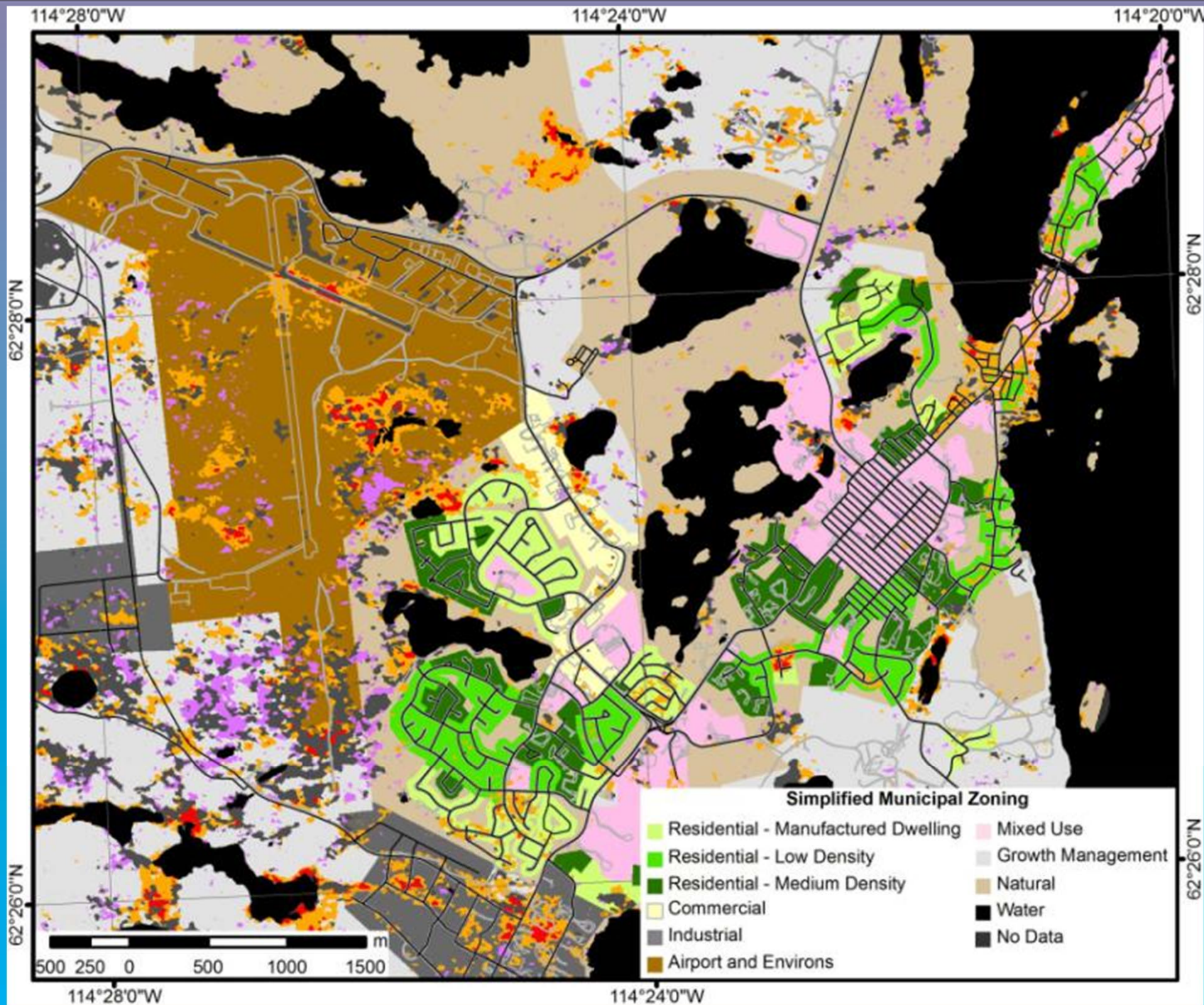
Interferograms

