THE NORTHERN TRANSPORTATION SYSTEMS ASSESSMENT

Executive Summary

January 2011

Disclaimer

This report reflects the views of PROLOG Canada Inc. only and does not necessarily reflect the official views or policies of Transport Canada.

Neither Transport Canada, nor its employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy or completeness of any information contained in this report, or process described herein, and assumes no responsibility for anyone's use of the information. Transport Canada is not responsible for errors or omissions in this report and makes no representations as to the accuracy or completeness of the information.

Transport Canada does not endorse products or companies. Reference in this report to any specific commercial products, process, or service by trade name, trademark, manufacturer or otherwise does not constitute or imply its endorsement, recommendation, or favouring by Transport Canada and shall not be used for advertising or service endorsement purposes. Trade or company names appear in this report only because they are essential to the objectives of the report.

THE NORTHERN TRANSPORTATION SYSTEMS ASSESSMENT

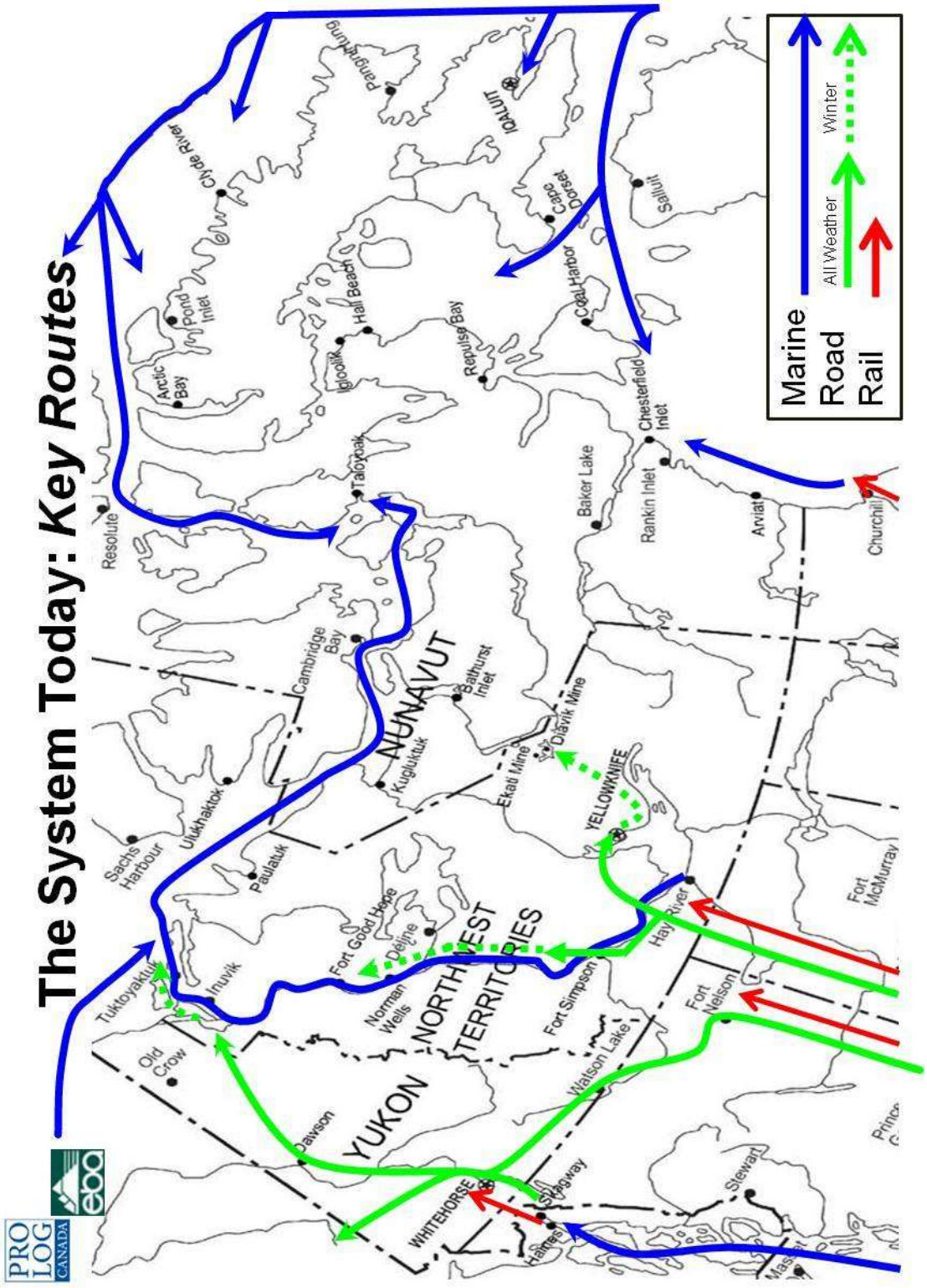
Executive Summary

Prepared for Transport Canada

Prepared by PROLOG Canada Inc.

In Association with EBA Engineering Consultants Ltd.

January 2011


The System Today: Key Routes
Marine
Road
Rail
All Weather
Winter
Clyde River
Pond Inlet
Arctic Bay
Igloolik
Hall Beach
Repulse Bay
Cape Dorset
Cape Dorset
Iqaluit
Salluit
Resolute
Taloyoak
Baker Lake
Chesterfield Inlet
Rankin Inlet
Arviat
Churchill
Cambridge Bay
NUNAVUT
Bathurst Inlet
Diavik Mine
Ekati Mine
Kugluktuk
Ulukhaktok
Sachs Harbour
Paulatuk
YELLOWKNIFE
Fort Good Hope
Déline
Norman Wells
Tuktoyaktuk
Inuvik
NORTHWEST TERRITORIES
Fort Simpson
Hay River
Fort McMurray
Fort Nelson
Watson Lake
Old Crow
Dawson
YUKON
WHITEHORSE
Skagway
Haines
Stewart
PROLOG CANADA

Northern Transportation Systems Assessment

Executive Summary

1. Introduction

The purpose of the Northern Transportation Systems Assessment is to determine what transportation infrastructure is required to support growing demand in the North over the next 20 years; and to determine what incremental improvements will build towards a transportation system that supports Canada's vision for northern development. That objective has been met in two phases: Phase 1 is a Transportation Demand Assessment and Phase 2 is an Infrastructure Needs Assessment.

Phase 1 has analyzed demand for the following current transportation systems supplying both communities and resource developments in the North:

- **Eastern Sealift System** – break bulk general cargo ships and bulk fuel product tankers with sailings from the East originating traffic to the Kivalliq, Qikiqtaaluk and Kitikmeot regions of Nunavut.
- **Western Sealift System** – combination deck cargo/bulk fuel Mackenzie River barges or deep draft ocean vessels with sailings from the West originating traffic to the Nunavut and NWT Western Arctic Coast.
- **Inland Marine Systems** – a combination of intermodal container/trailer services and integrated marine and rail or road bulk commodity hauls within Hudson Bay, the Mackenzie Valley and the Alaska/B.C. Inside Passage.
- **Highway Transport Systems** – a range of roads from the relatively extensive Yukon heavy haul highway system; to all-weather highways extended by winter/ice roads in NWT; to no roads at all in Nunavut.
- **Air Passenger & Cargo Systems** – Northern Regional Airports at Iqaluit, Rankin Inlet, Yellowknife and Whitehorse linked to Southern Gateway Airports at Montreal, Ottawa, Winnipeg, Edmonton, Calgary and Vancouver.

