



GNWT Winter Road System & Climate Change

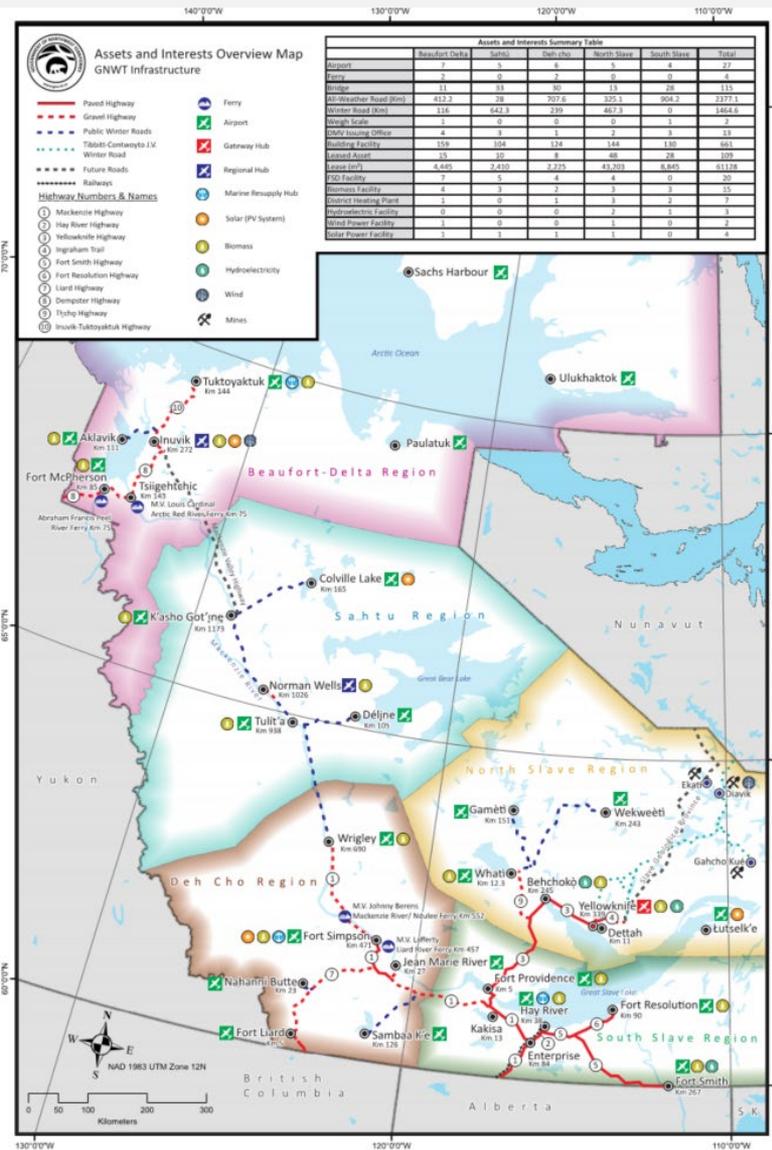
NWTAC

Nov 2022

GNWT INF Design & Technical Services
Mark Cronk, P.Eng.

Government of
Northwest Territories

GNWT Transportation System



The Government of Northwest Territories owns & operates:

All-Season Roads:

