Construction and Maintenance of Winter Roads in Manitoba

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This paper deals with the planning, constructing and maintaining of a winter road in Manitoba. We specifically dealt with the Island Lake community as an example.

1. History of the Winter Roads

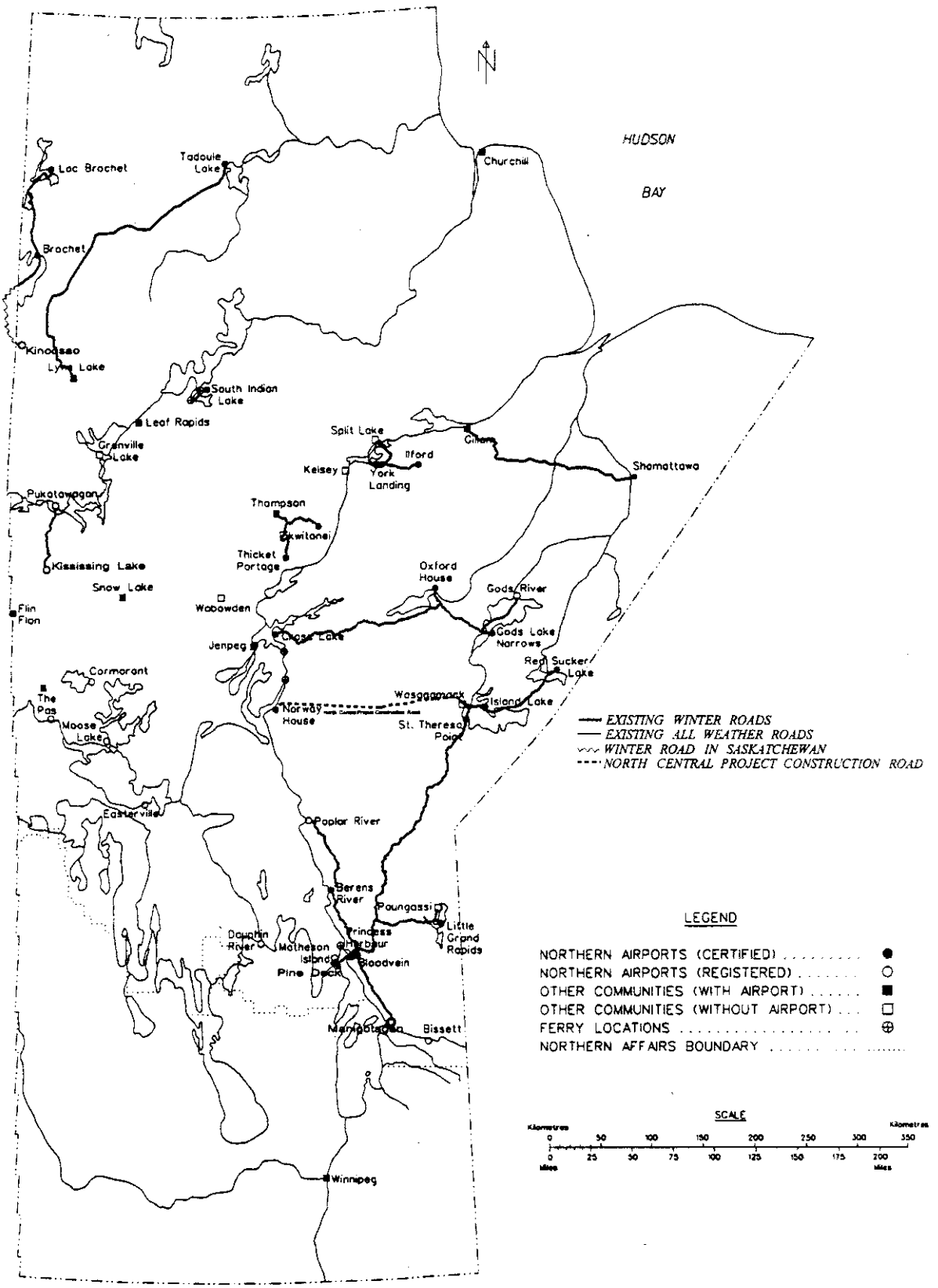
The main purpose of the winter road system is to provide an affordable means of transporting food, fuels, building products and other items to remote Northern communities.

