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Getting from Here to There

Transportation Infrastructure in Northern Ontario, Part 1: The Basics

By: Julien Bonin

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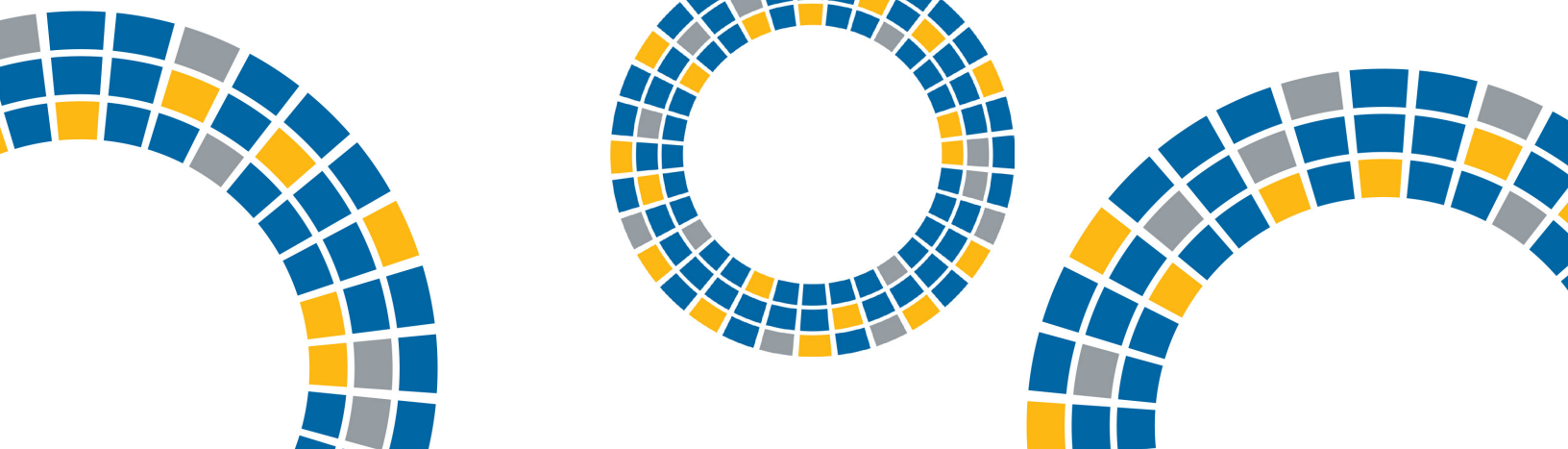


Introduction

Northern Ontario is a large geographic area with a low population density. Yet, its culture and natural environment provide numerous opportunities for natural resource development and emerging industries. A challenge for the region is its peripheral location which isolates it from the rest of the province and the country. The transportation infrastructure is a key component of the economy and sustainability of the region. It also is a commitment by the federal and provincial governments to connect isolated communities. The Northern Ontario economy relies on the transportation network to access natural resources, move goods between factories and markets (domestic and international), bring in consumers (Maoh, Anderson and Burke 2012), and move people. The geographic isolation is worsened by high transportation costs, limited transportation options, infrastructure constraints (Hall and Donald 2009), and network disruptions due to severe weather, physical breakdown, and accidents (Jenelius 2009). The governments of Canada and Ontario recognize the importance of the transportation network with its inclusion in the Growth Plan for Northern Ontario. This plan was developed to "guide decision-making about growth that promotes economic prosperity, sound environmental stewardship, and strong, sustainable communities" (Government of Ontario 2011, 3). The plan realizes that many factors such as "modern and efficient infrastructure," including transportation infrastructure, is "critical to achieving long-term global competitiveness" of the region (Government of Ontario 2011, 3).

Since the government has limited assets, there are insufficient funds to meet the rising demand and maintenance of aging infrastructure (Scott et al. 2006). While the Growth Plan suggests that transportation is an important factor for economic success, it does not guarantee it. A 1987 study by Vickerman suggests that a lack of funding or transportation investment does inhibit community growth or results in a decline; it does not, however, guarantee any type of growth. Since the transportation infrastructure is not normally revenue-producing, well-informed public policies are essential when making decisions.

