Northern Development Ministers Forum

Climate Change Challenges for Northern Infrastructure

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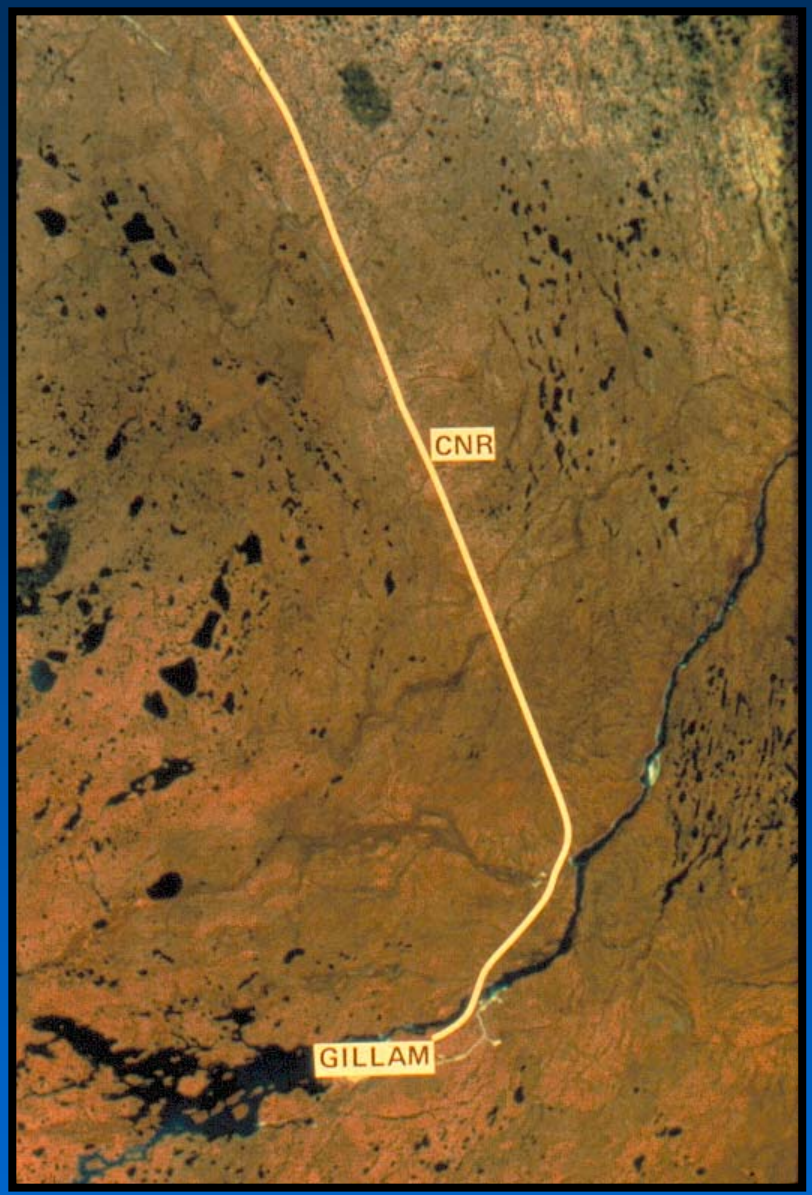
Permafrost, Ice and Climate Change

- Learn from the past
- Look to the future
- Adaptation by technology improvements
- Address the challenges
  - New buildings (defined life)
  - Site reclamation (perpetual)
  - Winter (Ice) roads and resource development

Dawson City, YT

Early Buildings on Permafrost, Dawson YT (1898 to 2005)

Main Street 1972



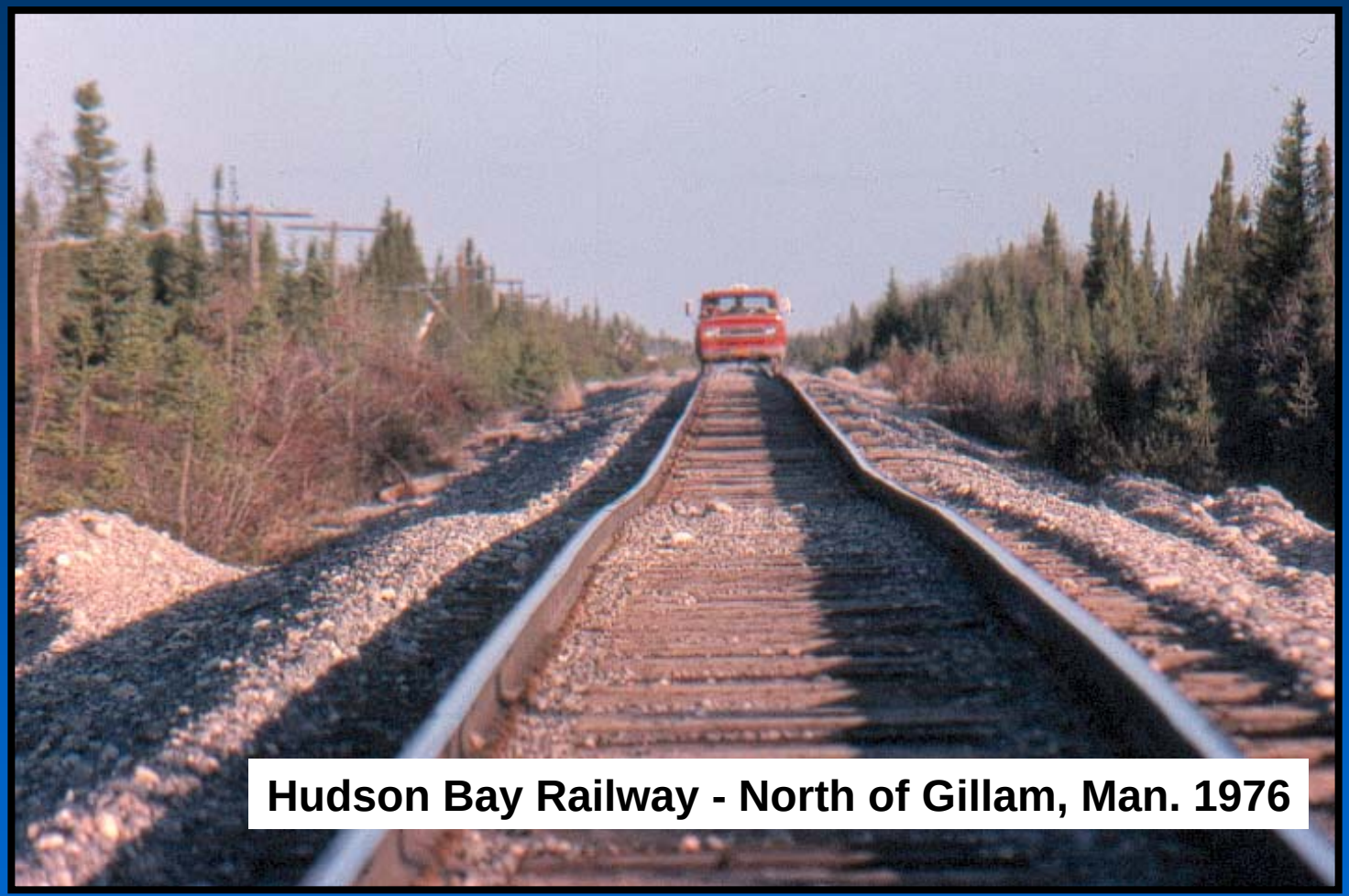
Hudson Bay Railway

The Pas to Churchill, Manitoba

(Constructed, 1910 to 1930)