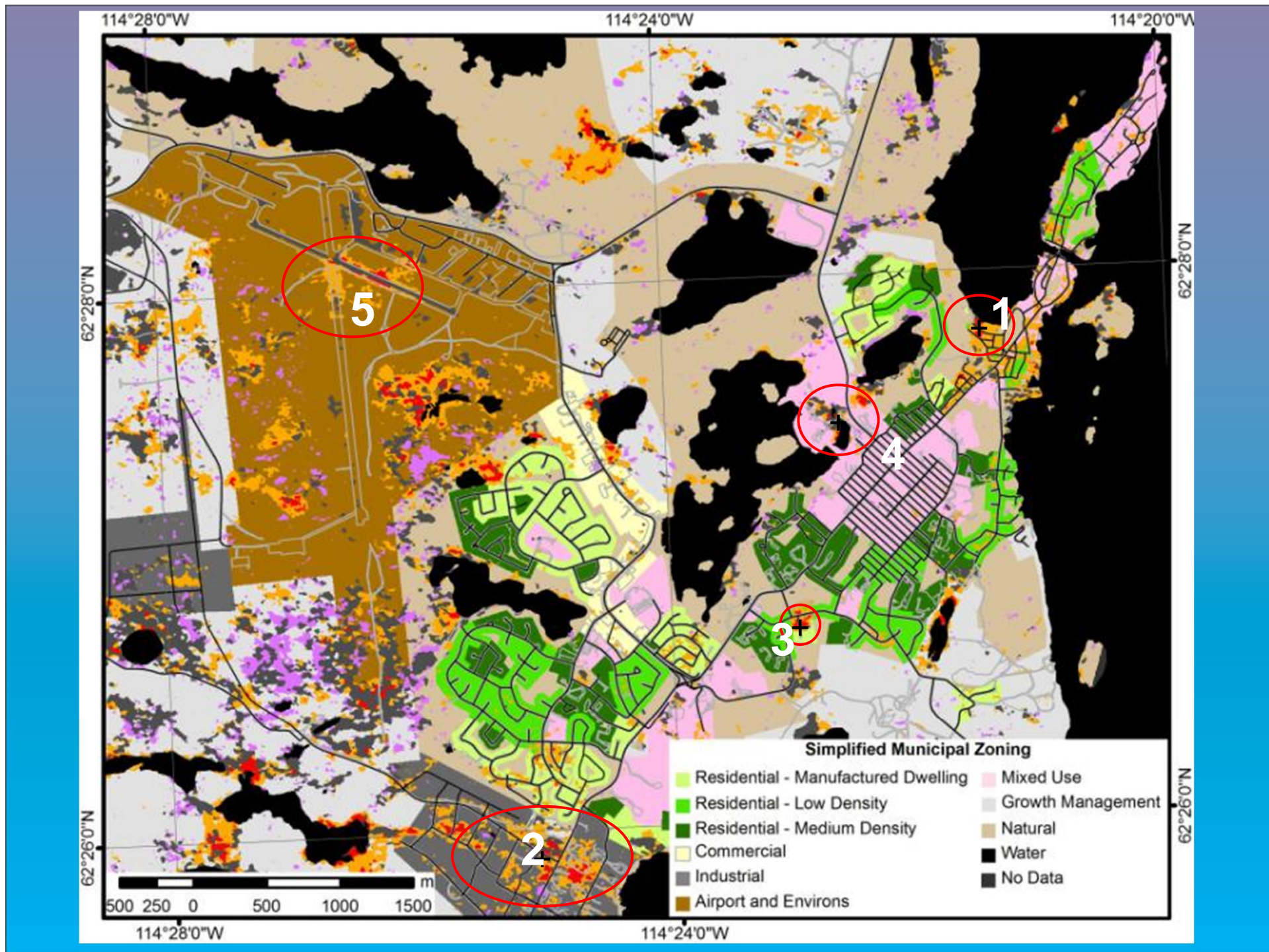
Cumulative displacement
May 21 – Sep. 18, 2010