The objective of this series of papers is to:

1. Investigate the current spatial distribution of the transportation infrastructure in Northern Ontario;
2. Identify gaps in the transportation network and describe socio-economic impacts;
3. Prescribe policy recommendations to remove some of the inefficiencies in the network;
4. Identify transportation "hot spots" and key areas where investment should be focussed.

This series is divided into three parts. The first part is the present paper, which will review the pertinent literature to provide general information about transportation infrastructure in Northern Ontario and contemporary issues or challenges facing this infrastructure.

The second part of the series will present results from the empirical analysis to describe, identify gaps, and make policy recommendations for each transportation mode. The methodology for the empirical analysis can be found in Appendix C of the second paper.

Lastly, the third paper will discuss and summarize key findings, identify transportation "hot spots" and areas where greater investment is required, and highlight the current trends in Northern Ontario's transportation infrastructure. It will also include a section called future studies, with recommendations for some additional transportation research and their policy implications. Finally, the third part will conclude with a review of the current state of the Northern Ontario transportation infrastructure along with its challenges and significance to the socio-economic development of the region.

Literature Review

Transportation infrastructure is an essential element of the economy as well as a vital component of the well-being of residents. The transportation infrastructure facilitates the movement of people and the delivery of goods, such as food, and provides access to health and social services (Bristow and Gill 2011). Northern Ontario's vast geography and low population density increase the challenges of providing adequate transportation infrastructure. According to the Growth Plan for Northern Ontario, transportation infrastructure consists of roads, rail, air, and waterways (Government of Ontario 2011). The infrastructure also determines the transportation mode (car or truck, train, airplane, ship) and services available:

- passenger: train, motorcoach, airline; and
- freight: rail, trucking or air cargo.

Cost of Transportation Infrastructure

There is a cost associated with each transportation method. Traditionally, transportation costs were quantified by using economic measures such as facility costs, vehicle operating costs, the financial cost of crashes, and travel time (Litman 2003). The monetary costs associated with infrastructure include construction and maintenance, while carrying costs include vehicles and equipment. As indicated by Scott et al. (1996), there is a limited amount of funds available; therefore, it is impossible to fulfill the demand and maintenance of all infrastructure needs. Subsequently, because of the limited funds available, monetary costs are a primary consideration in the decision-making process (Bristow and Gill 2011). Given the high financial cost and long life cycle of transportation infrastructure projects, public and private stakeholders are hesitant to take on the full risk for fear that the infrastructure no longer becomes sustainable (Bristow and Gill 2011). As a result, well-informed public policies and long-term planning are important when making decisions.

The practice of using economic measures in the decision-making process for transportation infrastructure is being increasingly criticized (Litman 2003). Studies such as Forkenbrock (2001) argue that while it is a good policy to minimize financial costs, the external or social costs of each transportation mode must also be considered. An external cost is described by Forkenbrock (2001) as any negative effect on the environment, health, safety, and welfare of the general public. External costs include such elements as noise, accidents, or pollution. Numerous studies, such as Levinson and Gillen (1998), Forkenbrock (2001), and Janic (2007), attempt to model the full cost of a transportation mode, which includes both financial and external costs and argue that the full cost must be considered in the decision-making process. Sustainable transportation is a term used by Litman (2003) to incorporate the full cost of transportation infrastructure. The author defines sustainability as "development that balances economic, social and environmental objectives" (Litman 2003, 3). The study goes on to argue that while there has been some progress in quantifying environmental costs, social costs remain largely unknown. The concepts of social impact, such as social exclusion presented by Litman (2003), are not only important for urban areas but could also be extended to intercommunity accessibility, in particular, for remote communities. The transportation infrastructure that connects a community to surrounding areas affects people's ability to access goods, services, and activities (Litman 2003). Table 1 provides examples of costs for each transportation infrastructure.