- 2,377 Km

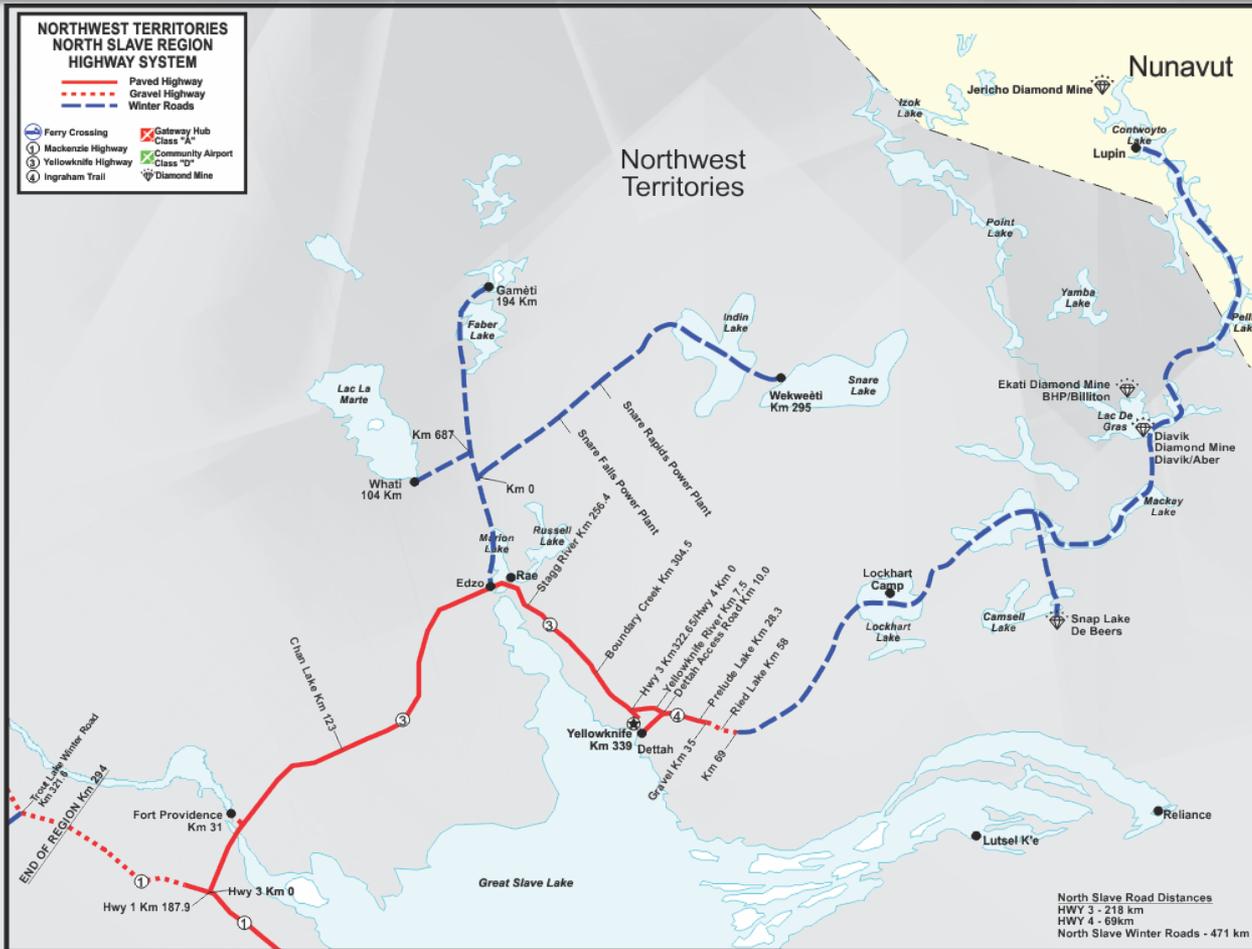
Winter Roads:

- 1,465 Km

Northwest Territories

Environment and Natural Resources

Private Winter Roads in North Slave



Joint Venture

- Hwy 4 (km 69) north to mines
- Approximately 600 km Winter Road
- Arguably the worlds longest private Ice Road
- Approximately 7,300 loads in 2022



Connecting Communities

Winter Roads

- Important to quality of life for Communities
- Some communities don't have barge or water access options
- Some communities have short runways which restricts size and type of air cargo