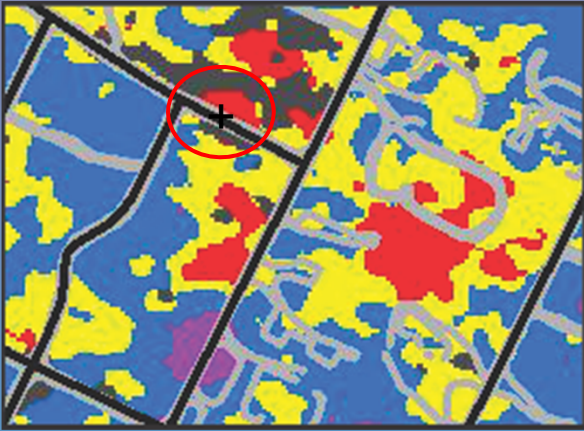




Peace River Flats – Fritz Theil Park



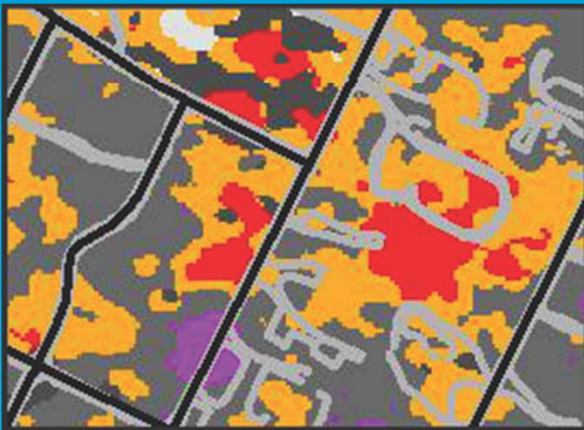
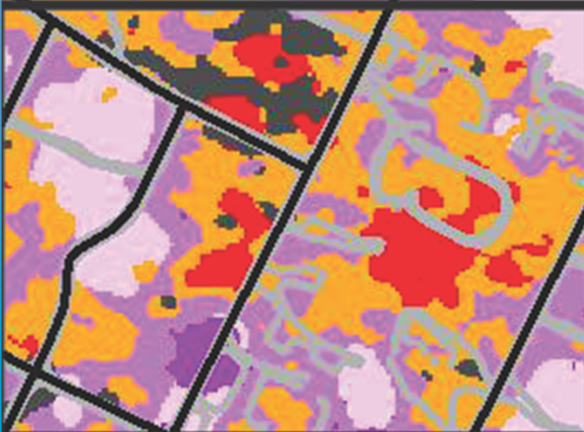
Kam Lake Industrial area