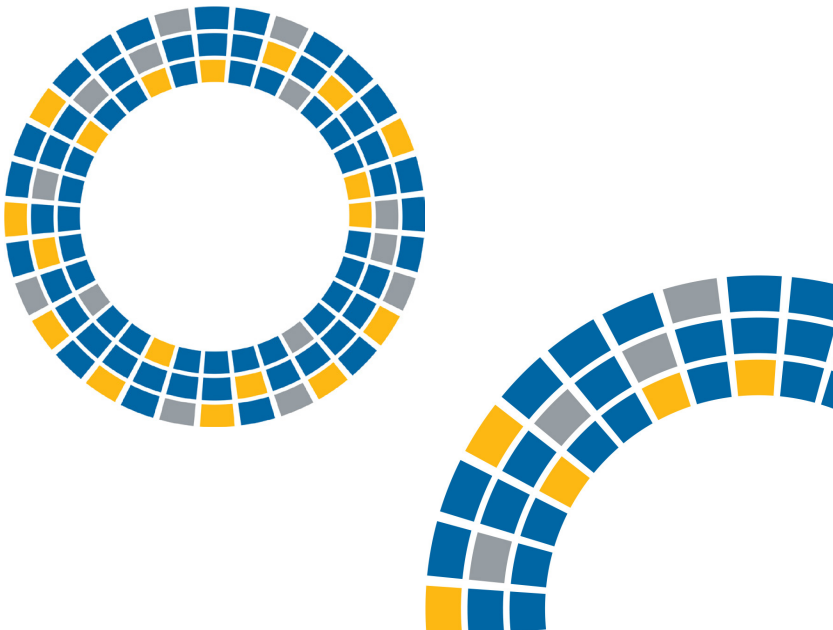


Table 1. Cost of Transportation Infrastructure

Cost	Roads	Railroads	Air	Sea
Infrastructure	Construction • land purchase • pavement Maintenance Administration Law enforcement Interest on Debt	Construction • tracks • station • Land Purchase Maintenance Administration Interest on Debt	Construction • terminals • airlines facilities and hangers • runways and taxiways Maintenance Administration	Construction • ports • other facilities Maintenance Administration
Carrier	Ownership • vehicle purchase Maintenance of the vehicle Gas Insurance Parking	Purchase • locomotives • cargo cars Maintenance of their equipment	Purchase • airplane Energy • Fuel Maintenance of the airplanes	Purchase • ships Energy • fuel Maintenance
External	Time Cost Congestion Accidents Pollution Noise	Inflexible Limited routes Fixed Schedule	Pollution Noise	Time Cost

Source: author's own.

Advantages and Weaknesses of Transportation Infrastructure

Each transportation infrastructure has advantages and disadvantages and is designed to accomplish certain tasks. As a result, each infrastructure has important policy considerations in the decision-making process.

Roads and Highways

Roads and highways are the most prominent transportation infrastructure today. The infrastructure is used for three different transportation modes and services: truck (or freight), motorcoach (passenger bus), and personal vehicle (automobile). Roads and highways provide significant advantages in terms of flexibility and convenience because they are not restricted by a schedule or a fixed route. A person using their own vehicle can depart whenever they are ready and use a preferred route to get to their destination. Meanwhile, a freight truck can leave when the truck is ready and drive directly to a store with minimal street restrictions such as load or size restrictions. Levinson (1996) believes that the automobile and motorcoaches are most cost-effective when they carry more passengers since the operating cost is shared by many users.

The disadvantage of road infrastructure is the high cost of ownership and maintenance for personal use (Hubpages 2008). There is increased attention to external costs such as environmental and social impacts. Automobiles and trucks are sources of numerous environmental problems such as air pollution, their contribution to climate change, and other external/social costs such as noise, safety (accidents), and congestion (Levinson 1996, Levinson and Gillen 2007, Haustein and Hunecke 2007, Janic 2007). Forkenbrock (2001) believes that trucking generates over three times the external costs of freight trains while significantly underpaying for its use of roads. Levinson (1996) argues that the road and highway system does not benefit from economies of scale. The reason is vehicles, in particular freight trucks, cause wear and tear on the road surface. As the number of cars and trucks on the road increases, the demand for new and larger roads also increases.

The road network is also adversely affected by weather conditions. Datla and Sharma (2008) state that extreme weather conditions (in any season or climate) cause traffic disruptions such as slower speeds, congestion, and accidents. Datla and Sharma (2008) found that snow and severe cold negatively affect traffic volume, particularly for discretionary trips and on long-distance rural roads. The physical state of roads is also adversely affected by climate. Weather conditions such as freeze-thaw in the winter and hot summer temperatures deteriorate roads and require ongoing maintenance (Bristow and Gill 2011).