Phase 2 includes a recommended approach for developing each of these systems based on an objective financial assessment of northern transportation infrastructure needs.

Yukon Mineral Concentrate Heavy Haul Truck Transport to Closest Tidewater at Skagway, Alaska

The Phase 1 Transportation Demand Assessment has set the baseline for current traffic flows over the following northern transportation systems:

Northern Transportation Systems Demand (Tonnes in 2009)

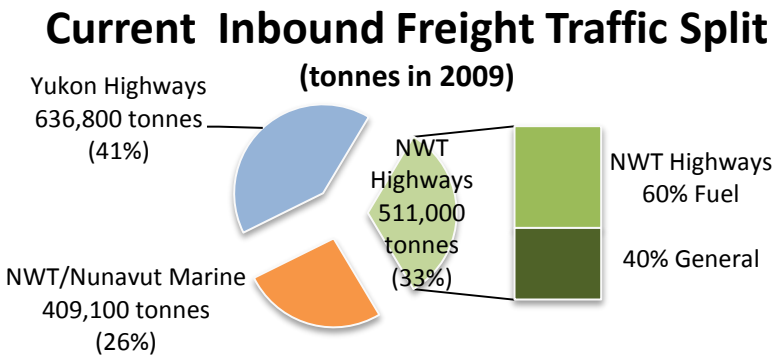
Northern Transportation System	Community Resupply General	Resource Projects General	Bulk Fuel Supply	Total Inbound Tonnes
Eastern Sealift	54,500	39,100	139,900	233,500
Western Sealift	3,700	3,800	59,000	66,500
Mackenzie River	8,900	3,900	26,200	39,000
Hudson Bay	4,300	27,300	38,500	70,100
Inside Passage*	*59,400*	*24,100*	*64,000*	*147,500*
Yukon Highways	371,000	143,900	121,900	636,800
NWT Highways	163,000	48,000	300,000	511,000
TOTAL INBOUND	605,400	266,000	685,500	1,556,900
Northern Air Cargo				20,000
Resource Exports				54,000
TOTAL TONNES				**1,630,900**

* Inside Passage Tonnes are included in Yukon Highways Tonnes and excluded from Total Tonnes.

Air North and Canadian North Combi Aircraft at Inuvik Airport

From these current demand statistics the following traffic split shows that:

- Yukon Highways carry the most northern traffic (over 40%);
- Nunavut Sealift and NWT Mackenzie River traffic is about a quarter of the total;
- Northwest Territories Highways carry a third of northern traffic and of that total;
- Fuel is approximately 60% of the Northwest Territories Highways traffic.



The modal split shifts across the North:

- From exclusively Sealift in the roadless Eastern Arctic;
- To a mix of Highway, Mackenzie River and Sealift in the Northwest Territories;
- To a preponderance of trucking on the extensive Yukon Highway System.

Northern transport systems demand development includes traffic generated by resource projects that are currently active. As well, forecasts extended from current baseline traffic are augmented with assessment of resource development projects that may take place over the next 20 years.

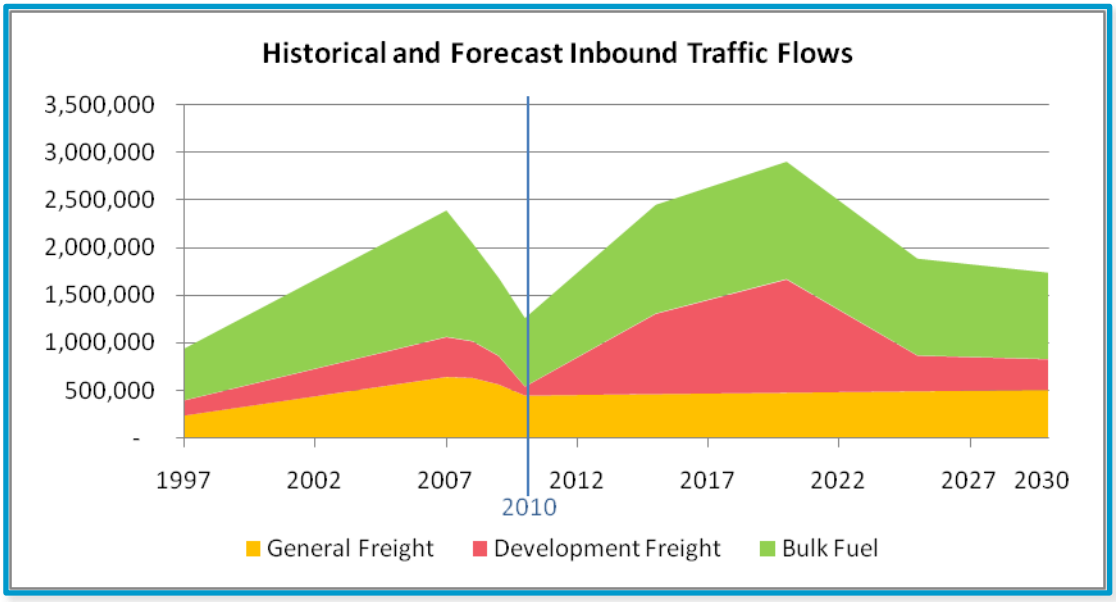
Northern Transport Demand Freight Forecast Summary (tonnes)

	2010	2015	2020	2025	2030
Community General	443,557	459,499	474,226	489,032	503,737
Resource General	94,100	846,100	1,193,000	375,000	322,000
Bulk Fuel Supply	718,986	1,142,164	1,233,712	1,017,954	908,614
Total Inbound	**1,256,643**	**2,447,763**	**2,900,938**	**1,881,986**	**1,734,351**
Outbound	**112,000**	**1,381,000**	**19,556,600**	**19,320,600**	**18,820,600**
Induced Demand*	***18,820***	***169,220***	***238,600***	***75,000***	***64,400***

*A .20 induced impacts multiplier is applied to development freight to account for the additional traffic demand that can be expected with spin-off economic activity from resource development projects. Induced demand is shown for information only and not included in the totals.

The following chart shows for northern transportation systems traffic demand:

- Historical growth during the decade from 1997 to 2007;
- Recent decline through the economic recession to 2010; and
- Resumed resource development driven growth forecast through 2020.



Source: PROLOG Northern Territories Transportation Systems Study (1998) for 1997 data and PROLOG contemporary and forecast demand statistics presented in the Phase 1 Report.