- Discontinuous permafrost encountered for the first time on a major transportation project
- The first recognition that embankments over permafrost must be continuous fill structures
- Terrain comprises the most extensive peatlands in the world (Hudson Bay Lowlands)

60 Years of Track Settlement –an indicator of climate change?



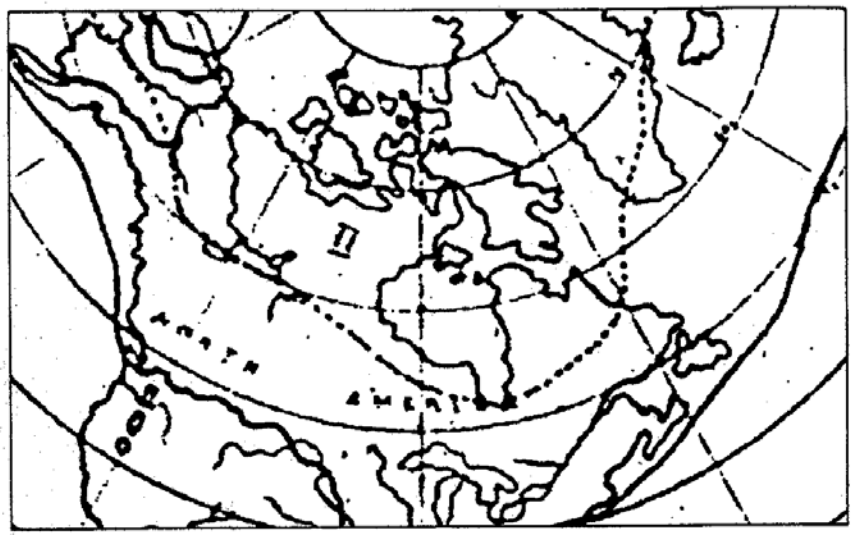
Hudson Bay Railway - North of Gillam, Man. 1976

Railway Grade – Disappearing Act

HBR - North of Gillam, Man.

CLIMATE CHANGE IMPACTS ON
PERMAFROST ENGINEERING DESIGN

MARCH 1998



The first published map of permafrost in Canada (Nikiforoff, 1926).

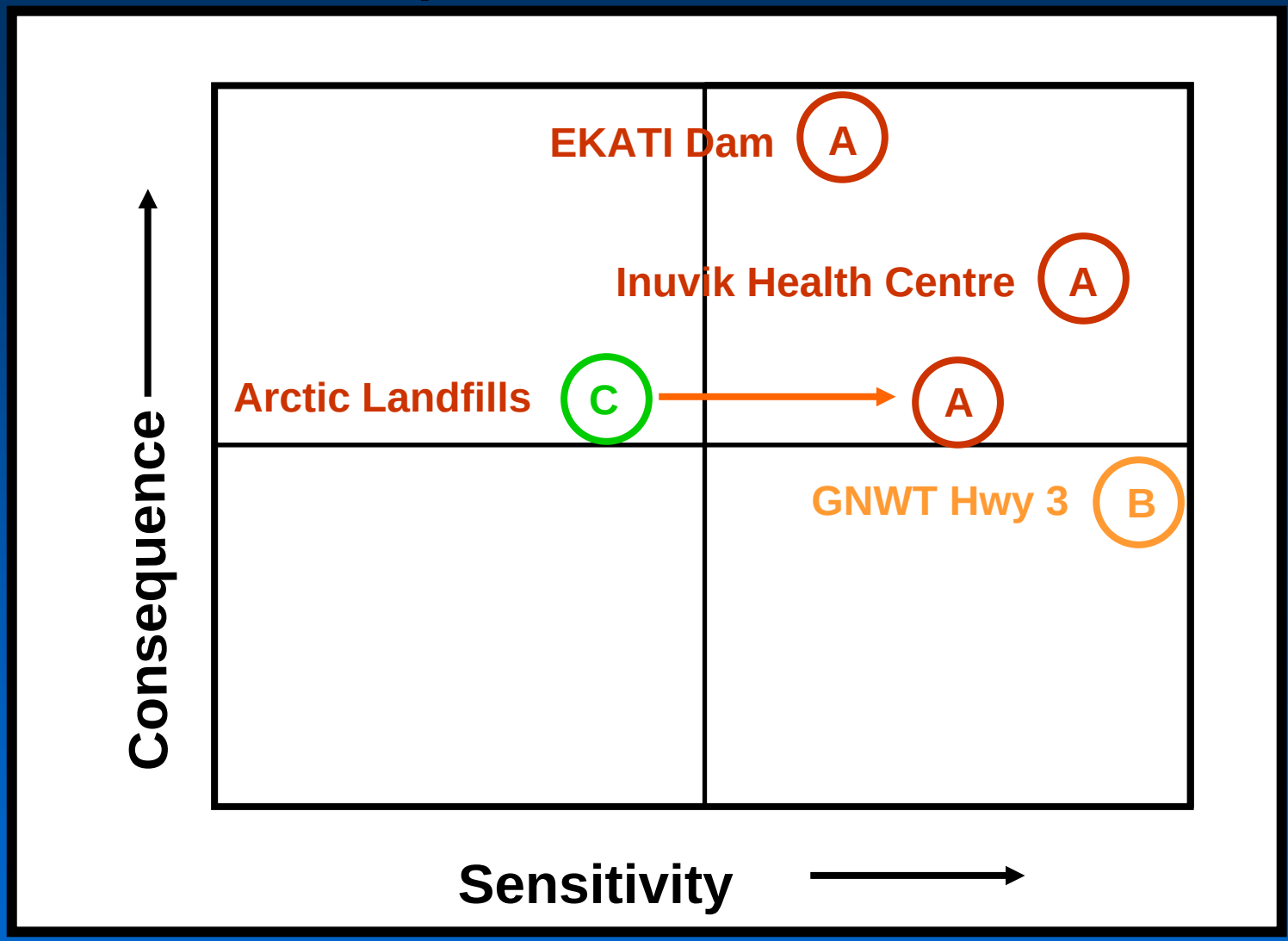
Funding for this Project Provided by:
Panel on Energy Research and Development (PERD)
Environment Canada Environnement Canada

An Engineering Tool For Managing Risk Associated with Climate Change

- Collaborative project
  - Government, university, industry
- Premise – Climate change is just one more uncertainty for design engineers
- Projects are screened based on consequences
- Guidance on climate warming scenarios based on latitude and season

Project Ranking By Risk

Examples From EBA Files



Water Dam, EKATI Diamond Mine

Climate Change Assessment

- ***Permafrost Sensitivity: Medium (short life,stable permafrost)***
- ***Failure Consequence: Catastrophic (environmental damage)***
- ***Analysis Requirement: A–Full quantitative impact analyses***