Railroad

Railway companies operate on privately owned and financed tracks (Forkenbrock 2001, Mongeau 2014). This private network, according to Mongeau (2014), is unique to rail companies because trucks operate on taxpayer-funded roads. Freight trucks receive indirect subsidies because they operate on roads paid for and maintained by the government. The freight truck industry pays taxes to the government for the use of roads. However, according to Forkenbrock (2001), freight trucks "significantly underpay for their use of public roads" (334), meaning that the damage on roads by freight trucks and subsequent maintenance costs are greater than the fees paid by the trucking industry.

The railroad offers several advantages, particularly with external costs. Trains do not increase road congestion, can transport large volumes, and are one of the safest and most environmentally friendly modes of transportation (FindLaw UK 2012). According to Levinson (1996), railway benefits from the economies of scale, meaning a high number of users or freight results in a lower cost per unit or passenger. A 2017 study by Jones and Rosenberg compared the potential of developing air or road transportation options for remote communities in Northern Manitoba as an alternative to the current railroad service. The study showed that rail services generally operate at a high cost and return low revenue. The cost of operating locomotives and maintaining the tracks is high. To offset the operating cost, a company must either charge high service fees (which are not beneficial to consumers) or have a high volume of freight or passengers. In their study, Jones and Rosenberg found the overall passenger loads were very low, below 20 per cent of capacity. Consequently, to be successful, shipping by rail requires large volumes and is mostly used by larger companies because the volumes required to achieve competitive rates are not possible for smaller companies that ship fewer goods (Drake 2013). Rail freight is often used for transporting high-volume goods and products such as metallic minerals (copper, nickel, and zinc), grain from the Prairies, and lumber (Drake 2013). Jones and Rosenberg (2017) also state that the main advantages of rail are in areas where the tracks are already built and the initial infrastructure investment has already been made.

The disadvantage of railroads is that they are inflexible. The flow of goods/people is restricted to the tracks (limited route) and schedule. The tracks are only used by trains, and they are largely unused, especially in areas of low service (Levinson 1996). Furthermore, another transportation mode is required to transport the goods to and from the station yard.

For passenger rail service, the reliability of trains is particularly weak. Studies by Vansteenwegen and Oudheusden (2007) and Grengs, Hu and Weitz (2009) emphasize the importance of time to rail users. Vansteenwegen and Oudheusden (2007) state that a "train operating on schedule is an important factor for successful passenger service." Meanwhile, Grengs, Hu and Weitz (2009) found that rail passengers were willing to pay higher rates if the train met their individual schedules and provided greater comfort. The report by Grengs, Hu and Weitz also found that travel time reliability was the most suggested element to improve service.

Air

The advantage of air transportation is speed. Compared to other transportation methods, air transportation allows users to travel greater distances in less time, thereby reducing overall travel time. According to Levinson (1996) and Jones and Rosenberg (2017), the airplane is the fastest transportation mode when not including access time, delays or cancellations during inclement weather. Air transportation is advantageous for remote northern communities in terms of infrastructure cost, where the cost and effort to construct, operate and maintain low-traffic all-weather roads or railways are not viable (Metrass-Mendes, de Neufville and Costa 2011). The infrastructure cost is low because an airport only requires a basic runway (grass or gravel), minimal buildings (hangar, terminal) and supplies (fuel). Once the airport is constructed, an aircraft is flexible to travel between any other airports within the aircraft's range.

Jones and Rosenberg (2017) state that air services are an attractive option when it comes to moving people but operating costs are much higher for freight. Nonetheless, the speed of airplanes is attractive for freight. According to Febbraro and Mitchell (2006), in the United States, the volume of cargo by all-cargo airlines grew by 10 per cent annually between 1991 and 1996, and the authors expect greater growth in the future. The reason discussed by Febbraro and Mitchell (2006) is the trade volume from Asia is on the rise, and air cargo offers the potential to create new transportation options and routes.

While the potential for air cargo continues to grow, air cargo remains limited in scope as an airplane is not equipped to transport all goods (FindLaw UK 2012). Aircraft are designed with certain limitations, such as size and weight, and certain materials could be too large to fit on the aircraft. Meanwhile, an aircraft cannot fly with cargo above its designed maximum weight capabilities. For example, aircraft can transport low-volume outputs of gold mines but cannot be used for the high volume and high weight of base metals such as copper or nickel. Subsequently, Drake (2013) suggests that the small volumes easily transported by airplanes make them useful for niche and/or high-tech markets. Another limitation discussed by Levinson (1996) is the high carrier cost of air travel because of the high purchase price of an airplane and the amount of energy required to keep it airborne. The transportation mode can also be restricted to a schedule and frequency of service, especially for commercial passenger service.