Winter roads have been constructed and maintained in Manitoba for over five decades and connect isolated northern communities to the provincial road system. Originally the roads were built by private contractors and used to transport bulky items that could not be flown into isolated areas.

The roadwork is carried out by frost penetration on land, muskegs, lakes, rivers and creeks. The winter roads were originally intended to serve as overland supply routes. As residents seek to expand recreational and social interaction, the roads increasingly allow for inter-community travel as well as public road access to and from the rest of the province. Freight hauling has increased steadily over the years.

2. Present Winter Road System

The Province of Manitoba currently has jurisdiction over the winter road system in Manitoba, excluding the roads built privately under Crown Land Use Permits. While the province is responsible for standards, specifications, and length of operation of the roads, it does not construct and maintain these roads but rather contracts the work out. A total of 3000 kilometres of winter roads are constructed each winter, approximately 1700 kilometres by the Province and 1300 kilometres by private construction companies and Manitoba Hydro. In order to best demonstrate the needs of northern Manitoba First Nations and others, the info will highlight the Island Lake communities.


HUDSON
BAY
Lac Brochet
Tadoule Lake
Churchill
Brochet
Kinoosao
Lynn Lake
South Indian Lake
Leaf Rapids
Granville Lake
Split Lake
Ilford
Gillam
Shamattawa
Kelsey
York Landing
Pukatawagan
Thompson
Ekwitanei
Thicket Portage
Kisasising Lake
Snow Lake
Oxford House
Gods River
Gods Lake Narrows
Wabowden
Flin Flon
Jenpeg
Cross Lake
Red Sucker Lake
Cormorant
The Pas
Moose Lake
Norway House
Wasagamack
Island Lake
St. Theresa Point
Easterville
Poplar River
Berens River
Poungassi
Little Grand Rapids
Dauphin River
Matheson Island
Princess Harbour
Bloodvein
Pine Dock
Manigotagan
Bissett
Winnipeg
EXISTING WINTER ROADS
EXISTING ALL WEATHER ROADS
WINTER ROAD IN SASKATCHEWAN
NORTH CENTRAL PROJECT CONSTRUCTION ROAD
LEGEND
NORTHERN AIRPORTS (CERTIFIED)
NORTHERN AIRPORTS (REGISTERED)
OTHER COMMUNITIES (WITH AIRPORT)
OTHER COMMUNITIES (WITHOUT AIRPORT)
FERRY LOCATIONS
NORTHERN AFFAIRS BOUNDARY
SCALE
Kilometres
0 50 100 150 200 250 300 350
0 25 50 75 100 125 150 175 200
Miles

3. History of the Reserve and Non-Reserve Communities

Scientific evidence dates early civilization in Manitoba to about 12 000 years ago. The people native to this region lived in small groups in the southwest where big game animals were abundant. Over time, the birds and animals moved northward and the people followed. People from Alaska migrated to northern Manitoba.

The people of the Island Lake area are known as the Rork people. They are believed to have migrated approximately 250-300 years ago from the St. Lawrence River Valley, escaping warfare and persecution. They were nomadic hunters and gatherers who moved according to the seasons. They made fishing, hunting, and trapping devices to get food for sustenance. The bow and arrow served as an effective hunting tool. These people moved on foot, by canoe, or by dog-team and lived in cabins, tipis, or wigwams. Like many of the first inhabitants of the land, the Oji-Cree were a hardy people capable of surviving through many hardships. The family was important to the First Nations people, including those living in Island Lake. The elderly, adults, and children alike all had important roles to play in the society. Elders were advisors, men worked outside the home, women were caregivers, and children assumed responsibility for household duties at an early age.

The first European settlement in the area was established by the Hudson's Bay Company in 1818 and is listed among those posts that were occupied when it merged with the Northwest Company. The reserve and non-reserve communities are dependent on each other. They share a school, stores, and the airport. There is only access between the communities by water and seasonal winter roads.