July 9, 2011

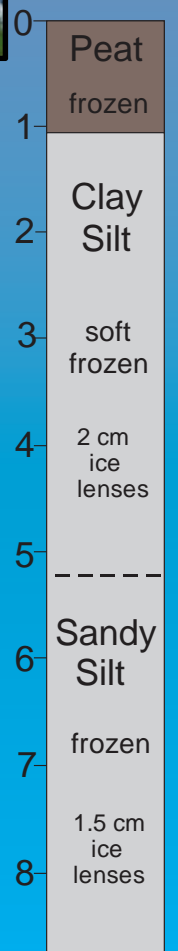
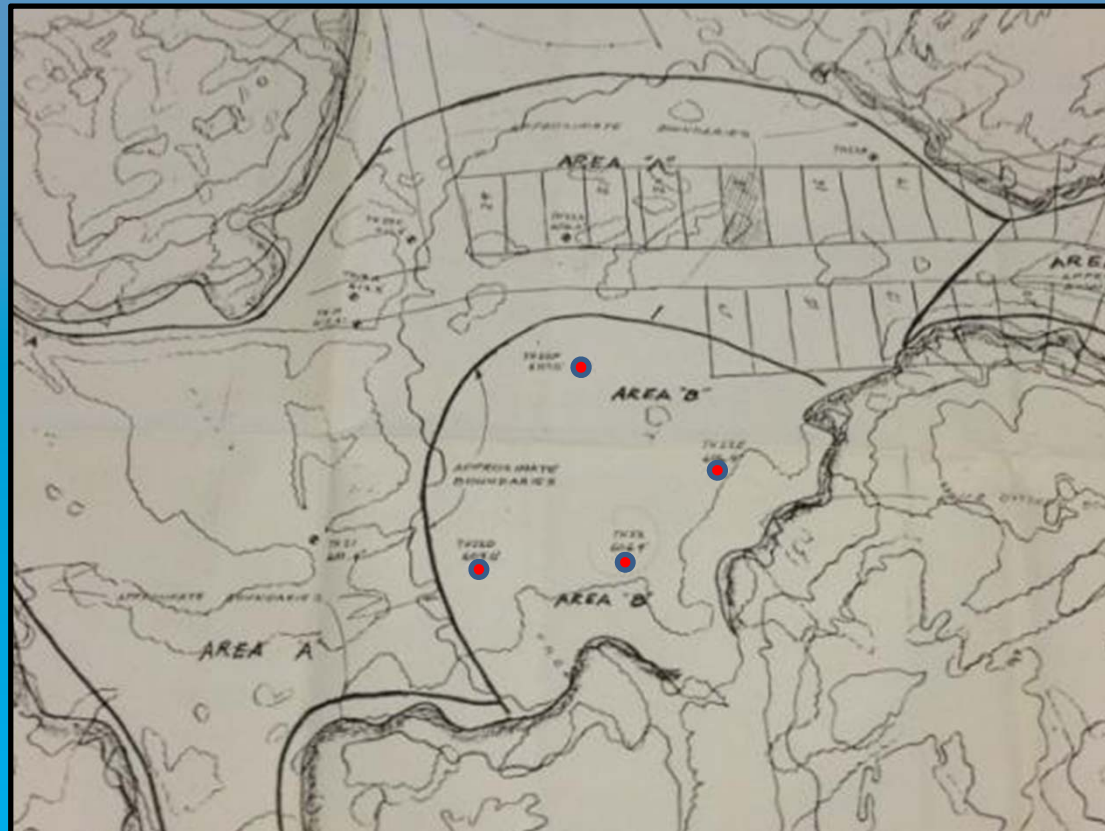
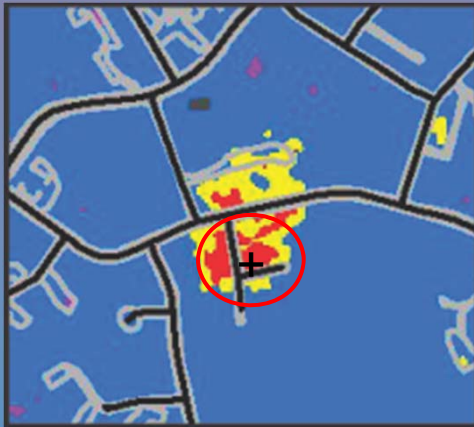


June 23, 2013



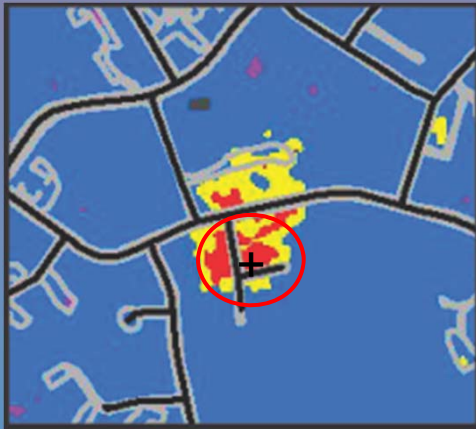
June 23, 2013

Forrest Drive: Area "B"