Sea

The major advantage of sea transport is that it is inexpensive to transport a large volume of goods. It is largely used to transport goods over long distances. The disadvantages of the mode are that it is very slow, restricted to waterways, and there are relatively few ports. Ports require specific environmental conditions such as deep water to accommodate larger ships. In Northern Ontario, with its proximity to large bodies of water (Lake Superior, Lake Huron, Hudson Bay and James Bay), the Port of Thunder Bay is the only one that is currently a member of the Canada Port Authorities (CPA). Transporting goods by sea is also dependent on other transportation modes to get the product to and from the port. Currently, the trend in transporting freight by sea is the use of shipping containers because these containers are easily transferrable between different transportation modes (Febbraro and Mitchell 2006). This trend of transferring freight from one transportation method to another (e.g. from ship transport to road transport or rail transport to road transport) is defined by Febbraro and Mitchell (2006) as transshipment or intermodal freight transport. In Canada, the destination of shipping containers is in transportation hubs largely located along coastal regions such as Vancouver, Montreal, Prince Rupert, Halifax, and Saint John (Statistics Canada 2015). The lack of rail/road intermodal facilities in Northern Ontario prevents the large-scale use of these shipping containers (Drake 2013).

Social Impacts of Transportation Infrastructure

Transportation infrastructure plays an important economic role by strengthening regional and global connections, providing access to natural resources, and providing commercial opportunities. However, transportation infrastructure also plays an integral part in the social well-being of a region. People use the transportation network to perform daily tasks such as commuting (work or education), accessing basic necessities (shopping), services, health care and recreational activities. According to Bristow and Gill (2011), transportation linkages are vital to a community's identity, while the lack of mobility has negative consequences. The concept of social exclusion is discussed by Litman (2003) and is defined as the inability to participate in adequate activities. The inability to perform or access basic activities results in isolation, which has negative social impacts on an individual or community. These negative impacts include higher unemployment rates, lower salaries, higher transportation costs, and longer travel distances (Litman 2003). According to Litman (2003), northern communities are particularly vulnerable due to geographic isolation and severe winters.