4. Members of the Island Lake Tribal Council

Garden Hill First Nation is located to the north of Island Lake, about 475 km northeast of Winnipeg and 300 km from Thompson. The Island Lake First Nation signed an adhesion to Treaty 5 in 1909 and split into four separate First Nations, including Garden Hill, in 1969. The reserve is 17,829 acres (72.2 square kilometres). The entire First Nation has a population of 2966 (as of December 1996). About 830 students from kindergarten to grade twelve attend Garden Hill Elementary School and Garden Hill High School. Community facilities include a band office, a nursing station, a curling rink, playing fields, and a hall. The schools have a gymnasium and an auditorium. There is a local R.C.M.P. detachment in the community. The nearest hospital is in Norway House, about 225 km to the west. Airmail service is available four times per week. Electricity is provided by diesel generating plants and water comes from Island Lake and is piped into the community. The local economy is based on commercial fishing and trapping. Businesses include a taxi service, a grocery store, a laundromat, a construction company, a gas station, a pool hall/café, a lodge, and a Northern Store. The community has no all-weather roads or rail systems. There is a 1067 metre gravel airstrip across the lake at Stevenson Island, and regular flights are available. A winter road runs from Bloodvein through St. Theresa Point to Garden Hill.

Red Sucker Lake First Nation is located on the north shore of Red Sucker Lake, about 530-km northeast of Winnipeg and about 320-km southeast of Thompson. The First Nation signed an adhesion to Treaty 5 in 1909. The reserve is 255 acres (1.0 square kilometres). The population of the First Nation is 648 (as of December 1996). About 220 students attend kindergarten through grade twelve at Red Sucker Lake School. Community facilities include a band office, a nursing station, a recreation centre, and a pool hall. The nearest hospital and R.C.M.P. detachment are in Norway House, 280 km to the west. Airmail service is available twice per week. Electricity is provided by diesel generating plants and water is obtained from Red Sucker Lake and trucked or piped into the community. The local economy is based on commercial fishing and trapping. Businesses include a taxi service, a construction company, a store and confectionery, an arcade, and a coffee shop. The community of Red Sucker Lake has a 914 metre gravel airstrip and regular air service is available. A winter road runs from the Garden Hill First Nation, located 80 km to the west on Island Lake.

St. Theresa Point First Nation is located on the southwest shore of Island Lake, 460 km northeast of Winnipeg and 300 km southeast of Thompson. The reserve is 17,829 acres (72.2 square kilometres). The population of the First Nation is 2488 (as of December 1996). About 810 students attend kindergarten through grade ten at St. Theresa Point School. Community facilities include a band office, a nursing station, a dental station, an elderly person's complex, a recreation hall, a gymnasium, an auditorium, and an arena. The nearest hospital is in Norway House, 200 km to the west. The nearest R.C.M.P. detachment is in Garden Hill, 15 km to the east across Island Lake. Airmail service is available every weekday. Electricity is provided by diesel generating plants and water comes from Island Lake and is trucked or piped into the community. The local economy is based on commercial fishing and trapping. Businesses include a bulk station, a Northern Store, a trading post, a garage, a sawmill, a construction company, and an air service. St. Theresa Point has a 1067 metre gravel airstrip and regular flights are available. There are no all-weather roads in the community. A winter road runs north from Bloodvein, passing through St. Theresa Point and continuing on to Garden Hill and Wasagamack.

Wasagamack First Nation is located on the western shore of Island Lake, 470 km northeast of Winnipeg and 290 km southeast of Thompson. The reserve is 17,829 acres (72.2 square kilometres). The population of the First Nation is 1195 (as of December 1996). About 440 students attend George Knott School from kindergarten to grade eleven. Community facilities include a band office, a nursing station, a recreation centre, and a pool hall. The nearest hospital is in Norway House, 200 kilometres to the west. The nearest R.C.M.P. detachment is in Garden Hill, 15 km to the east across Island Lake. Airmail is available three times per week. Electricity is provided by diesel generating plants and water comes from Island Lake and is trucked or piped into the community. The local economy is based on commercial fishing and trapping. Businesses include a café, a movie theatre, an engine repair shop, a woodworking company, a construction

company, a Northern Store, and a bank. There is a 1067 metre gravel airstrip in St. Theresa Point, about 10 kilometres south of Wasagamack. There are no all-weather roads into Wasagamack but a winter road runs north from Bloodvein through St. Theresa Point.