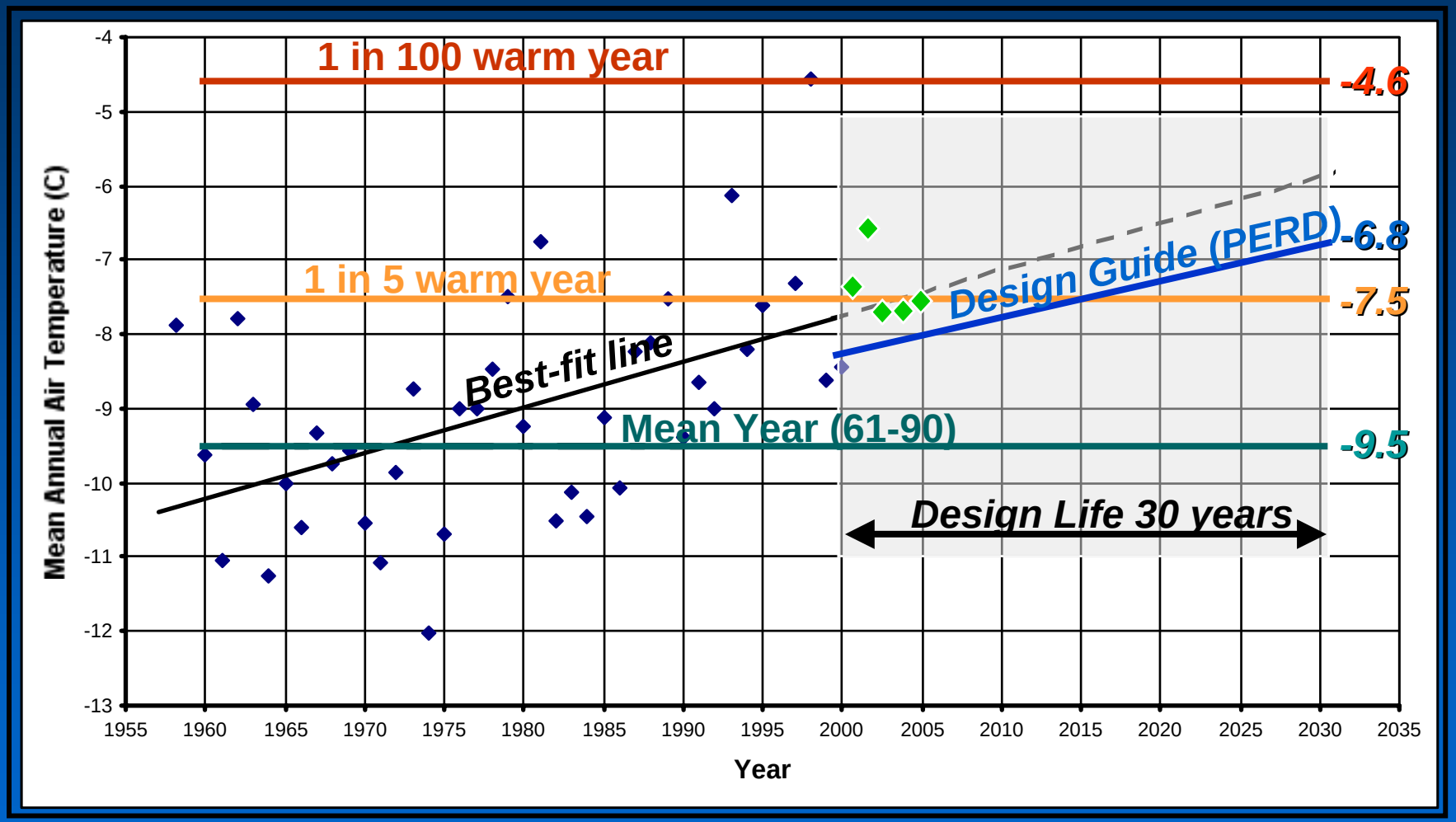
Regional Health Centre, Inuvik

Foundations complete, superstructure erection, October 15, 2001

Climate Change Assessment

- ***Permafrost Sensitivity: High (Ground ice, sensitive region)***
- ***Failure Consequence: Major (Low settlement tolerance)***
- ***Analysis Requirement: A–Full quantitative impact analyses***

Inuvik Climatic Assessment
Health Centre Foundation Design

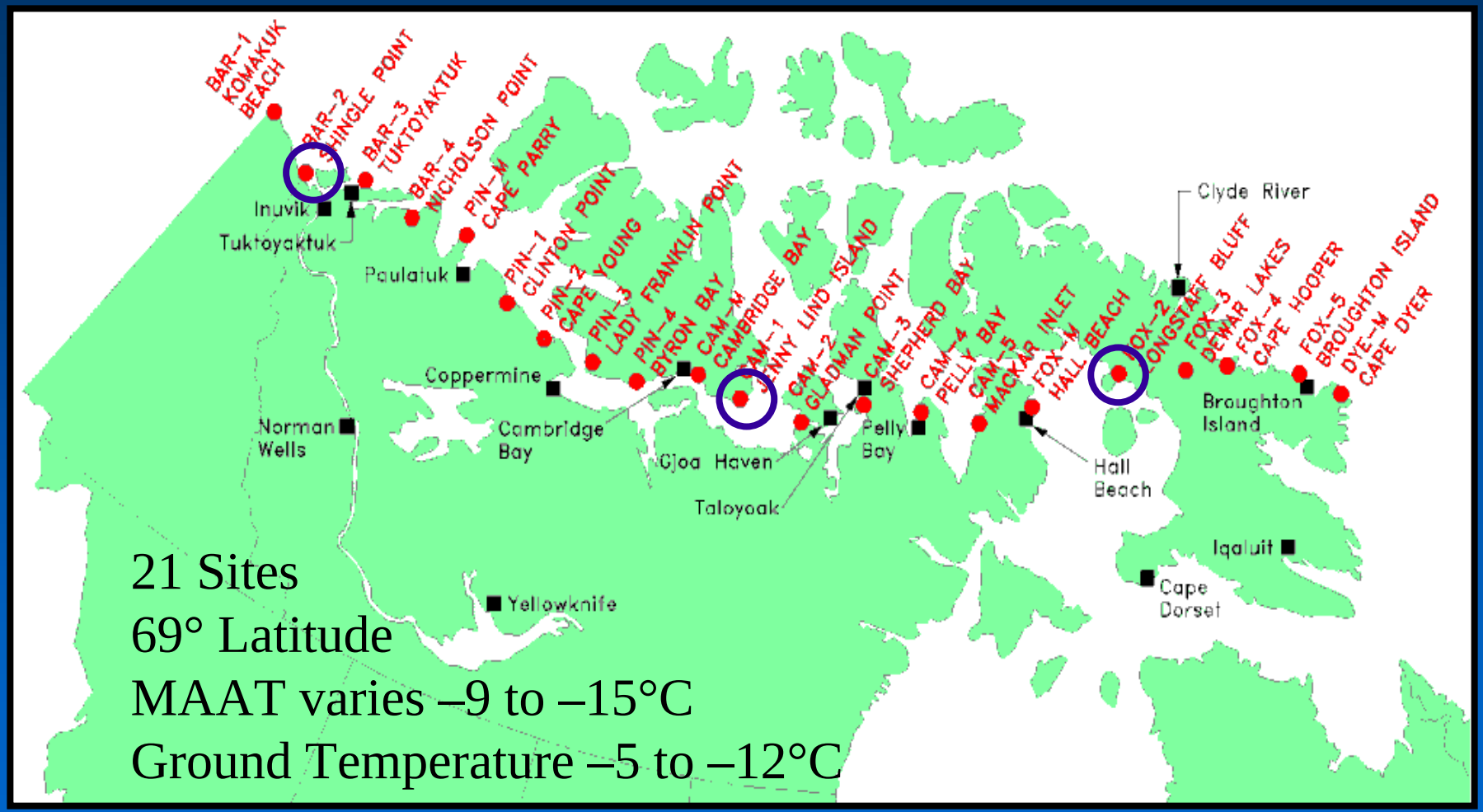


Climatic Design Criteria
Inuvik Health Centre

- Five consecutive 1 in 5 warm years followed by a 1 in 100 warm year
- Ten consecutive 1 in 5 warm years
- Global warming scenario +0.47°C per decade (high sensitivity case from EC/PERD report)

The foundation design was verified for each of the above criteria

Defense Site Reclamation Project (DEW Line)



Arctic Landfills
(Distant Early Warning Site Reclamation)

A structure left on the permafrost landscape in perpetuity requires a high level of risk-based analyses to consider all potential future consequences of climate warming.