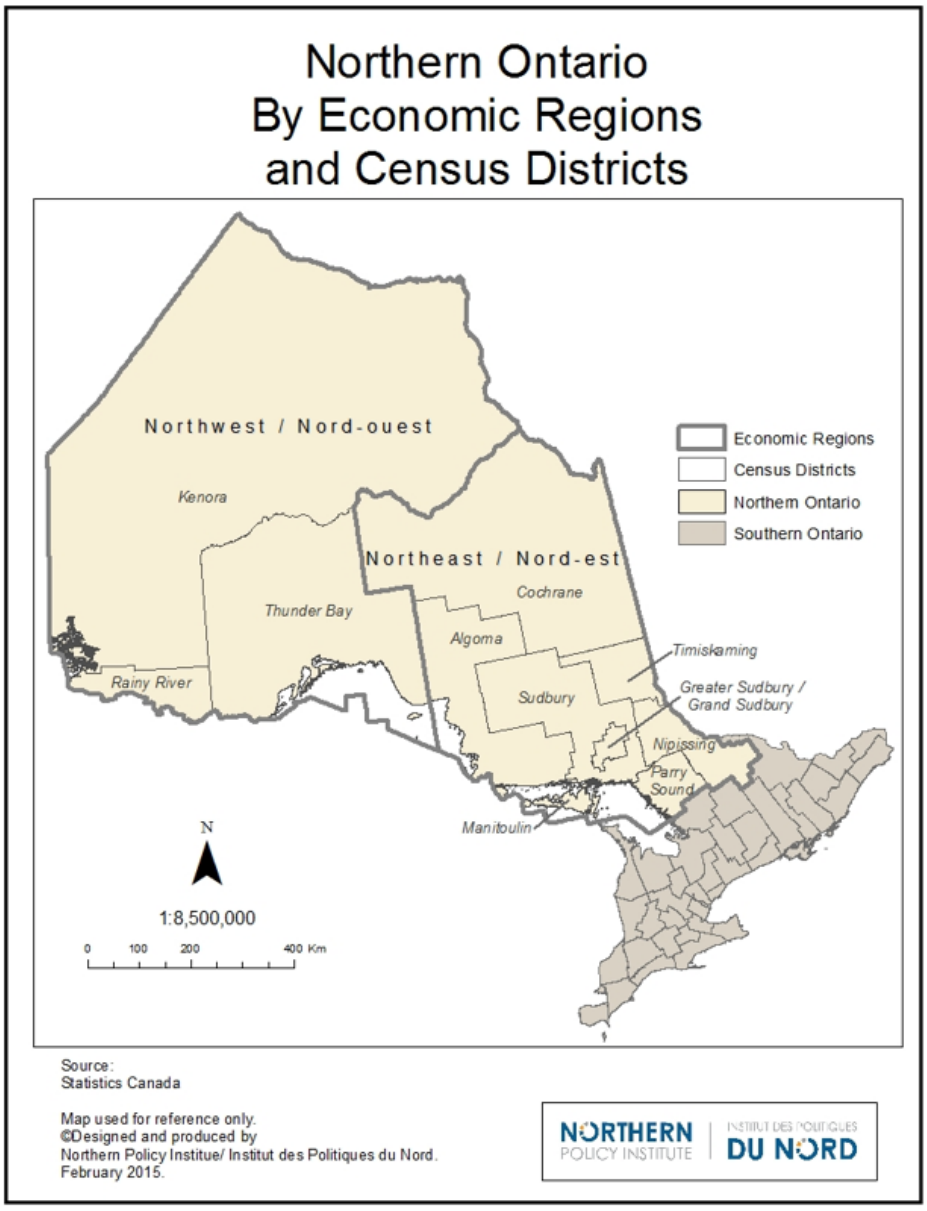
The Challenges of Transportation Infrastructure in Northern Ontario

Transportation infrastructure plays an integral role in the prosperity of Northern Ontario because it links communities and is essential for transporting products and people between destinations. Transportation infrastructure also allows access to the region's vast natural resources, such as mining and forestry. These resources are often located in remote communities and areas[1]. The Growth Plan for Northern Ontario recognizes the importance of transportation infrastructure to the well-being of the region:

> *"Efficient, modern infrastructure is critical to Northern Ontario's future. Transportation, education, health, energy, water and wastewater infrastructure, information and communications technology and community infrastructure are the building blocks for economic growth." (Government of Ontario 2011, 31)*

Northern Ontario is defined in the Growth Plan for Northern Ontario as the District of Nipissing, Parry Sound, Sudbury, Greater Sudbury, Temiskaming, Cochrane, Algoma, Manitoulin, Thunder Bay, Rainy River and Kenora (see Map 1). Northern Ontario is constrained by its spatial geography and low population density. The region covers 800,000 square kilometres and has a population of approximately 775,000 people. For this reason, it is difficult to efficiently connect the region due to the long distances between urban centres and low traffic volume. The Northern Highways Program 2012-2016 states that Northern Ontario has nearly 11,000 kilometres of Ontario's 16,600 kilometres of provincial highway system (Ministry of Northern Development and Mines Ontario 2012). The Study of Municipal Airports in Ontario highlights an example of the greater travel distance between activities in Northern Ontario and found that the distance between airports in the North is nearly double that of Southern Ontario (79 km vs 44 km) (Sypher 2006).

Map 1. Northern Ontario



[1] Musselwhite Mine and Victor Diamond Mine are located in the Far North. Other mines such as Detour Lake Gold Mine, Hemlo Mine and Lac des Iles Mine are located in remote locations.

The terrain also creates challenges for the region. The terrain is characterized as rugged, with environmentally sensitive areas that decrease accessibility to certain regions of the province. According to the Highway 69 Action Plan, because of Northern Ontario's geography, the estimated cost to four-lane Highway 69 will be roughly $6.5 million per kilometre. Meanwhile, in Saskatchewan, the construction cost was only between $1 million and $1.5 million per kilometre (Government of Ontario 2005).