122 kilometres of ice road connect the communities. The First Nations people and their construction companies construct these internal roadways.

5. Significance of the Winter Roads to the Communities

The work is contracted out to First Nation's construction companies. For example, the Nor-Win Construction Company (which is an amalgamation of ten bands) is the current contractor for the winter road system east of Lake Winnipeg. Nor-Win Construction is a major employer in the nine communities that have winter road service. Aside from the employment issue, winter roads allow necessary commodities to be transported into the communities at economical rates, thus reducing costs to consumers. The First Nations Communities are contracted to construct and maintain the winter roads to their own communities. The First Nations contractors are responsible for all equipment working on these projects and must ensure that the ice conditions are safe for equipment and operators. They must inform all foremen of work to be conducted and inspect any problems on the project. They must also ensure that an adequate communication system is available for operators working in remote areas.

6. The Responsibilities of the Department of Highways

The Department of Highways and Transportation supervises the work on their roads and the roads are constructed to Highways' specifications. The Department is also responsible for a number of other duties:

- imposing weight restrictions on the ice road system based on the ice bearing capacity as determined by using the Gold formula.
- providing adequate signing on all winter road sections as well as signing for openings and closures.
- notifying users of projected openings and closings to ensure everyone knows when hauling must be started and completed.

7. Planning

The planning of a winter road is no different than constructing an all weather road. It requires significant thought and study prior to construction. There are a number of issues to consider when planning the path of a winter road:

Land Muskeg is the best terrain to build a winter road on. It is easy to construct on since there is minimal clearing to be done, no steep inclines, or rock outcroppings. It is safer to build on muskeg than on lakes and unlike lakes, muskeg will not have major faults. Muskeg is easier to maintain since there are no stones to worry about. Thus muskeg generally gives the best winter road. Brush areas can also be used but are harder to maintain because they draw heat. Since these areas are not as cold due to the attraction of the sun, they will develop problems sooner. An area of higher ground is desirable to

lengthen the life of the winter road and areas that contain poplar trees indicate higher ground in a brush area. Rocky areas should be avoided since clearing is difficult and costly.

Lakes Over lake winter roads are a very common type of ice road in Manitoba. Construction is relatively economical since the surface is naturally smooth and no clearing is required. An ice road should not be constructed close to shore since that is where ice breakup occurs first. Maintain a distance of 0.8 kilometres from shore to gain maximum length of life from the road. The local people have a wealth of information regarding the location of currents and sandbars in the lakes. Sandbars should be avoided to eliminate wave action. Early or heavy snowfalls can cause delays that can raise the cost of construction

Good planning minimizes environmental damage and distance and increases safety standards. When choosing the location for a winter road:

- try to minimize the number of creek or river crossings,
- take advantage of lake surfaces to reduce terrain impacts and clearing costs
- choose low profile riverbanks to reduce the impact on the environment and provide a smooth transition from ice to land
- in addition to maps or aerial photography, summer field reconnaissance by helicopter can be used to adjust the routes.

8. Clearing

The clearing of the right-of-way is an integral part of any type of winter road construction. Clearing should be limited to winter, after the ground is well frozen so most trees will break off at ground level. Any trees and debris that are left should be windrowed to one side away from standing timber and compacted as tightly as possible. Burning slash is not allowed. No leaners or debris should be left in the standing timber.