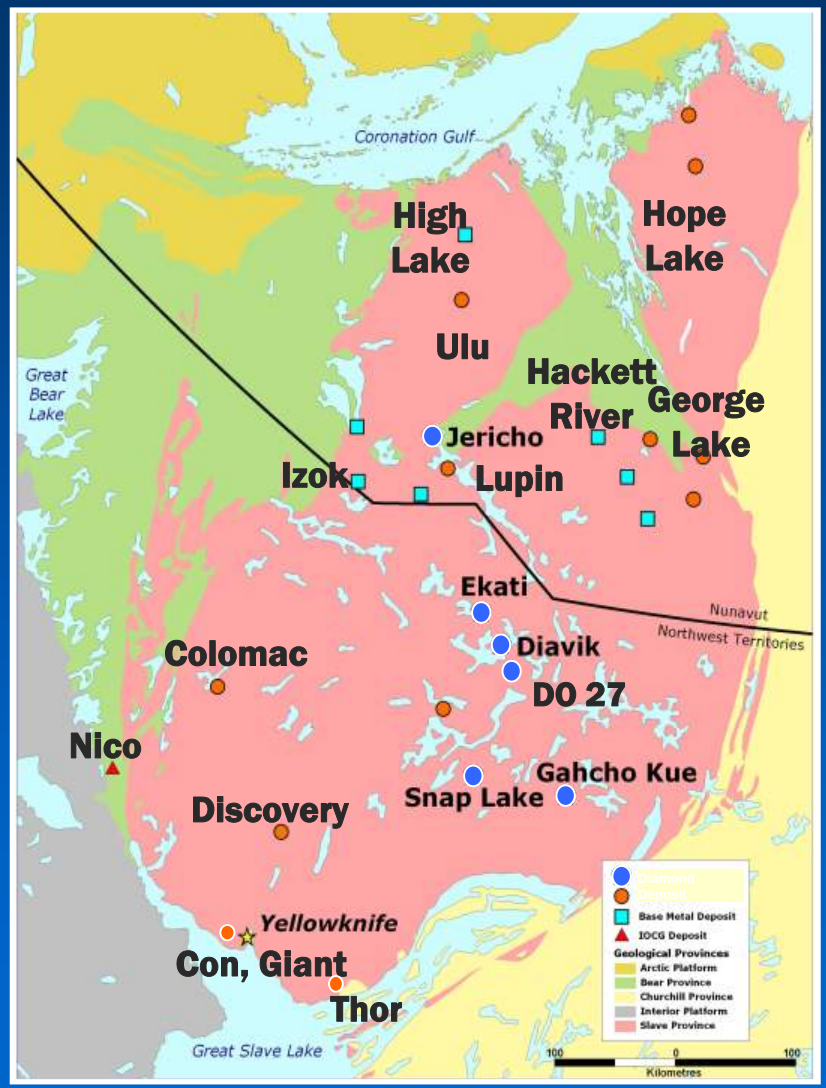
Climate Change Assessment

- ***Permafrost Sensitivity: Various locations – ice rich to ice poor***
- ***Failure Consequence: Major***
- ***Analysis Requirement: C to A – qualitative or quantitative analyses***

Winter Roads
Essential To Resource Development

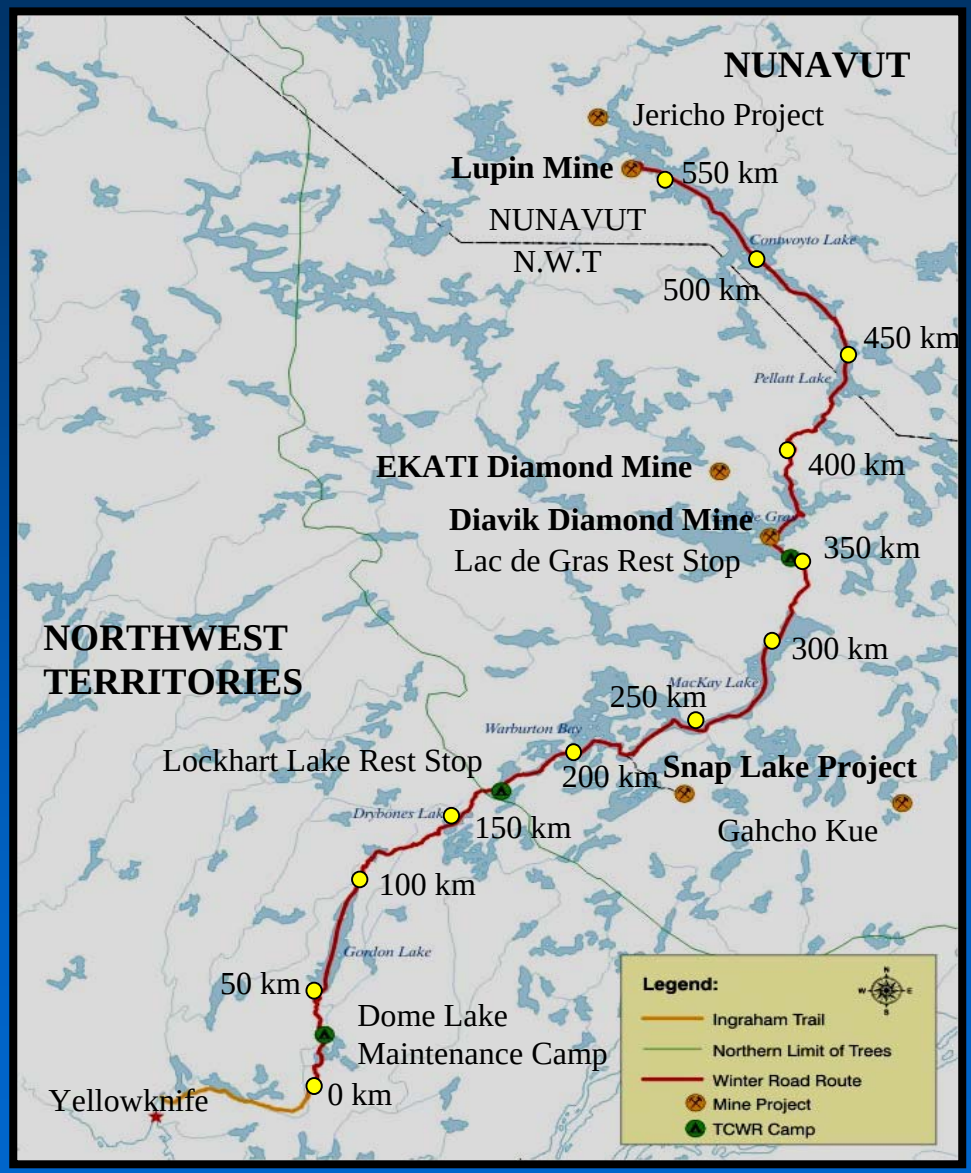
- Use of ice covers for transportation
- Seasonal – typically 70 to 90 days (southern NT)
- No significant grade construction
- Low capital cost but high maintenance
- Operating risks must be managed
- Low environmental impact