Mackenzie River East Channel Winter Ice Road

The Phase 2 Infrastructure Needs Assessment builds on results of the Phase 1 Demand Assessment to:

- Compare existing transportation capabilities and constraints with proposed infrastructure investments to determine potential performance changes in future cost, service or reliability.
- Apply potential performance changes to recast modal split projections, analyze transportation system reconfigurations, and monetize future infrastructure savings/benefits versus costs.
- Screen future infrastructure savings/benefits versus costs to help set northern transportation system investment priorities over a 20 year planning horizon.

The Phase 2 Assessment looks at major infrastructure needs with an eye for potential or existing multi-use facilities that can share the required investment among multiple users. The Assessment also identifies incremental options for staged building of the large scale infrastructure projects that are proposed for improving transportation in the North.

The Phase 2 Assessment provides a high-level financial analysis of major infrastructure investment proposals based on quantifiable savings that relate directly to the costs of moving goods in the North. However, many aspects of northern infrastructure needs are not so easily quantified. These include:

- Transportation safety and cargo security;
- Spill prevention and tanker systems integrity;
- Remote Community access and development; and
- Environmental Protection in a changing Northern Climate.

To the extent that potential investments indentified in the Phase 2 Infrastructure Needs Assessment can also provide benefits beyond transportation efficiency and cost savings, these benefits are important to balance the decision making process.

Google Earth Image of Sealift Tanker Discharge at Iqaluit Inuit Head Pipeline Header.

2. Canadian Arctic Sealift System

Over the next 20 years, the Canadian Arctic Sealift System is anticipated to encounter a warmer climate with an extended shipping season that will see:

- Increasing options for community resupply sealift;
- Reduced risk for resource development sealift;
- Greater international arctic activity; and
- Corresponding strategic national initiatives.

However, an extended sealift season will not create much commercial attraction for cargo ships to transit the Canadian Northwest Passage on a regular basis. The Russian Northern Sea Route is a shorter, more attractive passage between Europe and Asia – which is the major merchant marine market. Market economics will determine whether commercial ships will transit the Canadian Northwest Passage. A more relaxed ice regime will not make any difference without a market.

Ship owners see Canada's arctic as a destination market, rather than part of an international trade route. However, the lack of permanent marine facilities at arctic coastal destinations can constrain progress for community and resource development that, short of air access, is otherwise stranded without sealift.

A warming climate and extended shipping season are fostering new sealift supply chains for coastal destinations:

- Eastern Arctic Sealift ship owners are expanding into the Western Arctic; and
- Western Arctic Sealift is shifting from Mackenzie River barges to Pacific Coast vessels.

Non-commercial Canadian initiatives are also adding marine activity with a High Arctic Research Station at Cambridge Bay and an Arctic Training Centre joining the Polar Continental Shelf Project at Resolute Bay. As well a new fleet of Navy Arctic/Offshore Patrol Vessels and Coast Guard ice breakers are to be supported from Nanisivik.

Recommended Approach for Eastern Sealift

Seek development of multifunctional facilities that can more cost-effectively serve emerging resource industry needs in combination with ongoing Nunavut resupply reliability requirements; and ensure community marine infrastructure capability for:

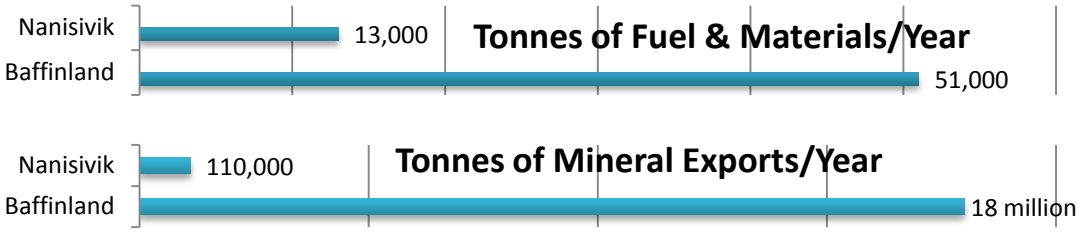
- ***Safe, secure landing and distribution of dry cargo; and***
- ***Environmentally secure fuel transfers with effective tanker systems.***

The Canadian Arctic Sealift System has been screened for potential performance changes and parallel infrastructure needs in both the Eastern Arctic and the Western Arctic.

In the Eastern Arctic - where a sealift beach is the typical marine terminal facility, these include:

- Public sector opportunities to reduce sealift costs and increase sealift reliability with regional distribution as inter-community roads are developed in the Kivalliq Region; and with incremental investment in permanent port facilities at Iqaluit; and
- Resource sector facilities investment proposed on northern Baffin Island at Steensby Inlet and Milne Inlet that will accommodate intensive year around import/export trade between Nunavut and Europe as well as summer sealift from Montreal, both with spin-off opportunities for Nunavut community resupply.

Proposed Baffinland Mary River Iron Mine vs. Closed Nanisivik Lead/Zinc Mine



Over the next 20 years the extent of permanent port infrastructure investment in the Eastern Arctic will, in combination with strategic non-commercial initiatives, be dependent upon the prospects for:

- Mining industry project specific full port facilities development; and
- Public sector incremental improvement in local and regional sealift facilities.

Private sector investment for the Mary River Iron Mine project will result in new port infrastructure on Baffin Island. Public sector investment is suggested to support regional sealift resupply through Iqaluit. A combination of public and private sector investment may make sense to develop Rankin Inlet as a regional transportation hub for the Kivalliq region.

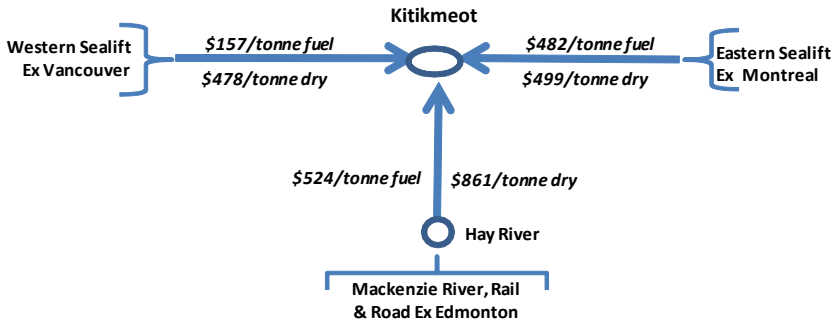
From the Phase 1 Traffic Demand Report, the following traffic projections provide the context for Eastern Sealift infrastructure needs assessment in Qikiqtaaluk Region.