Northern Ontario also has extreme weather conditions that can disrupt and damage the transportation infrastructure. The southern part of the region has a continental climate with long, cold winters and short summers. The northern part of the region has a subarctic climate, resulting in severely cold winters and short cool summers. The weather in the region is also influenced by its proximity to the Great Lakes, which creates extreme weather variation, not only seasonally but in some cases daily, creating harsh weather conditions, especially during the winter. Winters in Northern Ontario are characterized by extremely cold temperatures and heavy snowfalls, which can cause travel disruptions such as delays or cancellations, creating a negative impact on traffic volume (Datla and Sharma 2008, Datla et al. 2013). According to Datla et al. (2013), a snowfall of around 10 centimetres reduces traffic volume by 7 per cent to 17 per cent, and a snowstorm reduces traffic by 21 per cent to 51 per cent[2]. The study by Datla et al. (2013) also demonstrates that the impact of extreme weather is much greater for discretionary or recreational trips on more rural roads away from populated centres. Datla et al. (2013) found that cold weather reduces the traffic volume on recreational roads from 0 per cent to 31 per cent during the weekend compared to a reduction of 0 per cent to 14 per cent for weekday activities on commuter roads. This is mainly determined by the purpose of the trip and the risk associated with it. Traffic for work purposes is deemed "necessary," whereas discretionary trips are classified as "optional" and can be rescheduled. Shorter trips in more urban areas are considered safer compared to long-distance trips in more rural areas (Datla et al. 2013).

Northern Ontario is also affected by climate change. The change in climate has resulted in a rise in extreme weather events. The region has experienced an increase in temperature, precipitation, and intense storms (Ontario Centre for Climate Impacts and Adaption Resources 2010), and the resulting conditions have had a negative impact on the transportation infrastructure. Extreme precipitation and intense storms cause flooding and wash out roads (Bristow and Gill 2011, Ontario Centre for Climate Impacts and Adaption Resources 2013), which can result in millions of dollars in damages and repairs. In 2012, heavy rain caused flooding that washed away a section of Highway 17 near Wawa, forcing cross-provincial drivers to detour either by Highway 11 or through the United States (Kelly 2012). A trip between Thunder Bay and Sault Ste. Marie is around 700 km, a detour through the United States is 1,000 km (and two border crossings), and the Ontario alternative by Highway 11 is over 1,200 km.

The rise in temperature can also impact the condition of infrastructure. The occurrence of freeze-thaw cycles during the winter has increased. Freeze-thaw cycles and hotter summer temperatures deteriorate roads and increase the amount of maintenance required (Bristow and Gill 2011). Higher winter temperatures can also thaw the permafrost, damaging the foundation of roads, rail lines, and runways (Bristow and Gill 2011). These warmer winter temperatures shorten the season for winter roads, which are essential for many northern communities to access necessities, and services and facilitate the flow of residents. Winter roads provide connections to other communities, which reduces social isolation and allows residents to participate in cultural activities (Bristow and Gill 2011).

These disruptions are not isolated to roads. Jones and Rosenberg (2017) state that aircraft are also susceptible to cancellations during bad weather. Jenelius (2009) believes that these disruptions in the transportation network cause considerable economic and social strains due to delayed deliveries or increased time away from home. The lack of reliable transportation limits the opportunity for economic development as it is harder to transport the required material in and out of a community (Bristow and Gill 2011).

Warmer winter temperatures, on the other hand, could potentially have a positive effect on sea shipping. Warmer temperature lengthens the shipping season as the waters are free of ice for a longer period. The increase in temperature also opens up the possibility of shipping lanes in the Arctic Ocean. Reduced ice in the Artic could, according to Bristow and Gill (2011), lead to

[2] Snowfall of 30 cm or above.

"shorter and more efficient marine routes between North America, Asia, and Europe" (ii). The warmer temperature and greater Arctic access are not without risks. The Arctic Ocean is an environmentally sensitive area with a variety of navigation hazards, such as icebergs (Bristow and Gill 2011). Climate change is also a potential factor in decreasing water levels in the Great Lakes (The Globe and Mail 2014). Continually dropping water levels threatens the viability of the Great Lakes\St. Lawrence Seaway. The Mowat Centre estimates a direct economic impact of $18.8 billion by 2050 if water levels continue to decrease in the Great Lakes (Shlozberg, Dorling and Spiro 2014).