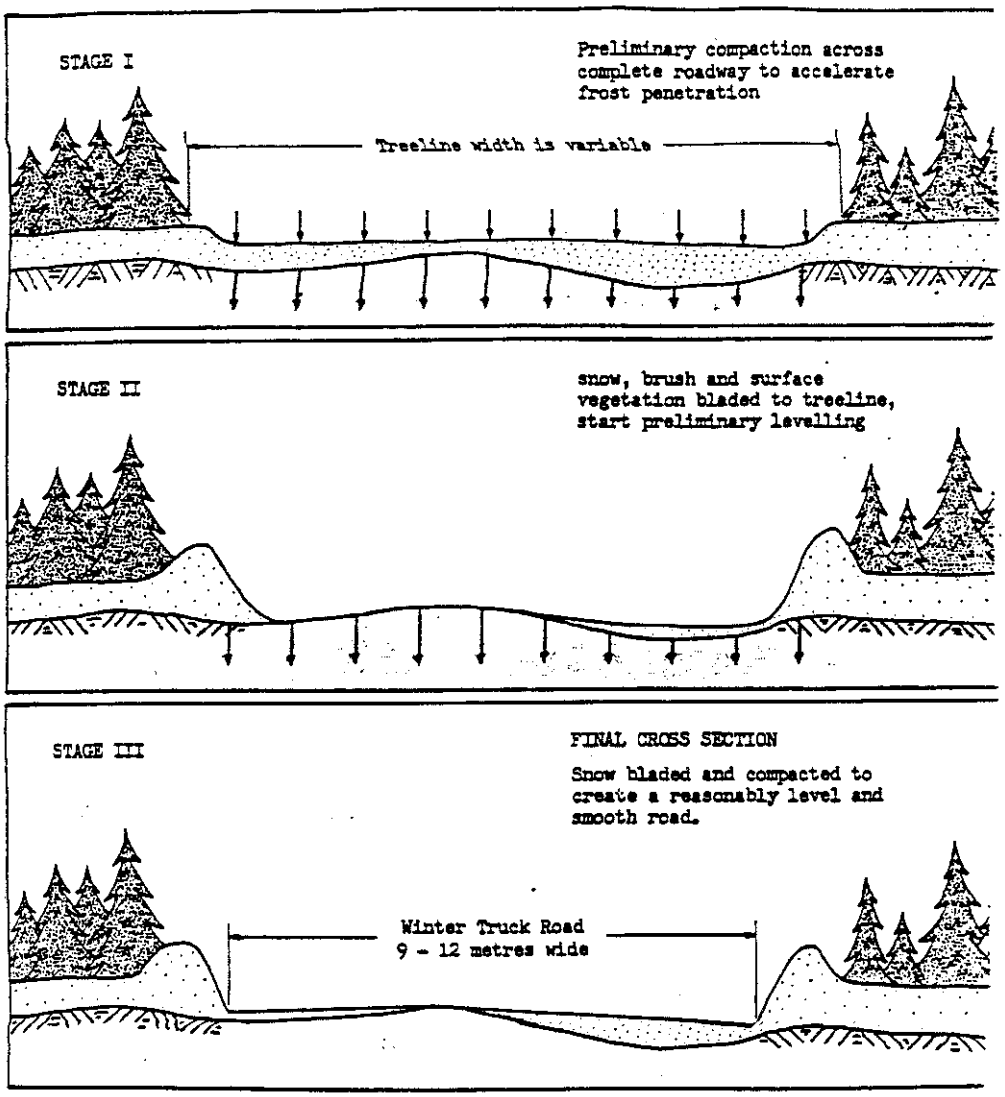
9. Construction

Construction can begin when sufficient snow cover has accumulated on the right-of-way; normally more than 20 centimetres. Initial compaction for frost penetration commences as soon as the bearing capacity of the terrain permits the use of lightweight low ground pressure equipment. Shaping begins when frost penetrates sufficiently to permit the use of heavier equipment. For winter roads constructed over water, flooding can commence once the full width of the roadway has been packed

- **Over land**: Initial compaction for frost penetration begins as soon as bearing capacity permits the use of lightweight low pressure equipment. The minimum width to be cleared is 9 metres for straight roadway and 12 metres for corners and curves.