Reduces Cost of Living in Communities

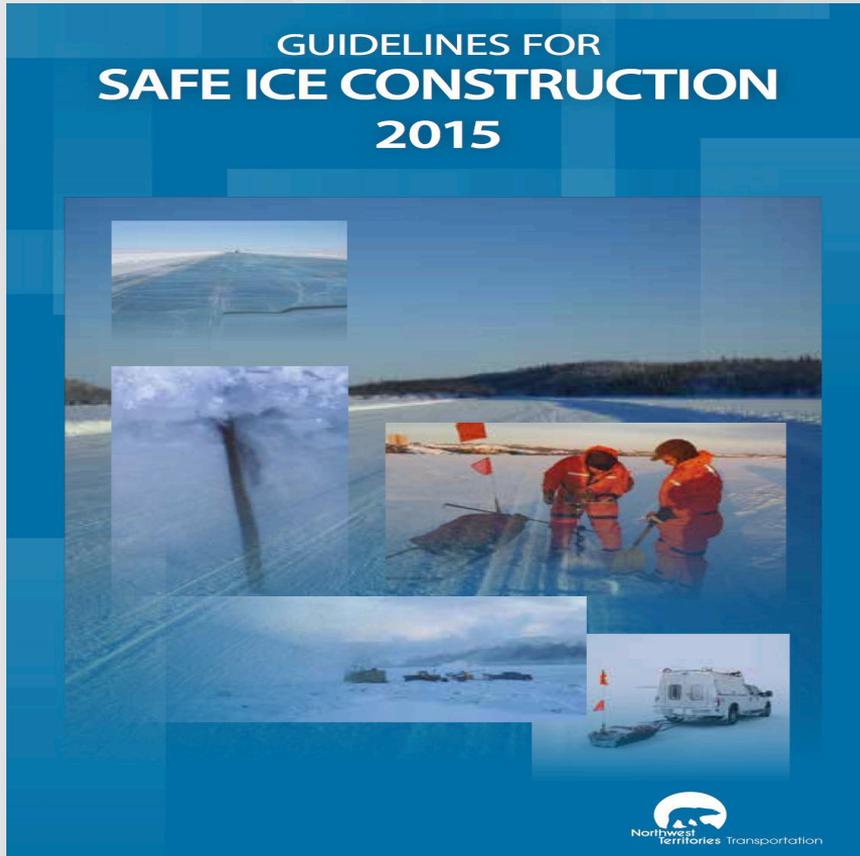
- Power
- Fuel / Heating
- Groceries
- General Construction Materials

Access

- Annually connects Communities
- Social and economic benefits for residents



Ice Road Safety



- Enhanced staff training
- Produced in partnership with experienced Ice Engineering Consultant
- Allowed Department to utilize the latest ice construction techniques
- Industry - JV Heavy Haul experience
- Currently regarded as one of the most advanced & encompassing Guides
- Implemented in 2016



Purpose of the Guide

- The standard for ice construction safety practices for Department INF and our Contractors
- Enable consistent application of best practices across the Department
- Priority on Safety and Due Diligence
- Flexible, Controlled, Permissive Framework



Three Elements of Ice Safety

Levels of Confidence in:

- Integrity of the Ice Sheet to support a load
- Effective thickness of the Ice Sheet
- Accuracy of the Loading Conditions



Gold's Formula

$$P = A \times h^2$$

P = Allowable Gross Vehicle Weight (GVW) load in kilograms

A = A value assigned dependent on the INF operating level selected

- **A=4 Routine Operations**

h = minimum ice thickness of good quality ice (cm)

P = Ice Bearing capacity (kg)

h = Ice thickness (cm)



Determining Ice Thickness

- Using very light equipment to get out on the ice sooner.
- Use ground penetrating radar (GPR) and/or manual borehole testing to identify ice thickness.
- Use of GPR profilers are now standard practice by the GNWT unless ice conditions restrict their use

Manual testing required to:

- Determine the ice texture and to assure ice is of good quality
- Calibrate GPR equipment



GPR testing



GPR Profile Routes

- Easy to see routing Google Earth
- Identify thin spots at a glance
- Ability to export and share easily
- Ideal for Maintenance Crews



Constructed Flood Ice

- Comparable to blue ice in strength and uniformity
- Considered to have same load bearing capacity as natural/blue ice
- Can reduce times to build strong ice