Current and Future Mining Prospects -Slave Geological Province-



- Winter road over ice is the only practical access
- The limit on annual re-supply has been reached–no reserve capacity

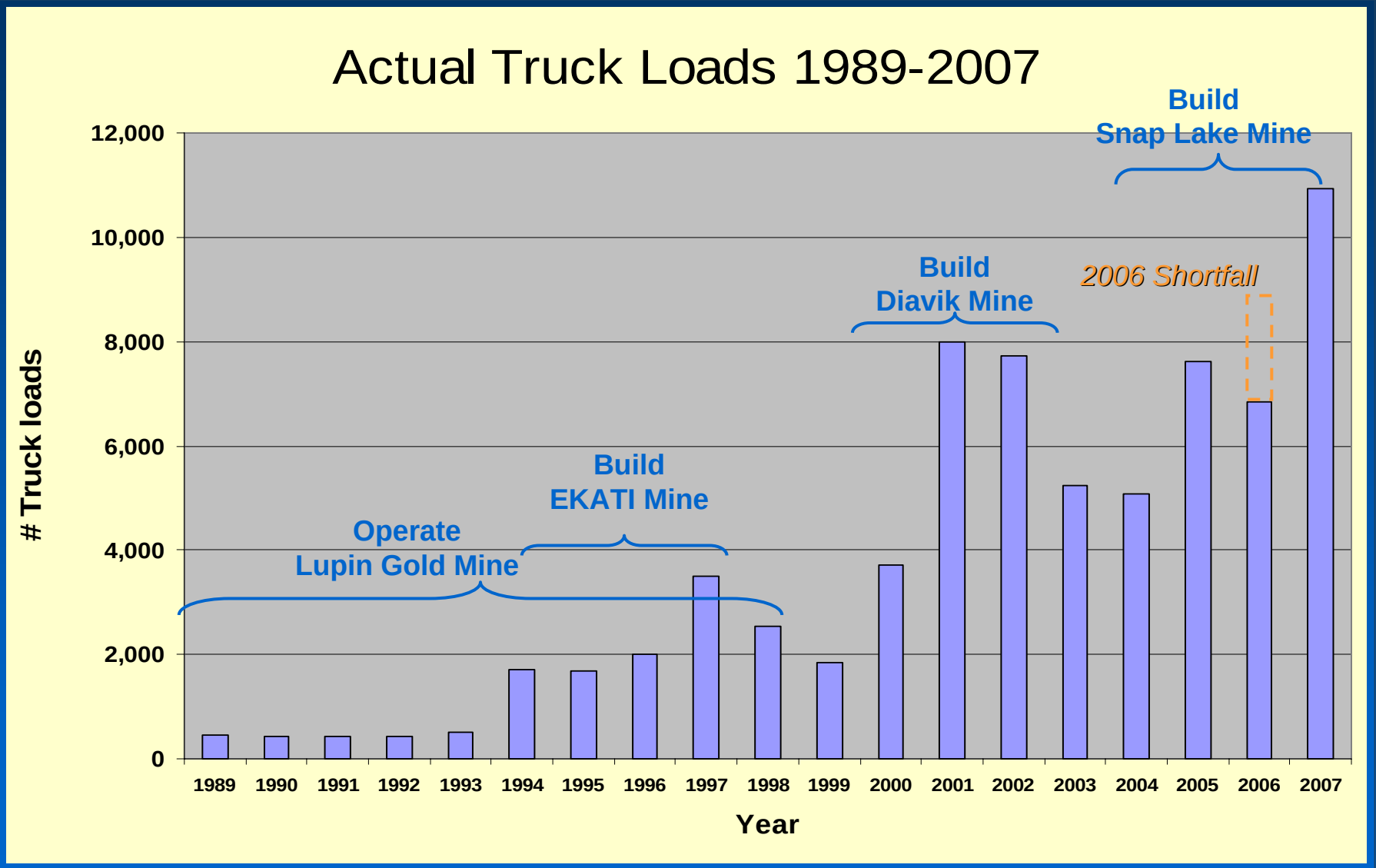
Tibbitt to Contwoyto Winter Road



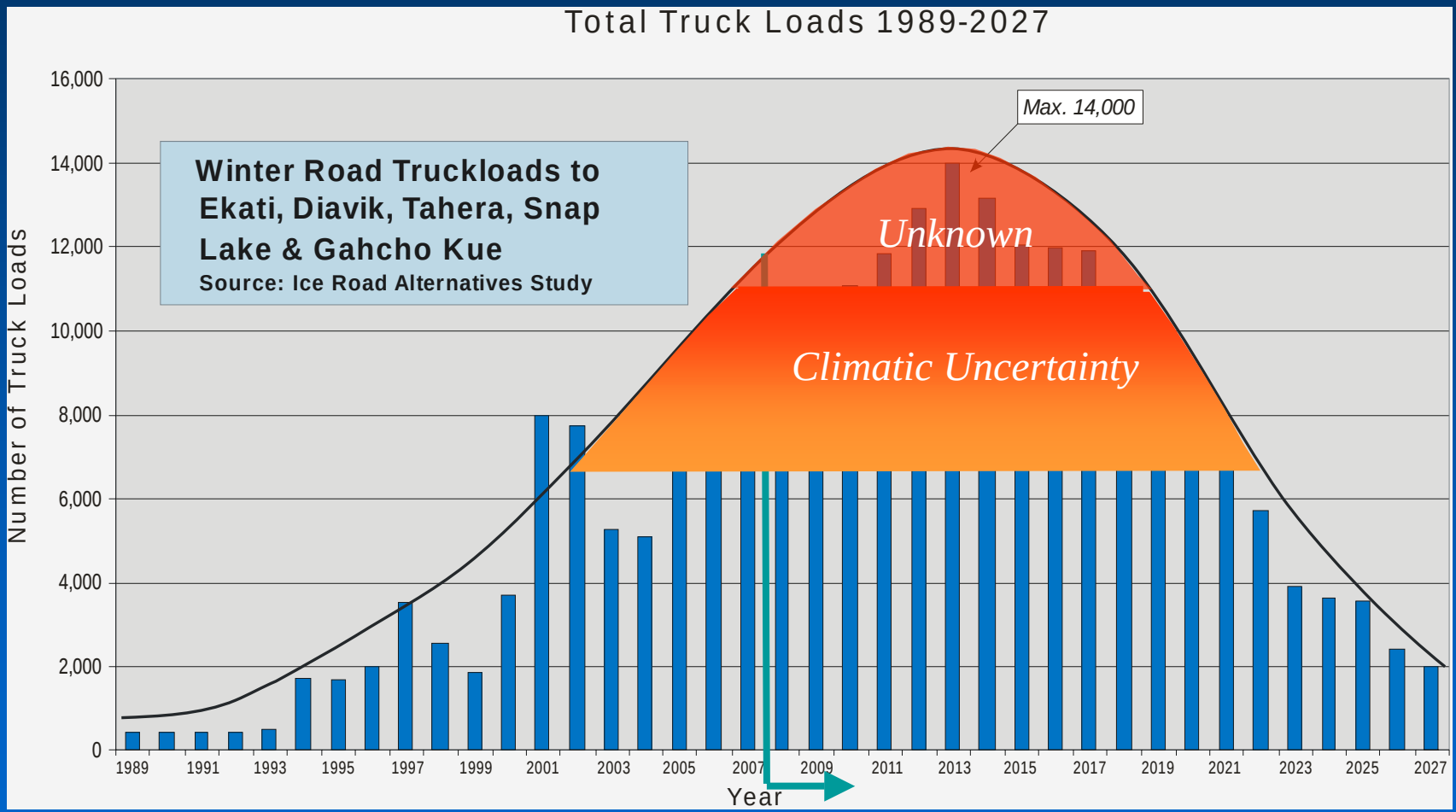
- Characteristics
  - 600 Km Long
  - 85% Over Lake Ice
  - Normal Season 78 Days
- Operations
  - Joint Venture of producing diamond mines
- Uniqueness
  - The Most Significant Use of Ice Covers For Transportation in the World