Ripley, Klohn & Leonoff, 1971

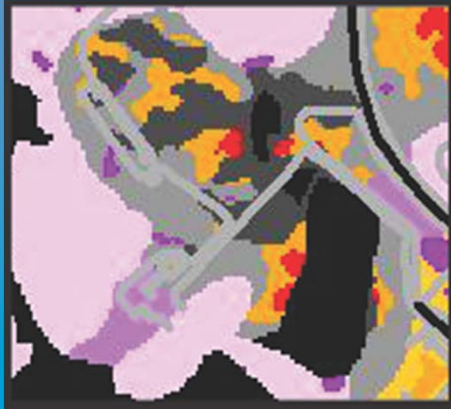
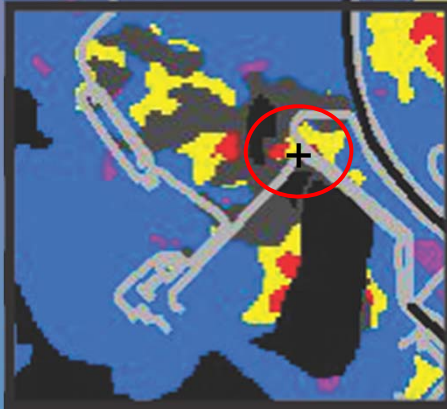
Forrest Drive: Area "B"