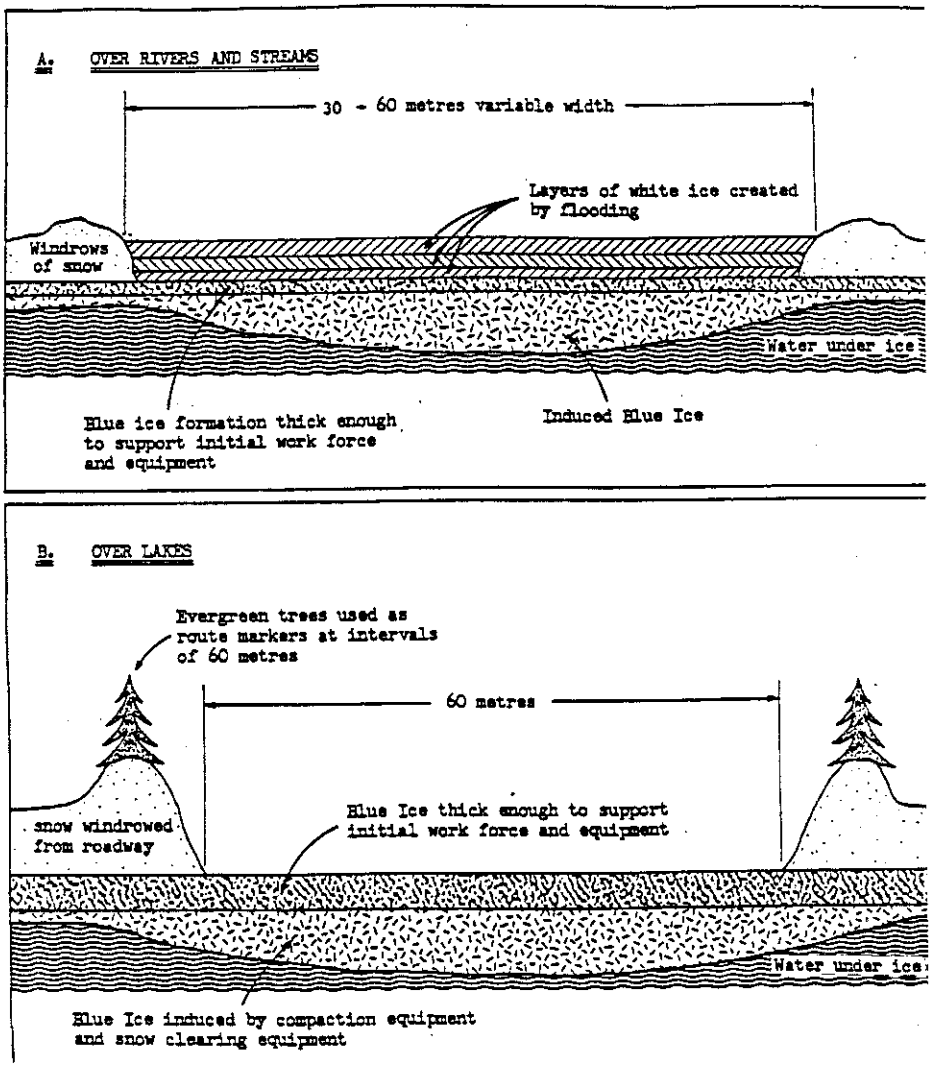
1250

CONSTRUCTION OF A WINTER TRUCK ROAD OVERLAND



- **Over rivers and streams**: Flooding can commence once the full width of the ice road has been packed. A Sleigh auger or a 12-inch auger attached to the rear of a bombardier can be used for flooding. The first flood should not exceed 25 mm (1") in depth. Subsequent flood should not exceed 50mm (2") in depth. Each flood must be frozen solid before the next flood is applied. The minimum width is 30 – 60 metres.
- **Over lakes**: Inducing freezing using lightweight low ground pressure equipment can commence when the ice thickness at least 300mm (12"). Clearing should start on the outside edges and continue towards the centre if the snow is heavy. The maximum width to be cleared is 60 metres, the minimum width is 45 metres.