Qikiqtaaluk Eastern Arctic Traffic Projections
(tonnes/year)

	2010	2015	2020	2025	2030
Baffinland Iron Ore Exports		**9,000,000**	**18,000,000**	**18,000,000**	**18,000,000**
Baffinland Mary River Mine Supply	1,000	107,000	10,000	10,000	10,000
Baffinland Mary River Mine Fuel	2,000	17,000	41,000	41,000	41,000
Total Resource Development	**3,000**	**124,000**	**51,000**	**51,000**	**51,000**
Community Fuel Supply	73,596	77,680	81,327	84,464	87,236
Community Resupply	15,145	15,985	16,736	17,381	17,951
Mining Induced Resupply*	600	24,800	10,200	10,200	10,200
Total Inbound Traffic	**92,341**	**242,465**	**159,263**	**163,045**	**166,387**

In the Western Arctic - sealift operations are changing rapidly as a competitive marketplace emerges in one of the most remote arctic regions of Canada, characterized by:

- Eastern sealift cargo ships and product tankers entering the western arctic while Mackenzie River barges are superseded by ocean vessels from the west coast; and
- A shift from traditional use of river barges that can come alongside shallow draft community wharfs, to shallow draft barge shuttles from deep draft ocean vessels.



Ongoing changes in sealift supply and demand will impact infrastructure requirements for two ports in the Western Arctic:

- Tuktoyaktuk - the once and future supply base for Beaufort Sea/Mackenzie Delta oil and gas field development, and the only improved port in the Western Arctic with the depth of water to allow cargo transfers - but with access constrained by an undredged channel entrance.
- Coronation Gulf Port and Road - infrastructure investment that is required before Nunavut base metal mines can be developed, but that currently producing NWT diamond mines could use as soon as available to significantly reduce the cost of bulk supply – and to avoid Tibbitt to Contwoyto Winter Road warm weather risk – providing early revenue certainty for project investment now .

Recommended Approach for the Western Sealift System

Resource driven infrastructure investment in two multi-user, multi-functional Western Arctic Sealift hubs:

- ***Tuktoyaktuk for oil and gas field development; and***
- ***Coronation Gulf Port and Road for mining development.***

Island Tug and Barge photograph of deep draft articulated tug barge tanker transferring fuel to shallow draft river/ coastal barges in the Western Arctic.

The following table recaps from the Phase 1 Demand Study, ongoing NWT coastal community resupply traffic combined with projected resource development traffic and additional "spin-off" resupply traffic that will be induced by oil & gas activity.

NWT Western Arctic Inbound Traffic Projections

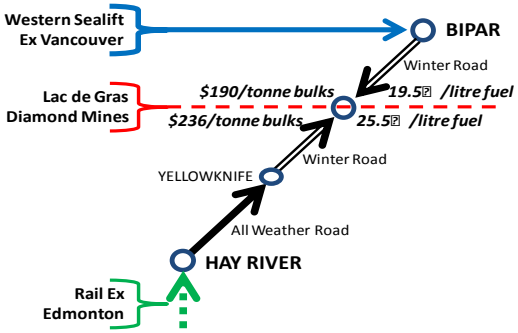
(tonnes/year)

	2010	2015	2020	2025	2030
Mackenzie Gas Pipeline*		400,000	5,000	5,000	5,000
Oil&Gas Field Development**	6,000	69,000	73,000	102,000	142,000
Total Resource Development	**6,000**	**469,000**	**78,000**	**107,000**	**147,000**
Oil&Gas Induced Resupply***	1,200	93,800	15,600	21,400	29,400
Community Resupply	15,956	16,576	17,208	17,779	18,442
Total InboundTraffic	**23,156**	**579,376**	**110,808**	**146,179**	**194,842**

* Construction material and resupply traffic spread out along the full Mackenie Valley pipeline right-of-way.
** Includes Central Mackenzie Basin resupply from North or South pending proposed all-weather road.
*** Induced traffic assumed as .2 x total resource development traffic.

While Tuktoyaktuk is projected to resume a proven position as supply base for Mackenzie Delta/Beaufort Sea oil and gas projects, feasibility for Slave Geological Province base metal mining prospects is dependent upon access to Western Arctic Sealift in Coronation Gulf. As a context for potential development of a Coronation Gulf Port and Road to serve both Nunavut base metal mines and NWT diamond mines, following are resource development traffic forecasts from the Phase 1 Demand Assessment.

		FUTURE SLAVE GEOLOGIC PROVINCE MINING FORECAST VOLUMES					
			(tonnes/yr)				
MINE			**2010**	**2015**	**2020**	**2025**	**2030**
Base Metal Mines							
Izok Lake	Outbound			430,000	430,000	430,000	430,000
	Inbound	Fuel		28,000	28,000	28,000	28,000
		Other Bulk		4,000	4,000	4,000	4,000
Hackett R	Outbound			450,000	450,000	450,000	450,000
	Inbound	Fuel		30,000	58,000	58,000	58,000
		Other Bulk		34,000	76,000	76,000	76,000
		Total Inbound Bulk		96,000	166,000	166,000	166,000
Diamond Mines							
Diavik	Inbound	Fuel	18,000	69,000	69,000	69,000	
		Other Bulk	16,000	59,000	59,000	59,000	
Ekati	Inbound	Fuel	36,000	57,000	57,000		
		Other Bulk	5,000	7,000	7,000		
Snap Lake	Inbound	Fuel	26,000	29,000	29,000	29,000	29,000
		Other Bulk	2,000	6,000	6,000	6,000	6,000
Gahcho Kue	Inbound	Fuel		25,000	25,000	25,000	25,000
		Other Bulk		12,000	12,000	12,000	12,000
		Total Inbound Bulk	103,000	264,000	264,000	200,000	72,000
		Total BIPAR Throughput	**103,000**	**360,000**	**430,000**	**366,000**	**238,000**



(Bathurst Inlet Port and Road)

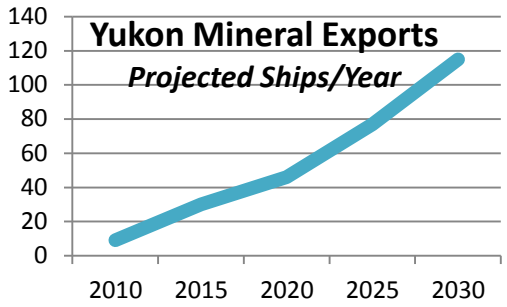
While a Coronation Gulf Port and Road project is integral to future Nunavut base metal mining feasibility, winter road risk and savings benefits for currently producing NWT diamond mines can offset advanced project investment on a stand-alone basis.

3. Yukon Resource Access Systems

Over the next 20 Years, growth in Yukon transportation demand will be driven primarily by resource development - principally base metal mineral development.

Yukon mineral exports in currently average 13,000 tonne ocean shipments will require[1]:

- A ship every 12 days by 2015
  (30 ships at about 400,000 tonnes/year);
- A ship every 8 days by 2020
  (46 ships at about 600,000 tonnes/year);
- A ship every 5 days by 2025
  (77 ships at about 1 million tonnes/year); and
- A ship every 3 days beyond 2030
  (115 ships at about 1.5 million tonnes/year).