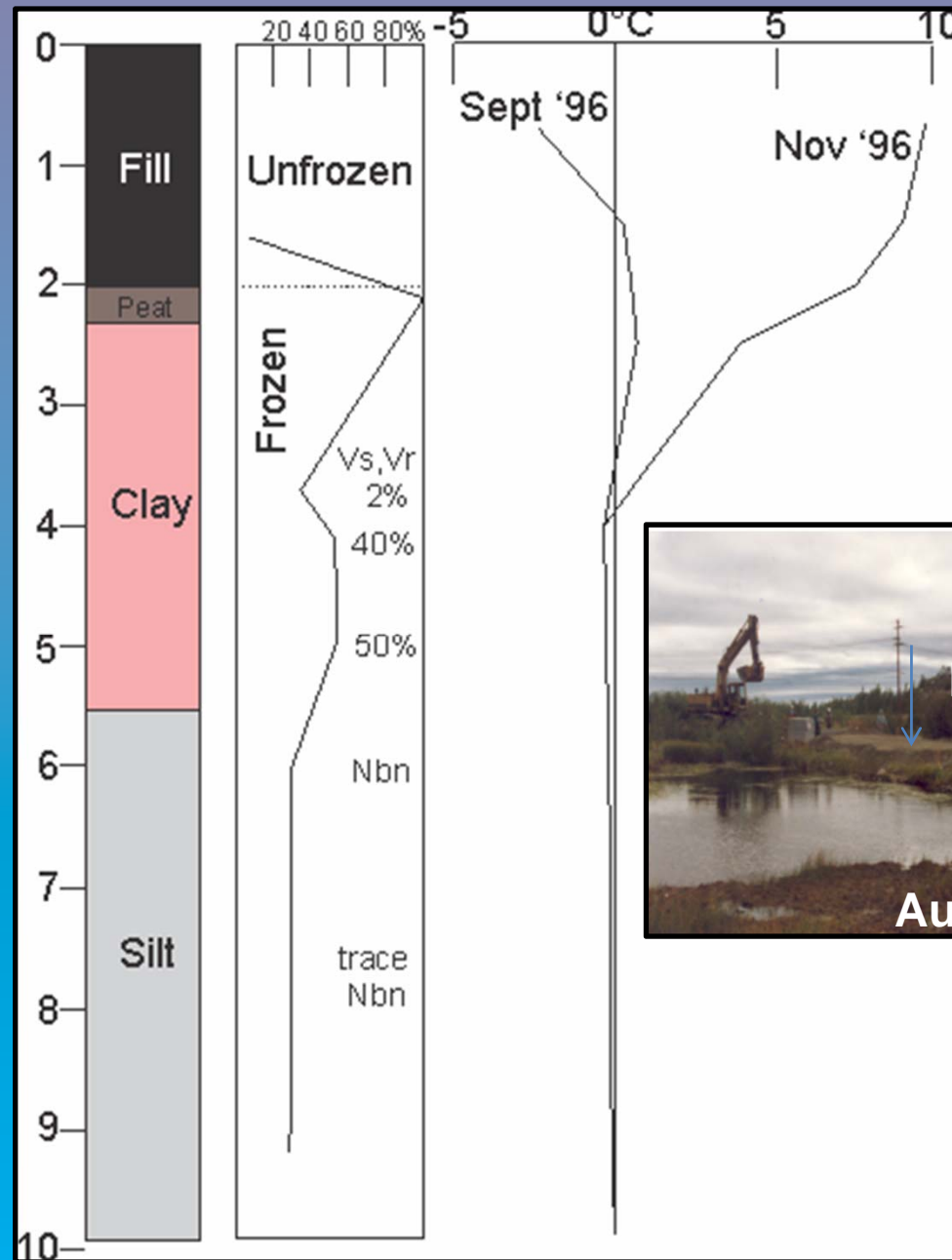
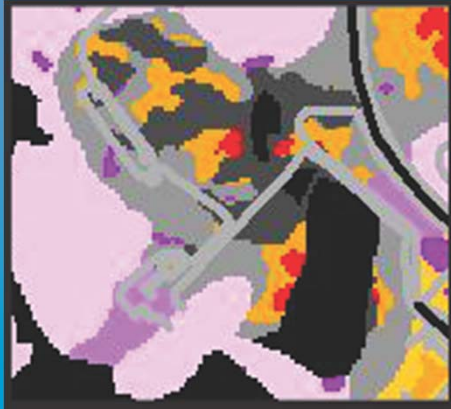
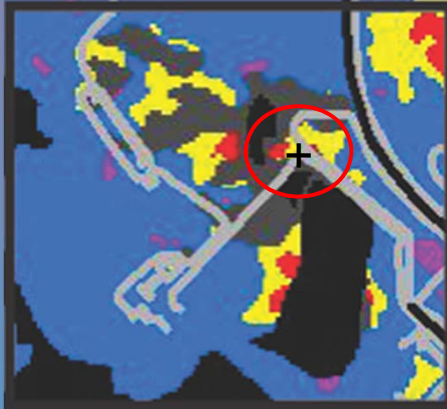
“The soils encountered in the test holes in this area exist with numerous ice lenses. On site visual examination of samples recovered from the test holes at the time of drilling indicate percentage of clear segregated ice to be of the order of 10 to 15 percent. On degradation of permafrost, this area will be subjected to subsidence and could result in settlement problem for the structures, utilities and roadway. The settlements are anticipated to be of the order of 1 to 2 feet excluding the deformations within the surface peat.”

Ripley, Klohn & Leonoff, 1971

Legislative Assembly Access Road

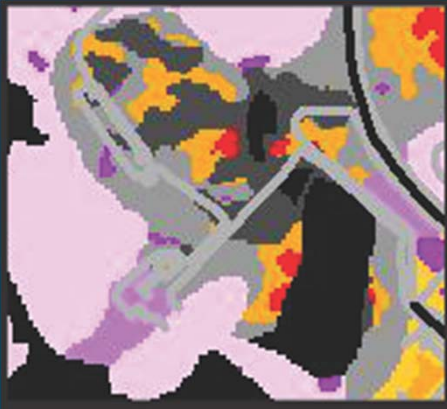
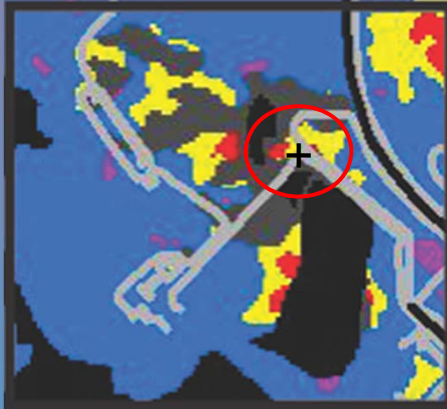