Constructed Ice



Department Operating Levels

Working or Traveling on Ice

Routine

- Departmental normal standard operations
- Minimum level of controls & measures
- Most conservative level of design and construction

Enhanced

- Can be used when Routine is not satisfactory
- Increased level of controls & measures
- Increased level of design and construction

Acute

- Professional experienced ice Engineer – Stress analysis reports
- Used as required on non-standard loads
- Highest level of controls & measures
- Approval required by Regional Superintendent



Climate Change Mitigations

Examples of Mitigations:

- Improved understanding of ice through better monitoring
- Earlier start times getting on to the ice, safely
- Better management approaches
 - Increased level of effort/diligence in road maintenance
 - Improved traffic and load management
 - Protecting portage conditions
 - Reducing travel to night time only
 - Realigning sections with poor ice to over land
- Creating all season bridges for MVH winter road
 - 40 of 42 bridges required are now in place
- Constructing all season roads – ITH & TliCho Hwy



Historic Open/Close Dates

WINTER ROADS	ICE ROADS	ICE CROSSINGS	PRIVATE MINING ROAD
Ft. Simpson - Wrigley (Highway #1)	Aklavik Ice Road	Mackenzie River Crossing at Fort Providence	Tibbitt-Contwoyo Winter Road
Wrigley to Tulita Winter Road (Highway #1)	Detah Ice Road	Liard River Crossing at Fort Simpson	
Tulita to Norman Wells Winter Road (Highway #1)	Tuktoyaktuk Ice Road	Mackenzie River Crossing at Tsiighetchic	
Norman Wells to Fort Good Hope Winter Road (Highway #1)	ICE CROSSINGS		
Colville Lake Winter Road	Mackenzie River Crossing at Fort Providence		
Delijne Winter Road	Liard River Crossing at Fort Simpson		
Sambaa K'e Winter Road	Mackenzie River Crossing at Fort Simpson		
Nahanni Butte Winter Road	Peel River Crossing		
Wekweeti Winter Road	Mackenzie River Crossing at Tsiighetchic		
Whati Winter Road			
Gameti Winter Road			

Last 20 years average	Open	17-Dec	23-Dec	25-Dec	22-Dec	27-Dec	15-Jan	22-Dec	10-Dec	N/A	28-Jan	19-Feb	Open	20-Dec	24-Dec	15-Dec	Open	24-Dec	28-Nov	24-Nov	16-Nov	15-Dec	Open	30-Jan
	Closed	11-Apr	28-Mar	01-Apr	01-Apr	01-Apr	31-Mar	28-Mar	01-Apr	N/A	15-Apr	15-Apr	Closed	29-Apr	16-Apr	27-Apr	Closed	17-Apr	22-Apr	05-May	06-May	21-Apr	Closed	31-Mar
Last 5 years average	Open	N/A	16-Dec	19-Dec	19-Dec	19-Dec	11-Jan	19-Dec	14-Dec	07-Mar	29-Jan	16-Feb	Open	15-Dec	07-Jan	11-Dec	Open	29-Dec	30-Nov	01-Dec	24-Nov	16-Dec	Open	01-Feb
	Closed	N/A	27-Mar	29-Mar	29-Mar	30-Mar	29-Mar	01-Apr	10-Apr	13-Apr	13-Apr	13-Apr	Closed	27-Apr	14-Apr	28-Apr	Closed	17-Apr	19-Apr	05-May	06-May	19-Apr	Closed	28-Mar



Conclusions

- Climate change is impacting winter road operations
- Opening closing dates suggest we are able to adapt:
 - We are generally able to open the roads on time
 - We are able to keep the roads open for normal durations
 - However, to do this is requiring:
 - More money, more effort/maintenance by crews
 - Better equipment, techniques and decision making
 - New overland alignments to avoid problem areas
- Current mitigations are resulting in successful operations of the winter road systems to support community resupply
- Climate change will continue to be a challenge and the department is monitoring this risk



Questions ?



Thank you to staff and contractors for safely building and operating the winter road system, every year – it is a significant accomplishment, done under difficult conditions