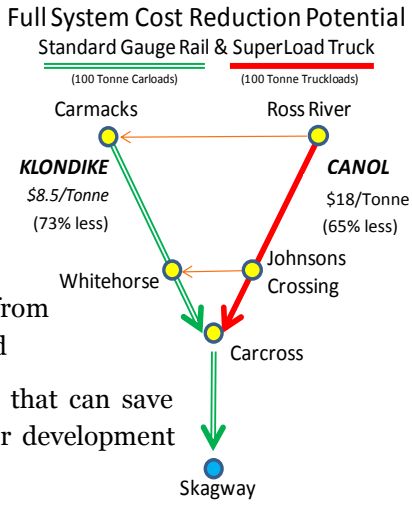


Base metal mining transportation demand is subject to constraints from two perspectives:

- First - ore terminal storage, berthing and loading capabilities at Skagway, Alaska will constrain tidewater access as Yukon mineral exports increase; and
- Second – the remote inland location of Yukon mines means that long distance transportation costs to tidewater can constrain mineral production feasibility.

These constraints can be relieved with infrastructure investment in:

- Skagway port development to overcome capacity shortfalls constraining Yukon mine feasibility and production decisions and that can provide up to 70% transportation savings benefits by avoiding distant port alternatives;
- CANOL Resource Corridor development between Ross River and Carcross to cut 20% of the distance and double the payload that in combination can provide up to 65% truck transport savings;
- KLONDIKE Resource Corridor development with initial rail rehab from Carcross to Whitehorse providing a 50% savings below truck cost; and
- Subsequent standard gauge conversion and extension to Carmacks that can save 73% of truck cost – but is mutually exclusive with CANOL Corridor development that would divert rail traffic threshold density from Carmacks.



[1] Future shipment size may increase up to full shiploads of 25,000 to 35,000 tonnes. However, staging full shiploads will require much greater ore terminal storage capacity, especially to segregate storage for multiple mines.

As a context for port infrastructure needs at Skagway, following are resource development traffic forecasts from the Phase 1 Demand Assessment.

Phase 1 Mineral Export & Inbound Supply Recap

Inside Passage Ports Demand Forecast

A) Short Range Mining Projects (Start-Up within 10 years)

Producing Mines		*Outbound Tonnes/Year*			
Mine	Concentrates	2010-15	2015-20	2020-25	2025-30+
Minto	Copper	65,000	65,000	65,000	
Wolverine	Lead/Zinc	45,000	135,000	135,000	
Whitehorse	Magnitite	300,000			
Total MIN Scenario (Total Producing)		**410,000**	200,000	200,000	
Probable Mines					
Bellekeno	Lead/Zinc	20,000	20,000	20,000	
Carmacks	Copper (cathodic)		16,000	16,000	
Selwyn	Lead/Zinc		320,000	500,000	500,000
Total MID Scenario (Producing+Probable)			**556,000**	736,000	500,000
Possible Mnes					
Casino	Copper/Moly			300,000	300,000
MacTung	Tungsten			15,000	15,000
Total MAX Scenario (Producing+Probable+Possible)				**1,051,000**	815,000

B) Longer Range Mining Projects (Start-Up Within 20 Years)

Potential Additional Mineral Exports		
Marg	Zinc/Copper	135,000
Andrew	Lead/Zinc	50,000
Kud Ze Kyah	Lead/Zinc	170,000
Tom & Jason	Lead/Zinc	290,000
Longer Range Total		**1,460,000**

C) Very Long Range Mining Projects (Start-Up Beyond 20 Years)

Crest	Iron Ore	28,000,000

All Projects	*Inbound Tonnes/Year*			
Inbound Traffic	2010-15	2015-20	2020-25	2025-30+
Mine Fuel	31,000	95,000	228,000	173,000
Mine Supply	7,000	29,000	99,000	80,000
Total Mining Inbound	**38,000**	**124,000**	**327,000**	**253,000**
Alaska Gas Pipeline (peak year & ongoing supply)			786,500	3,000
Oil & Gas Exploration/Development				6,000
			1,113,500	**262,000**

Recommended Approach for Inside Passage Ports

Facilitate cost effective Pacific port access in Alaska for Canadian resource development in Yukon with infrastructure investment at Skagway to:

- ***Expand ore terminal capacity for an impending influx of Yukon mineral exports;***
- ***Load ore ships without disrupting a seasonally intense cruise ship market; and***
- ***Provide seamless transfer of Canadian container and general cargo.***

The Alaska Inside Passage Ports - of Haines and Skagway are a key part of Canada's present and future northern transportation system. For Yukon and Mackenzie Delta/Beaufort Sea resource development projects, Haines and Skagway offer the closest access to ice-free ports.

Alaska Inside Passage Ports are Canada's northernmost Pacific Gateways, just 24 kms from the Canadian border at Skagway and 72 kms from the Canadian border at Haines. Canadian transportation infrastructure provides Alaska Inside Passage port access via:

- The Haines/Alaska Highway from the Port of Haines;
- The Klondike/Dempster Highway from the Port of Skagway; and
- The White Pass railway through British Columbia and Yukon from Skagway.

Unique geographical circumstances which find the United States separated by Canada from Alaska; and Canada separated from the Alaska Inside Passage by a few kilometres in the United States, have historically fostered mutually beneficial bilateral cooperation:

- The U.S. built and Canada now maintains the Alaska Highway in B.C. and Yukon;
- Canada has maintained the Klondike Highway in Alaska (Curragh Mine Haul); and
- The U.S. has reconstructed Yukon's Haines and Alaska Highways (Shakwak Project).

Canadian infrastructure investment in Skagway port development can unblock current port capacity constraints that will otherwise increasingly impede Yukon resource development.

The Yukon Heavy Haul Transportation System - Yukon has the most extensive highway system in Northern Canada embracing Alaska Highway, Klondike Highway and Dempster Highway connections to both Inside Passage and Arctic Ports. This system links most mineral production areas in the territory to tidewater at the Alaska Inside Passage Port of Skagway. It also provides direct trucking access from Watson Lake via Cassiar Highway 37 in British Columbia to the B.C. Inside Passage Ports of Stewart, Kitimat and Prince Rupert.

The CANOL Corridor is an unimproved, summer only, single lane route through Ross River that connects to the Klondike Highway at Whitehorse or Carcross. It offers the opportunity to combine a new short-cut to Skagway with "super load" mine haul trailers to substantially increase productivity of the Yukon heavy haul trucking system.

Recommended Approach for Yukon Heavy Haul Transportation System

Incremental rail and/or road investment where relatively high density mining traffic can support new modal systems to:

- ***significantly improve cost performance; and***
- ***reduce resource development public impacts.***

The KLONDIKE Corridor is the principal port access route and running through it parallel to the heavy haul highway is the White Pass & Yukon Route railway, a legacy from an earlier period of intense mining activity and intermodal mine haul transportation in Yukon. The narrow gauge White Pass railway is currently active between Skagway and Carcross, but only for passenger trains operated during the summer tourist season. Rail track is in place, but not in service between Carcross and Whitehorse.