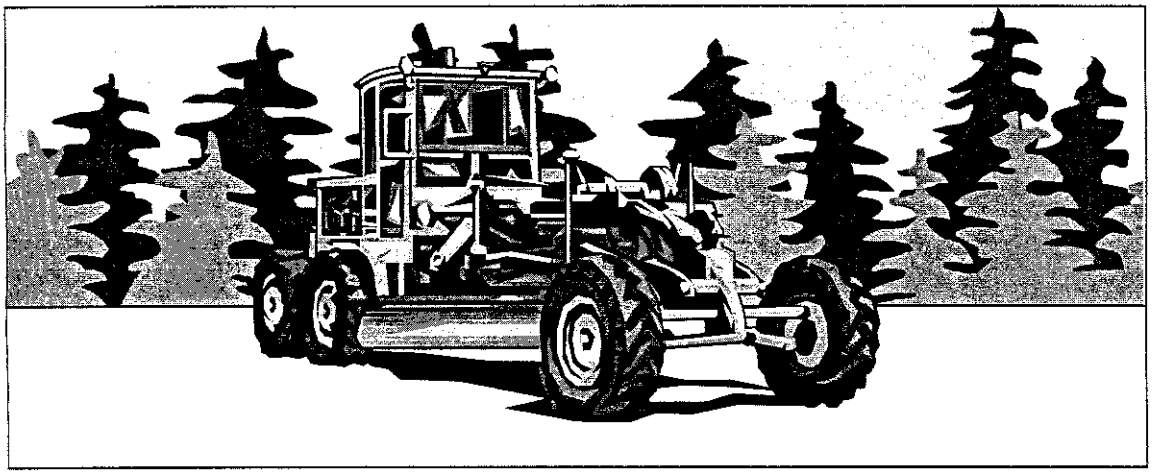
CONSTRUCTION OF A WINTER TRUCK ROAD ON ICE



A number of types of equipment are used for construction:

- Lightweight Packing Equipment
  - Snowmobiles are used for initial compaction and frost penetration
  - bombardier & auger are used for deeper frost penetration and flooding
- Lightweight Clearing Equipment
  - flex tack with V-plow
  - loader with bucket
  - skidder with blade
  - 3/4 ton truck with blade
- Heavy Clearing Equipment
  - patrol grader with wing blade
  - patrol grader with wood or steel drag
  - dozers (not to be used on lakes)
  - loader with skidder
  - 5 ton truck plow with blade and wing
- Maintenance Equipment
  - patrol grader with blade, wing and drag
  - truck plow

10. Maintenance



Maintenance of winter roads is no different than that of a regular road. Maintenance generally consists of blading, dragging or both. Other maintenance activities that can improve safety are the timely removal of leaners and overhanging trees, and clearing wider right of way on sharp curves. Reducing the degree of curves improves sight distances for added safety. In addition, inspectors check the roads and the ice thickness regularly. Ice checking is done to make sure the ice roads have enough thickness and ice bearing capacity. Inspectors use hand or power augers to check ice thickness. In order to achieve bearing capacity of 36.5 tonnes, the ice must be 72 cm thick as calculated by the Gold formula (Blue ice).