Is Climate Change a Threat?

Winter Road Load Counts



Projected Future Northbound Traffic



Managing the Risk of Ice Failure by Technology Improvements

Failure resulting from speed-related blowout, March 2001

Technology Improvements

Ice capacity by stress analyses

- More efficient use of B-trains for fuel haul
- Safe movement of heavy loads

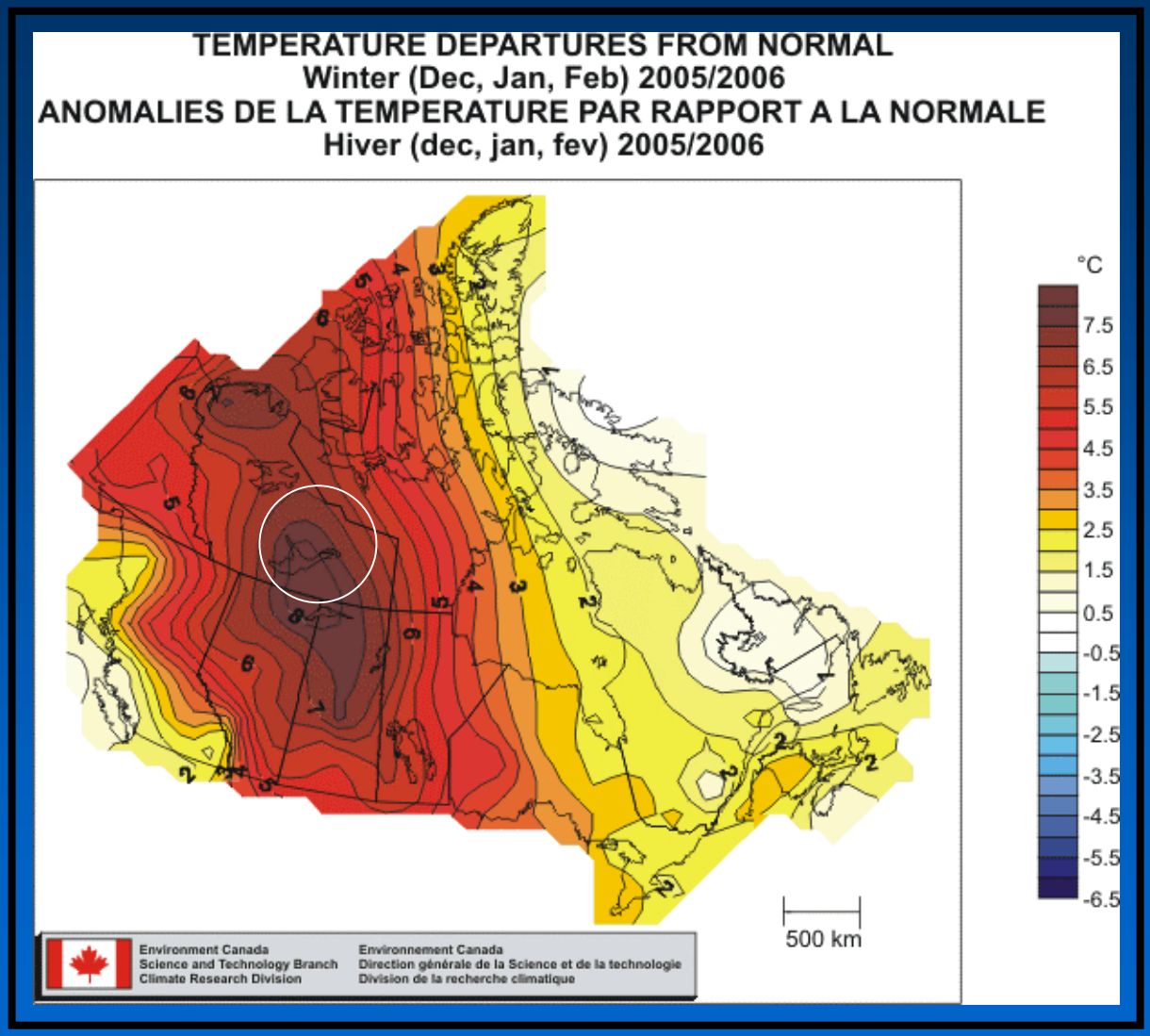
Technology Improvements

Technology Improvements

- Understanding ice deflection

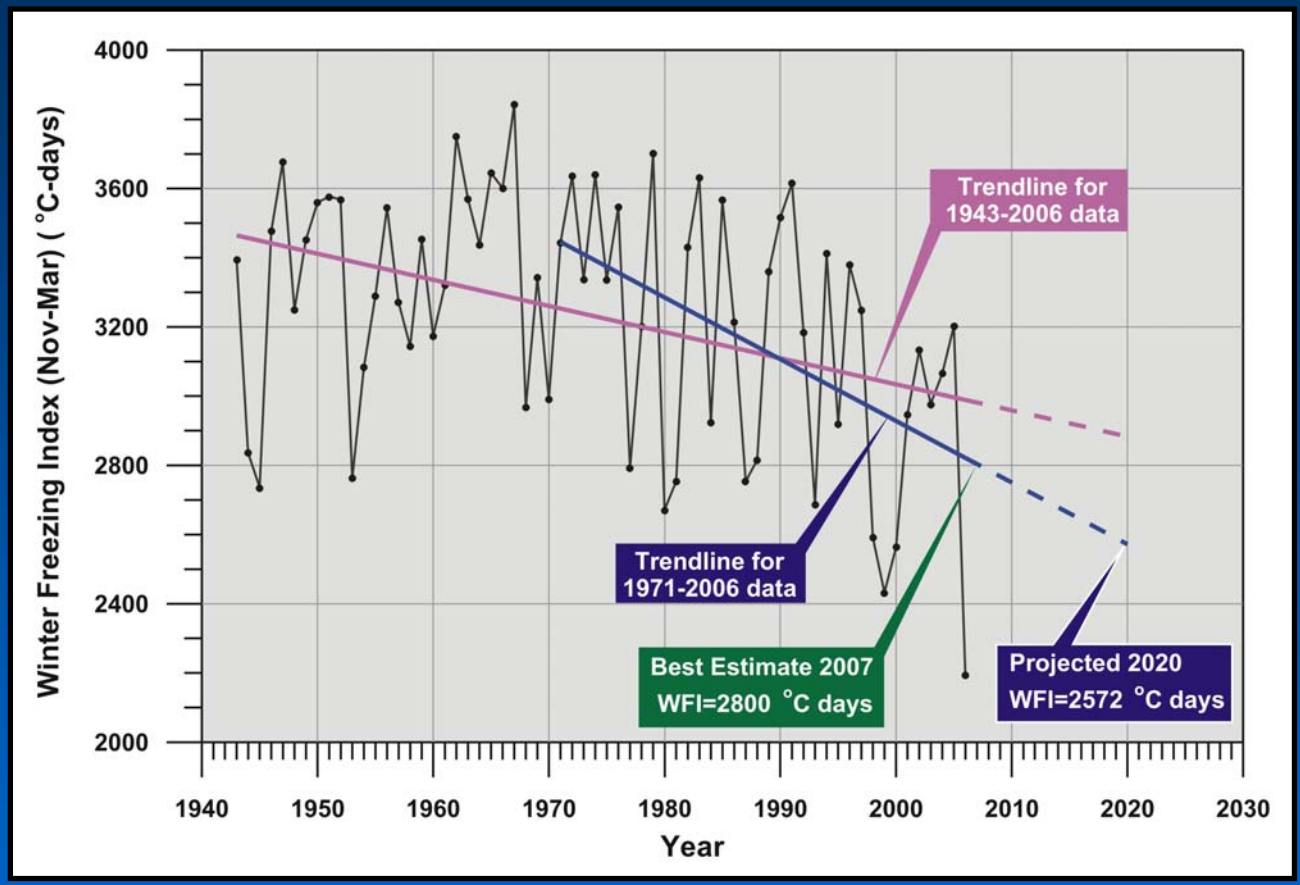
- Improved Ice Radar

What Happened in 2006?



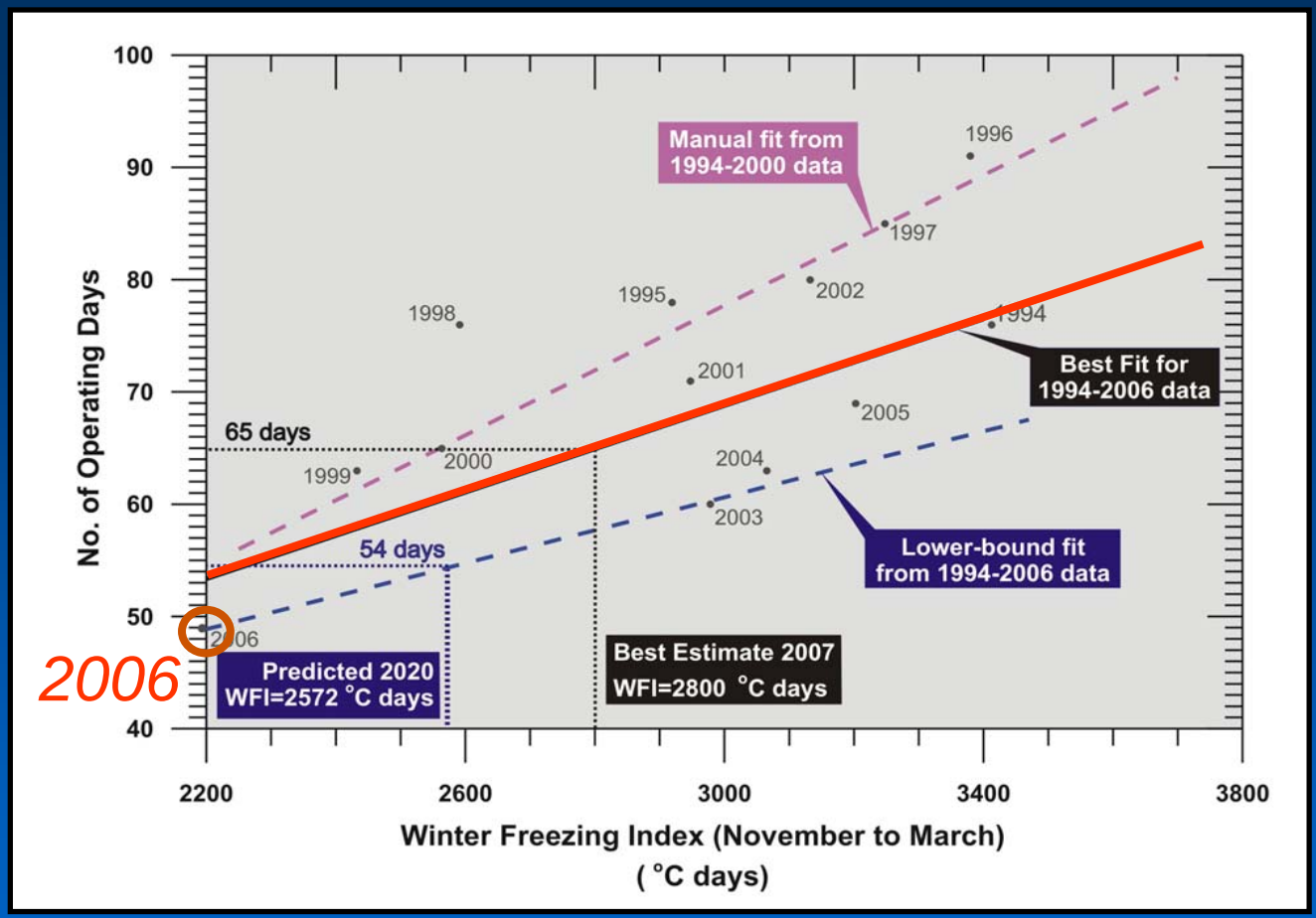
- Great Slave Lake–The Arctic Hot Spot 2006
- The Warmest Winter in 70 Years of Record