The Phase 1 Demand Report forecasts Yukon mine haul activity to surge past previous peaks of around 600,000 tonnes/year within the next 5 to 10 years and to exceed 1 million tonnes/year within the next 10 to 15 years. As traffic density increases, so will the attraction of building on existing, underutilized rail infrastructure to achieve lower transportation rates with rail costs that decline as volumes increase.

At the same time a parallel rail alternative can relieve the public highway impacts from rapidly growing mine haul truck traffic. These include increased highway maintenance requirements, increased greenhouse gas emissions, reduced public safety and reduced tourism attraction. This last impact is especially significant because of the importance of the Klondike Highway for Yukon's tourism industry.

4. NWT/Nunavut New Road Systems

Many communities in the Northwest Territories and all communities in Nunavut have no all-weather road connections to the southern Canadian highway system. Public investment proposals for the Mackenzie Valley Highway and for the Nunavut-Manitoba Road would start to close that infrastructure gap.

While resource access roads will connect to these highways, the principal purpose is a public highway to connect communities – with a public interest in public investment. The Tibbitt to Contwoyto Winter Road, on the other hand, is exclusively a resource access road which is constructed each year at private sector expense.

Both types of highway infrastructure investment are considered in this assessment:

- A Mackenzie Valley All-Weather Highway from Wrigley to Inuvik and from Inuvik to Tuktoyaktuk that in part or in full will benefit increased community and resource development access – and provide Canada's only southern highway connection to an arctic port. The assessment identifies surface and air transportation savings for people and cargo that are compelling, exceeding annual highway maintenance costs, with a net transportation savings benefit that equals 20% of the capital cost of construction.
- A Seasonal Overland Road that can extend the operating season for the Tibbitt to Contwoyto Winter Road that serves NWT and Nunavut mineral properties in the Slave Geological Province. The assessment considers the risk that a warming climate will repeat the 100,000 tonne capacity shortfall of 2006 and the trade-off of a large SOR investment with a short life versus a smaller BIPAR investment with a long life.
- A Nunavut-Manitoba All-Weather Road Investment that with an initial inter-community regional distribution system could improve sealift cargo delivery via a single Kivalliq hub port. The assessment identifies the full investment benefit of year around, just-in-time trucking to reduce inventories and reorder lead times at no more cost than summer-only sealift. It also considers large air passenger and air cargo savings that in combination with sealift dry cargo diverted to trucks, exceed anticipated highway maintenance costs leaving net benefits that equal 15% of construction capital cost.

Arctic All-Weather Road Construction South from Tukoyaktuk

The Mackenzie Valley Highway System - is an extension of the existing NWT all-weather and winter road system comprised of:

- The All-Weather Mackenzie Highway from Alberta to Wrigley;
- The Mackenzie Winter Road from Wrigley to Fort Good Hope; and
- The Inuvik-Tuktoyaktuk Winter Ice Road on the Mackenzie River East Channel.

At present the all-weather NWT Mackenzie Highway 1 ends at Wrigley. A seasonal winter road connects Wrigley to Fort Good Hope via Tulita and Norman Wells. There is no road (winter or all-weather) between Fort Good Hope and Inuvik. A winter ice road along the Mackenzie East Channel connects Inuvik to Aklavik and Tuktoyaktuk

Infrastructure investment in a new Mackenzie Valley Highway system will attract traffic from the two season Mackenzie River barge and Winter Road truck operations; from the longer Dempster Highway route to the Mackenzie Delta; and from Mackenzie Valley/Delta Air Cargo and Passenger services. This traffic potential is shown in the following recap of the Phase 1 Mackenzie Valley and Delta/Beaufort Traffic Forecast.

Recap of Phase 1 Mackenzie Valley & Delta/Beaufort Sea Traffic Forecast
(Tonnes/Year)

Mackenzie Valley	2009/10	2015	2020	2025	2030
Barge Deck Cargo	7,844				
Winter Road Truck	1,300				
Community Resupply	9,144	9,583	9,949	10,305	10,662
Mackenzie Basin Oil & Gas	6,000	27,000	27,000	40,000	54,000
Mackenzie Delta/Beaufort Sea					
Dempster Hwy Truck	22,000	23,056	23,936	24,794	25,652
Beaufort Sea Oil & Gas		4,000	8,000	8,000	12,000
Mackenzie Delta Oil & Gas		38,000	38,000	54,000	76,000
Mackenzie Valley/Delta Air Traffic					
Cargo Tonnes per Year	1,700	2027	2,353	2758	3,162
Passengers per Year	119,193	136,953	151,136	166,870	178,273

Many of the benefits of infrastructure projects such as the Mackenzie Valley Highway extension are difficult to quantify. An important consideration for the Mackenzie Valley Highway project is that it will help to mitigate potential impacts of climate change on the existing transportation system.

According to Environment Canada, warmer than normal temperatures have occurred in 25 of the last 26 seasons and this warming trend has been strongest in northern Canada with the Mackenzie District showing the greatest increase of 2.3°C over the past 63 years of record. This warming trend in the NWT has and will continue to pose challenges and opportunities for the transportation system.

The Mackenzie Valley and other regions of the NWT transportation system rely on a number of ferries, ice bridges and winter roads to connect communities and provide access to resources. This system is subjected to winter freeze-up, spring break-up and other climatic influences that can affect the duration and reliability of the system.

The variable nature of the transportation system adds uncertainty to development projects and poses challenges for community mobility, resupply and economic diversification. The existing limited transportation window makes development and exploration activities less efficient and more expensive.

Climate change has impacted fall freeze up and spring thaw dates, which in turn has delayed the opening dates of ice bridges on all-weather highways and reduced the operating window of the winter road system. An incrementally developed all-weather road through the Mackenzie Valley would help alleviate problems associated with the reduction of winter road reliability, uncertainty of road opening and closing dates and reduced periods of operation. Staged all-weather road construction from the south to link up with permanent bridges already in place on the winter road system would provide timely transformation of the current intermittent system to one that increasingly functions 365 days per year.

Recommended Approach for the Mackenzie Valley Highway System

Incrementally replace winter road segments, as compromised by warmer weather, with corresponding extension of the all-weather road system from the south to provide increasingly better access for:

- ***Mackenzie Valley and Delta communities;***
- ***Mackenzie Gas Pipeline Project construction; and***
- ***Mackenzie Valley and Western Arctic Oil & Gas Development.***

Slave Geological Province Mine Haul System - The Slave Geological Province includes current and future mines in both the NWT and Nunavut. These mines are seasonally supported by annual construction of the Tibbitt to Contwoyto Winter Road (TCWR). In 2006 a warm winter season lead to premature TCWR closure and consequent extremely costly airlift of over 100,000 tonnes of mine traffic for which truck delivery was precluded. There is concern that risk of premature road closure may become more frequent with a warming climate in the North. A seasonal overland road (SOR), parallel to southern portions of the TCWR has been proposed to mitigate this risk.