Legislative Assembly Access Road



EBA, 1996

Legislative Assembly Access Road



“... paving the road increases (warms) the ground temperature, thereby thawing or partially thawing the ice-rich permafrost. **Settlement can be expected as the permafrost thaws. Two types of settlement can be anticipated: the initial settlement as the ice melts and the long-term settlement as the silt and clay consolidate**”

Yellowknife airport

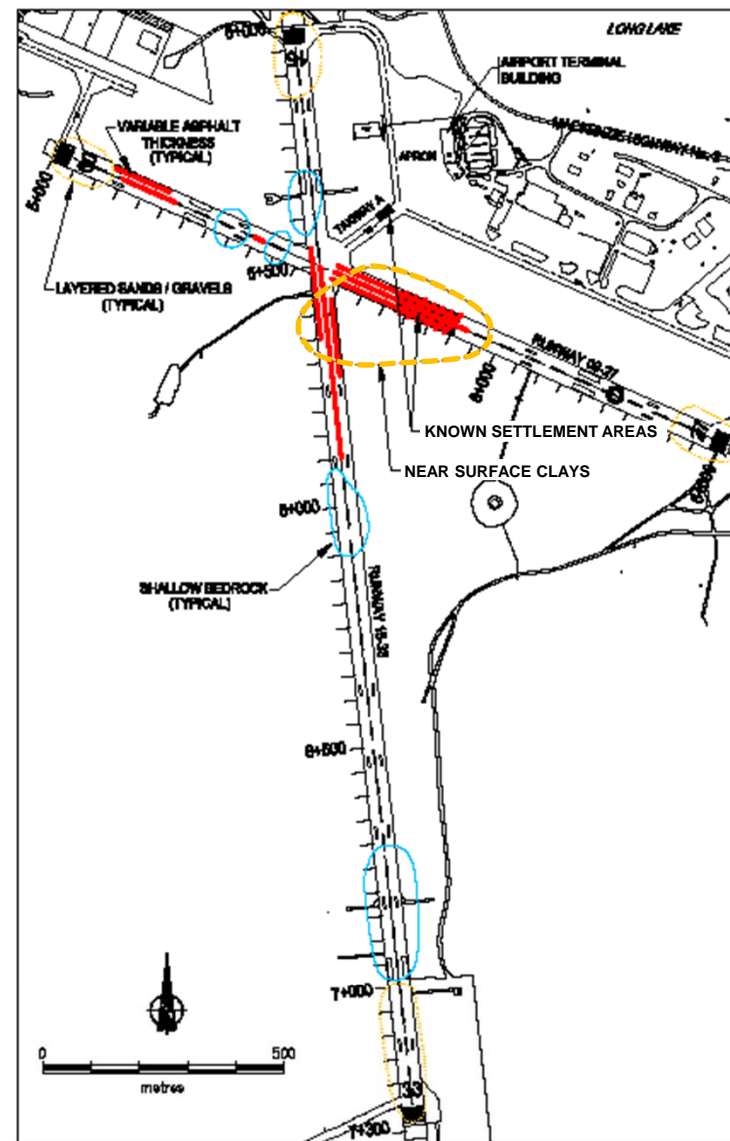
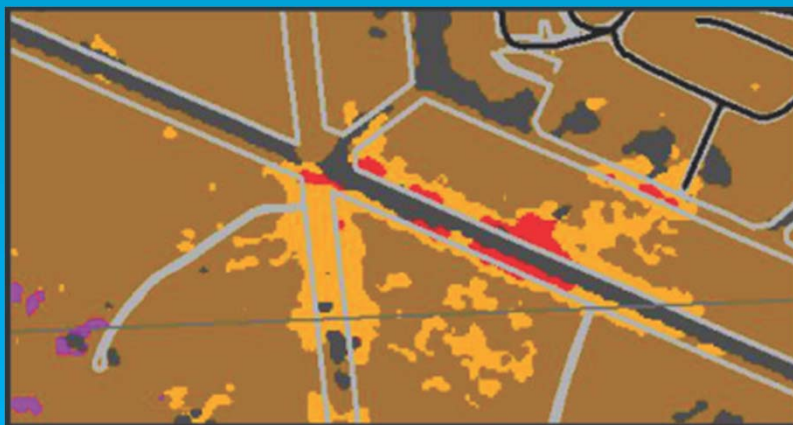