Understanding Climatic Variability



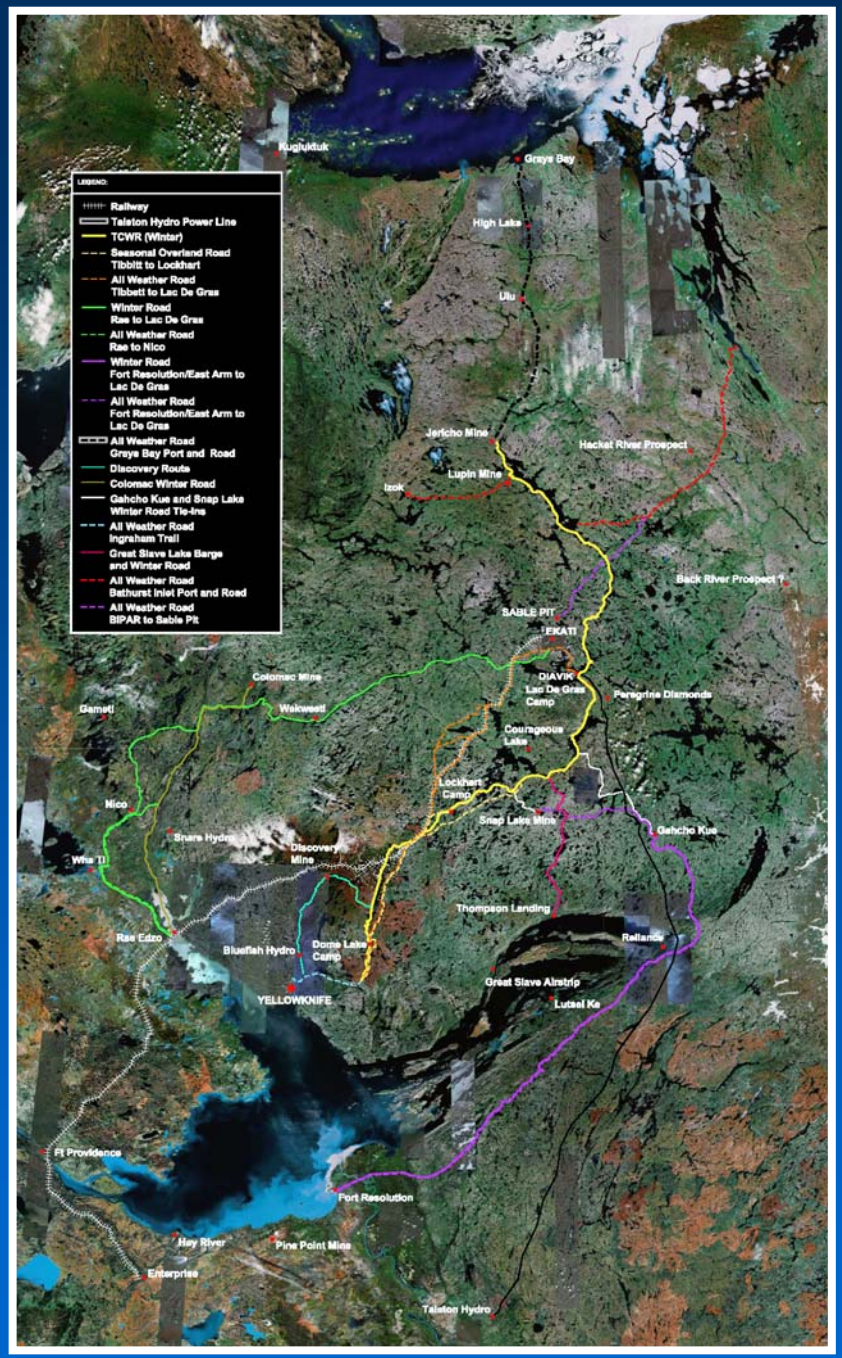
- Freezing Index is a measure of winter severity–higher is better
- The steeply dipping trend is a clear indication of climatic warming

Freezing Index Determines Operating Days



- 2006 was unprecedented but the trends and extremes have been severe during the last decade.
- There is a high risk of reoccurrence.

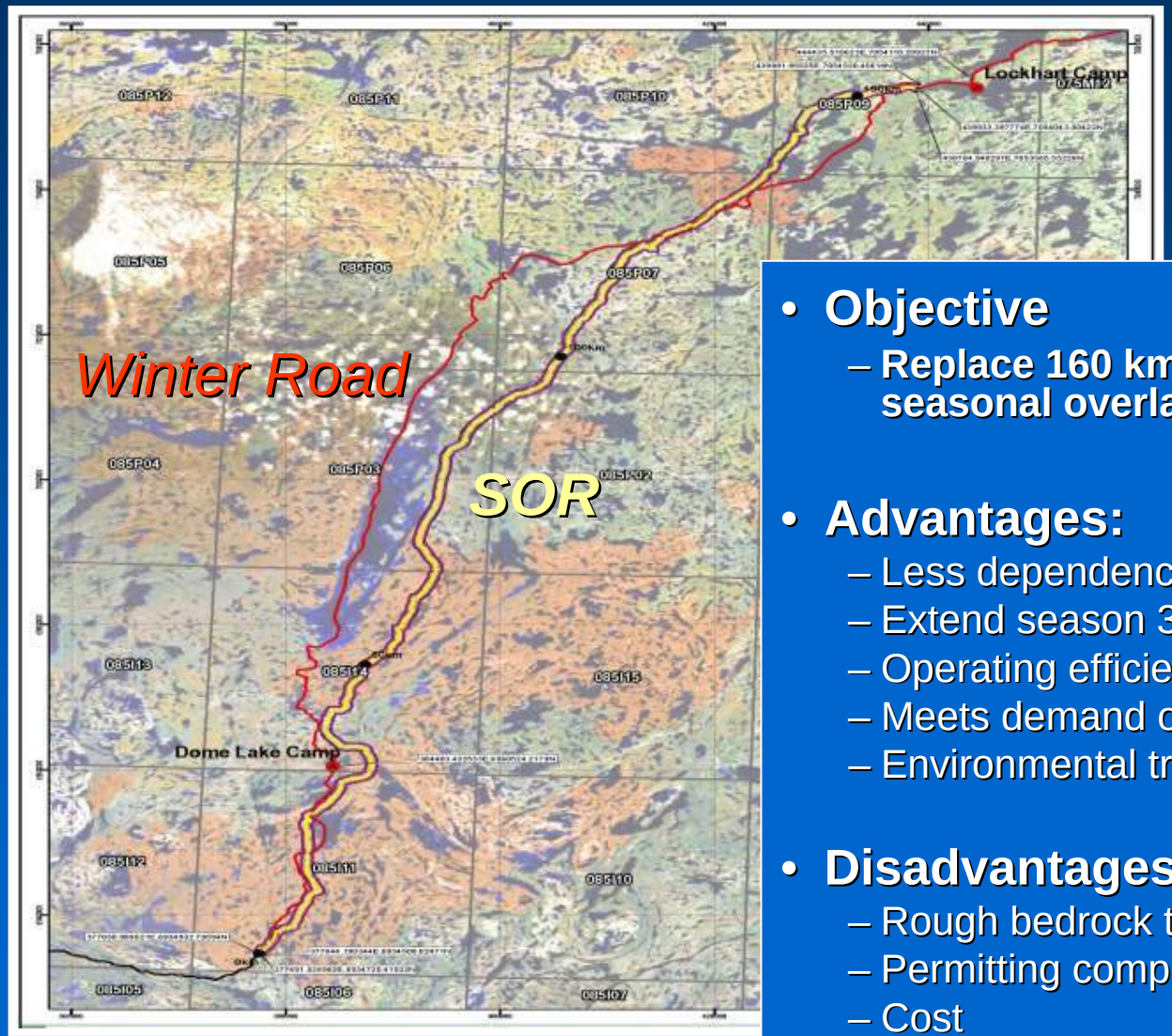
Evaluation of Alternatives?



Transportation Alternatives

- Roads (South and North)
- Supplementary Winter Roads
- Rail
- Air
- Hydroelectric

Seasonal Overland Road Study



- **Objective**
  - **Replace 160 km of over-ice road with seasonal overland road**
- **Advantages:**
  - Less dependency on climate variability
  - Extend season 30 days
  - Operating efficiencies
  - Meets demand objectives
  - Environmental tradeoff with winter road
- **Disadvantages:**
  - Rough bedrock terrain
  - Permitting complexity?
  - Cost

Climate Warming and Northern Infrastructure
What's the plan?

- **Immediate Defense**
  - **Contingency planning**
  - **Continue to invest in technology**
- **Planning**
  - **Continue to evaluate transportation infrastructure options**
  - **Address the immediate needs now (SOR)**
- **Strategic Partnerships**
  - **Industry-Government co-funding (P3)**
  - **Engage First Nations**