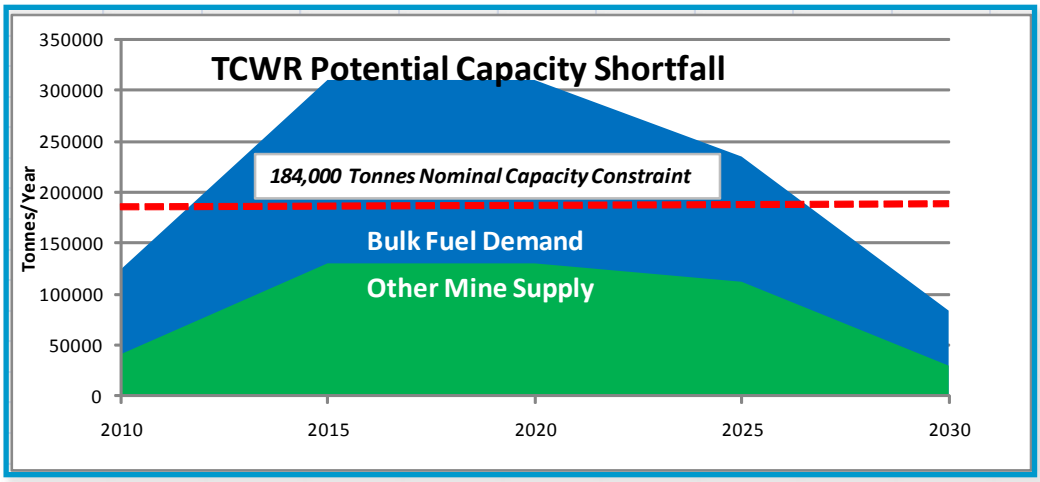
As a context for this infrastructure assessment, the table below provides a recap of the relevant Phase 1 traffic demand projections for Slave Geological Province diamond mine resupply through 2030.

Recap of Phase 1 Slave Geological Province Mine Supply Traffic Forecast

(Tonnes/Year)

Mine		2010	2015	2020	2025	2030
Ekati	Fuel	36,000	57,000	57,000		
	Supply	12,000	18,000	18,000		
Diavik	Fuel	18,000	69,000	69,000	69,000	
	Supply	22,000	82,000	82,000	82,000	
Snap Lake	Fuel	27,000	29,000	29,000	29,000	29,000
	Supply	6,000	12,000	12,000	12,000	12,000
Gacho Kue	Fuel	2,000	25,000	25,000	25,000	25,000
	Supply	1,000	18,000	18,000	18,000	18,000
Total	**Fuel**	**83,000**	**180,000**	**180,000**	**123,000**	**54,000**
	Supply	**41,000**	**130,000**	**130,000**	**112,000**	**30,000**
	All Traffic	**124,000**	**310,000**	**310,000**	**235,000**	**84,000**

The following graph shows the years during which there is a risk that forecast traffic can exceed a nominal TCWR capacity constraint of 184,000 tonnes/year based on the 2006 seasonal capacity shortfall.



The graph above also shows that if bulk fuel demand is removed from the TCWR capacity requirement, the residual of other mine supply traffic can be accommodated without any risk of a shortfall over the 20 year forecast period. The proposed Coronation Gulf Port and Winter Road would be extremely attractive for bulk fuel traffic that could be diverted from the TCWR and avoid any prospect of capacity shortfall.

As an alternative to the Coronation Gulf Port and Road option, a Seasonal Overland Road can replace the southern 170 km of TCWR with a 163 km parallel overland road. It is estimated that the SOR would add about 30 days to the current TCWR operating season.

The SOR would be an "insurance policy" against the risk of warm winters and the added expense of airlifting displaced truck traffic in case of a warm winter. However, by the time the SOR is implemented most diamond mines may already be in production decline, which could make unattractive a large SOR investment with a short life cycle. The trade-off may well be a large SOR investment with a short life versus a smaller BIPAR investment with a long life.

Recommended Approach for Slave Geological Province Mine Haul System

Continue existing, privately funded, Tibbitt to Contwoyto Winter Road trucking system as lowest total cost mine supply system:

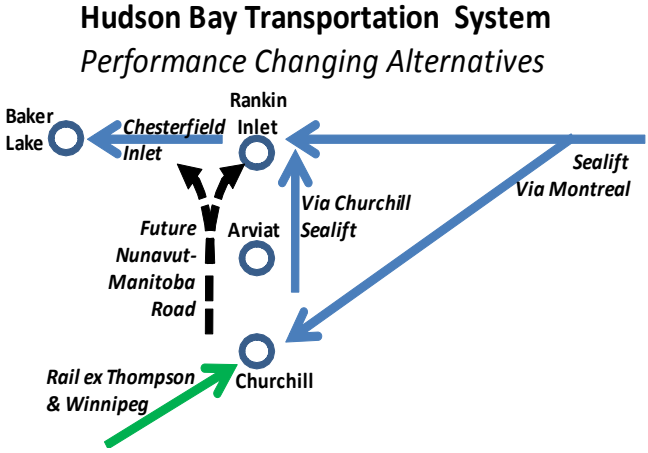
- ***for producing diamond mines; and***
- ***for new mineral exploration and development***

The Nunavut-Manitoba Road System - The Kivalliq Region, while in closest proximity to the southern Canadian rail and road network, like the rest of Nunavut is dependent upon sealift for resupply shipments that can only be scheduled in the limited summer season – and on air transport for everything else.

Incremental investment in a Nunavut-Manitoba road system is proposed in stages that will first connect Rankin Inlet, Whale Cove and Arviat in the Kivalliq Region. Each stage of development would include truck transport currently unavailable between Kivalliq communities and the rest of Canada, with connection:

- to intermodal rail service at Churchill, initially by a cross-boundary winter road, followed by completion of a year around all-weather road; and
- to the Manitoba Highway system following completion of the final stage of all-weather road construction linking Churchill to Gilliam.

The specific transportation benefits of the full Nunavut - Manitoba Road development include a shift of sealift general cargo to fast, frequent highway general freight; air cargo shift to much less expensive trucking; and air passenger shift to personal vehicle travel. Initial development of an inter-community road system may also provide some interim sealift benefit for regional hub distribution.



Current Kivalliq sealift and air transport forecasts will change significantly with Nunavut-Manitoba Road System development. As a baseline from which to recast future traffic shifts, the table below recaps the Phase 1 forecast of sealift and air transport for Kivalliq Region mines and communities assuming no change in current modal split.