Bearing Capacity of Blue Ice Chart

Imperial		Metric	
1 in. = 100 lbs.	21 in. = 44,103 lbs.	2 cm. = 28 kg.	52 cm. = 19 009 kg.
2 in. = 400 lbs.	22 in. = 48,403 lbs.	4 cm. = 112 kg.	54 cm. = 20 499 kg.
3 in. = 900 lbs.	23 in. = 52,903 lbs.	6 cm. = 253 kg.	56 cm. = 22 046 kg.
4 in. = 1600lbs.	24 in. = 57,604 lbs.	8 cm. = 450 kg.	58 cm. = 23 649 kg.
5 in. = 2,500 lbs.	25 in. = 62,504 lbs.	10 cm. = 703 kg.	60 cm. = 25 308 kg.
6 in. = 3,600lbs.	26 in. = 67,604lbs.	12 cm. = 1 012 kg.	62 cm. = 27 023 kg.
7 in. = 4,900 lbs.	27 in. = 72,905 lbs.	14 cm. = 1 378 kg.	64 cm. = 28 795 kg.
8 in. = 6,400lbs.	28 in. = 78,405 lbs.	16 cm. = 1 780 kg.	66 cm. = 30 623 kg.
9 in. = 8,100 lbs.	29 in. = 84,106 lbs.	18 cm. = 2 278 kg.	68 cm. = 32 507 kg.
10 in. = 10,000lbs.	30 in. = 90,006 lbs.	20 cm. = 2 812 kg.	70 cm. = 34 447 kg.
11 in. = 12,100 lbs.	31 In. = 96,106 lbs.	22 cm. = 3 403 kg.	72 cm. = 36 443 kg.
12 in. = 14,401 lbs.	32 in. = 102,407 lbs.	24 cm. = 4 049 kg.	74 cm. = 38 496 kg.
13 in. = 16,901 lbs.	33 in. = 108,907 lbs.	26 cm. = 4 752 kg.	76 cm. = 40 605 kg.
14 in. = 19,601 lbs.	34 in. = 115,608 lbs.	28 cm. = 5 512 kg.	78 cm. = 42 771 kg.
15 in. = 22,501 lbs.	35 in. = 122,508 lbs.	30 cm. = 6 327 kg.	80 cm. = 44 992 kg.
16 in. = 25,601 lbs.	36 in. = 129,609 lbs.	32 cm. = 7 199 kg.	82 cm. = 47 270 kg.
17 in. = 28,902 lbs.	37 in. = 136,909 lbs.	34 cm. = 8 127 kg.	84 cm. = 49 604 kg.
18 in. = 32,402lbs.	38 in. = 144,410 lbs.	36 cm. = 9 111 kg.	86 cm. = 51 994 kg.
19 in. = 36,102lbs.	39 in. = 152,110 lbs.	38 cm. = 10 151 kg.	88 cm. = 54 440 kg.
20 in. = 40,002 lbs.	40 in. = 160,011 lbs.	40 cm. = 11 248 kg.	90 cm. = 56 943 kg.
		42 cm. = 12 401 kg.	92 cm. = 59 502 kg.
		44 cm. = 13 610 kg.	94 cm. = 62 117 kg.
		46 cm. = 14 876 kg.	96 cm. = 64 788 kg.
		48 cm. = 16 197 kg.	98 cm. = 67 516 kg.
		50 cm. = 17 575 kg.	100 cm. = 70 300kg.

Imperial and Metric Conversions

Inches x 2.54 = Centimetres	lbs. x 0.4535 = kg.
Centimetres x 0.3937 = Inches	kg. X 2.205 = lbs.

Cracks, pop outs or punch out of ice on ice roads are common problems which can occur. Flagging, tree marks and poly-posts are used to mark the ice road section across a pressure ridge. Spills of hazardous materials have to be handled carefully and immediately.

Maintenance of winter roads consists of the following operations:

- ploughing to remove excess snow

- widening to maintain constructed width
- dragging or patching to maintain quality of riding surface
- repairing ice bridges and roads

The use of truck plows is an effective and economic means of maintaining winter roads since the lighter vehicle allows contractors to get on the ice sooner than with a grader. During maintenance, snow should be cleaned as far away from the road surface as possible since snow and slush on the sides forcing up the centre cause cracking down the centre of an ice road.

11. Safety

Safety should be the first, second and third consideration. Travelling in a winter road situation requires preparation and careful observation of weather conditions. Apply common sense and logic to avoid being stranded or being put into a hazardous situation. Safety guidelines and specs for winter roads could be made available from the Department of Highways.

12. Special Situations

A number of unique situations can occur during the construction and use of the winter road system such as:

- Fuel Spills
  Diesel fuel spills may be contained and burned off but gasoline must be mopped up using defined spill procedures.
- Ice Failures
  Ice failures must be repaired or alternate road locations must be chosen.
- Major Faults
  In building the road to the Island Lake community, Lake Winnipeg must be crossed at Pine Dock. Ice is no different than concrete and will crack. In ice, this is known as a pressure ridge. The Department must be prepared to put in Bailey bridges or use other methods to cross these faults.
- Early Thaw
  The Department of Highways determines opening and closing procedures. Generally, the roads are open January 15 in the Island Lake community and close approximately March 15. This 10-week period can vary and may include partial closures during that time due to weather conditions.

13. Conclusion

The winter road system as it exists in the province of Manitoba provides an economical means of transporting goods to communities that otherwise have no road access. Good planning, efficient construction practices and timely maintenance all contribute to the safety and service of the winter roads.