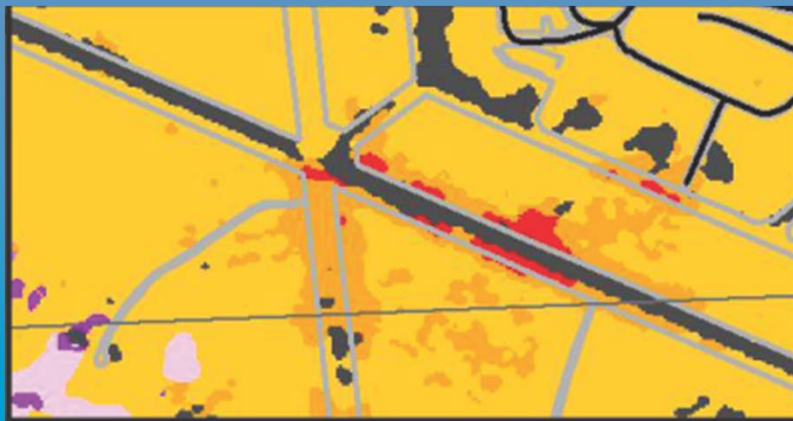
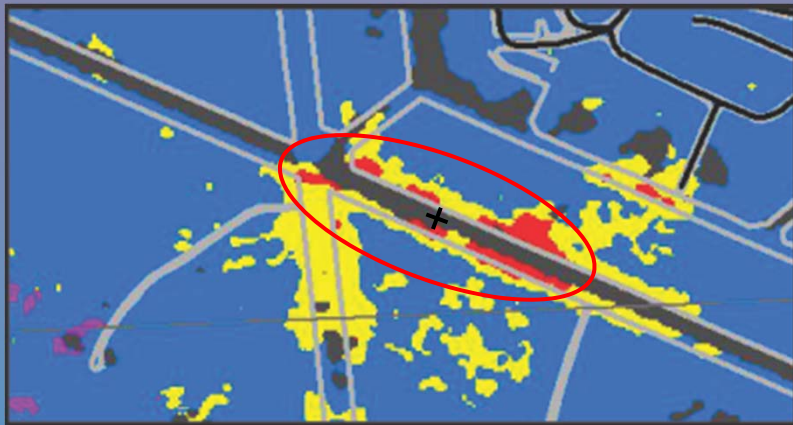


FIGURE 5 - LOCATIONS OF INTERPRETED SUBSURFACE FEATURES

105-0448/2002

Seto et al., 2004

Recommendations

- Review of geotechnical knowledge in place
- Concerted science and engineering effort towards understanding the (changing) state of permafrost
- Integrated adaptation plans for infrastructure on discontinuous permafrost

ANY PARTICULAR REASON
YOU'RE DRIVING IN THE DITCH
INSTEAD OF ON THE ROAD ?

FEWER BUMPS.