Recap of Phase 1 Traffic Forecast for the Kivalliq Region
(Tonnes/Year)

Sealift Transport	2010	2015	2020	2025	2030
Mines					
General Freight	17,100	38,100	68000	68000	16,500
Bulk Fuel	23,200	52,200	78,000	78000	24,000
Total	40,300	90,300	146,000	146,000	40,500
Communities					
General Freight	14,592	15,403	16,126	16,748	17,892
Bulk Fuel	27,696	29,233	30,606	31,786	32,029
Total	42,288	44,636	46,732	48,534	49,921
TOTAL					
General Freight	31,692	53,503	84,126	84,748	34,392
Bulk Fuel	50,896	81,433	108,606	109,786	56,029
Total	82,588	134,936	192,732	194,534	90,421
Air Transport					
Air Cargo (tonnes/year)	4,298	5,457	6,615	8,205	9,705
Air Passenger (psgrs/year)	175,000	197,050	217,525	240,275	265,300

Highway connection to the railhead at Churchill, Manitoba or to the roadhead at Gilliam, Manitoba could substantially change the cost and service performance of the transportation system in the Kivalliq Region.

Recommended Approach for the Nunavut-Manitoba Road

Integrated development of an all-weather and winter road system providing inter-community connections first, followed by connections to the rest of Canada, gradually transforming the Kivalliq Region transportation system with:

- ***Initial potential for regional sealift cargo distribution;***
- ***Interim Intermodal Integration via Churchill railhead; and***
- ***Ultimate all-year alternative for sealift cargo, air cargo and air travel.***

Intermodal Railhead at Port of Churchill, Manitoba

5. Northern Air Transport Systems

At many northern communities the movement of people and goods is only accomplished by seasonal surface transport or by air. Air transportation also provides a crucial link to essential services and work opportunities that are often not available within the community.

Ongoing incremental infrastructure investment continues to meet the requirements of isolated northern communities for passenger, cargo and medevac services as well as for inconsistent resource development demand - and compliance with changes in the Canadian Aviation Regulations. Currently anticipated northern airport infrastructure needs include the following priority capital projects:

- Iqaluit Airport – In excess of $200 million capital investment estimated for runway repaving, airfield electrical system replacement, combined services building and including a new $60 million air terminal building.
- Cambridge Bay Airport - $34.4 million in short-term improvements to extend apron, upgrade runway lighting and landing systems and including $10 million to shore up the gravel runway. Longer term, within 5 years runway paving and extension, and within 10 years air terminal building expansion, is required.
- Rankin Inlet Airport - $32.2 million for short-term improvements to construct a new taxiway, extend aircraft parking apron and expand the air terminal building. Longer term, additional 50% expansion of the air terminal building is required.
- Whitehorse International Airport - $15.7 million air terminal building expansion completed in 2010 to accommodate international flights, including currently Condor and potentially Swiss Air, with continuing flights to Alaska.
- Mayo Airport - $2.2 million over 5 years for visual approach navaids and to rebuild runway due to permafrost degradation, including $1.5 million for runway resurfacing, apron and taxiway reconstruction. Pending scheduled service will require additional investment for airport recertification.
- Faro Airport - $1 million over 5 years for new air terminal building, apron expansion and airside resurfacing. Additional investment may be required to accommodate intense resource development activity currently anticipated.
- Northwest Territories – $20.7 million Yellowknife Airport Combined Services Building recently completed and $6 million in runway extension projects currently underway or completed at Tulita, Fort Good Hope and Fort McPherson.

Recommended Approach for the Northern Air System

Maintain highest possible standards with additional air system capacity investment as required to support largely roadless northern communities heavily dependent on air transport:

- ***For travel, medevac and other essential services;***
- ***For all-season resupply including food and mail; and***
- ***For sustainable resource, tourism and other economic development.***

6. Conclusions

Following are key findings from the Northern Transportation Systems Study:

- *Combined with incremental community harbour improvements ongoing in Nunavut, the full scale of transportation infrastructure proposed for the Mary River Iron Mine on Baffin Island may create spin-off opportunities for long term community resupply improvement in the Qikiqtaaluk Region.*
- *Staged development of a Coronation Gulf Port and Road could initially provide lower cost inbound bulk transport for existing Diamond Mines in the Northwest Territories with early project revenues for subsequent full facility development to support base metal mining in the Kitikmeot Region of Nunavut.*
- *Port, rail and/or road infrastructure investments would provide the resource development industry in Yukon with lower cost tidewater access to help mineral exports stay competitive in the Asian market.*
- *Incremental investment in both the proposed Mackenzie Valley Highway and the Nunavut-Manitoba Road could initially improve community resupply reliability, local goods distribution and regional resource development access; and ultimately supplement high cost air cargo and passenger transport with all-weather road connections to the southern highway system.*
- *Runway extensions, new aprons and air terminal buildings may be required for workforce crew changes and air cargo support for the large scale resource development projects being considered over the next 20 years.*

This report concludes with the following high level financial summary that should be considered as a first step in helping to prioritize infrastructure investments in the North. Project benefits that are not quantified here include increased safety, reliability, community development and environmental protection. Though less easily monetized, these benefits may be equally, if not more, significant to infrastructure decisions in a changing Northern climate.

Infrastructure Investment Project	Investment Capital Cost	Internal Rate of Return	Net Present Value	Benefit To Cost Ratio	Pay Back Period
Skagway Mineral Export Terminal	$81 million	40%	$431 million	7 : 1	3 yrs
Canol Corridor Super Load Road	$52 million	20.5%	$209 million	5.4 : 1	7 yrs
Klondike Corridor Rail to Whitehorse	$67 million	17.1%	$174 million	4 : 1	8 yrs
Yukon Hwy 1 & 2 Truck Lane Build-Out	$82 million	11.3%	$72 million	2 : 1	10 yrs
Coronation Gulf Port & Road(BIPAR)	$127 million	10.6%	$52.5 million	1.5 : 1	8 yrs
NWT Seasonal Overland Road *	$192 million	9%	$55 million	1.3 : 1	8 yrs
Standard Gauged Rail to Carmacks	$576 million	8.4%	$237 million	1.5 : 1	12 yrs
Iqaluit Sealift Ramp/Staging Site	$22 million	6.1%	$2.6 million	1.2 : 1	15 yrs
Iqaluit Deep Water Port	$65 million	-1.2%	-$34 million	.44 : 1	30 yrs
Mackenzie Valley All-Weather Hwy	$1.8 billion	-4.9%	-$1.3 billion	.20 : 1	50+ yrs
Nunavut-Manitoba All-Weather Hwy	$1.3 billion	-6.8%	-$1.0 billion	.15 : 1	50+ yrs

* assuming highest risk of warm winter/short season (every 5 years).

Although the financial assessments are derived from shipper savings, which are not the same as commercial revenue streams or broader socio-economic benefits, they do provide a high level indication of the relative attraction for public and/or private investment. Moving toward the top of the table, investments show increasing private sector financial viability. Moving toward the bottom of the table, investments show increasing requirement for public interest financing.

Resource projects will increase the prospects for private sector financing of northern transportation infrastructure. Governments should look closely for any opportunities to piggyback community resupply benefits on resource development projects. Public sector buy-in to a private sector project can leverage the legacy of northern transportation infrastructure investment. To further that legacy in a harsh environmental and financial climate requires careful consideration of all options for cost sharing partnerships where multiple needs can be met with a single multi-use facility.

White Pass & Yukon Route Railway at Carcross, Yukon (2010)