Furthermore, Northern Ontario, as part of the province of Ontario, is subject to intra-province politics and decisions and must adhere to decisions made by the Ontario Government. Despite its large geographic area and large transportation infrastructure requirements, Northern Ontario only accounts for about 6 per cent of the province's total population (Northern Ontario has a population of 775,178 compared to 12,851,821 for Ontario) (Statistics Canada, 2012). The decisions made by the provincial government are in response to this population difference and the necessities of the entire province. Regardless, critics believe that the decisions made in Queen's Park do not always suit the needs of Northern Ontarians.

The Ontario Government announced in April 2014 that it was investing nearly $29 billion over the next ten years in public transit and roads to modernize transportation infrastructure (Government of Ontario 2014a). Of the $29 billion investment, $15 billion is allocated for the Greater Toronto and Hamilton Area (GTHA)alone, whereas the remaining $14 billion is for the rest of the province. In addition, the Province announced on April 30, 2014, plans to construct a high-speed rail that will connect London via Kitchener-Waterloo to Toronto (Government of Ontario 2014c). In Northern Ontario, however, the Ontario Government completely cut the Northlander, Ontario Northland's passenger rail service between Toronto and Cochrane. Thus, on September 28, 2012, the Ontario Northlander made its last voyage.

The Ring of Fire is an important economic development opportunity in Northern Ontario that requires major transportation infrastructure investment. Located in the Hudson Bay Lowland, approximately 500 km northeast of Thunder Bay and 350 km west of James Bay, the site requires a transportation infrastructure to move a large volume of base metals. However, the development project faces all of the challenges outlined above; long distances, difficult terrain, harsh weather, and a tentative provincial government.[3]

Road Network

The road network is the most extensively used transportation infrastructure in Northern Ontario, being the principal transportation mode for personal use and most industries. According to Drake (2013), the road network was the most important transportation infrastructure for mining, forestry, agriculture, manufacturing, and tourism. For mining, roads and trucks are the main transportation mode to move inputs and outputs for base metals. Roads were used to transport roughly 90 per cent of aggregate material within 100 km of the quarry (Drake 2013). In forestry, they are used to transport wood from the logging sites to processing facilities, in addition to transporting the finished product to consumers. Roads are the primary transportation option for the agriculture sector, as the majority of goods are moved by trucks along highways (Drake 2013). Accordingly, improving the road network was found by Drake (2013) and Dirks (2013) to be a top priority, with some of the suggested improvements being: additional passing lanes or four-laning or twinning, in particular Highway 11, Highway 17, Highway 69, and Highway 11/17, increase road maintenance, construction of all-season roads to replace winter roads, and more rest stops along Highway 17 and Highway 11 to ensure drivers are well-rested (Dirks 2013). In 2013/2014, the Ontario Government invested $513 million into the expansion and maintenance of Northern Ontario highways (Ministry of Northern Development and Mines 2013). Currently, highway investment projects include the four-lane widening of Highway 69 between Sudbury and Parry Sound, Highway 11 to North Bay, and the four-lane widening of Highway 11/17 between Thunder Bay and Nipigon in Northwestern Ontario (Ministry of Northern Development and Mines 2012).

Dirks (2013) also found that for large urban centres, inner-city traffic and congestion also need to be addressed, most notably in Greater Sudbury, where there is heavy transport truck traffic (Dirks 2013, Drake 2013). According to a 2005 Greater Sudbury Transportation Study Report, trucking is an "efficient and cost-effective means of moving goods within Sudbury" (Earth Tech 2005, 40). However, the high number of trucks within an urban setting is a contributing factor to urban congestion, especially on routes with signalized intersections, because of the time required to accelerate (Earth Tech 2005). Trucks also have a negative impact on safety because they require more room to operate. The lack of maneuverability can frustrate automobile and truck drivers, which can result in collisions (Earth Tech 2005). The use of trucks also increases the rate of pavement degradation, causing higher maintenance costs (Earth Tech 2005).

[3] Peat lands and marshes cover much of the area, which makes the site difficult to access.

Dirks (2013) suggested that improvement to local transit service within cities is required to respond to the aging population. Northern Ontario has numerous small and rural communities, and these communities have a higher proportion of elderly residents (Noxon Associates Limited 2009). Seniors who may no longer drive still need to accomplish various tasks such as shopping, social engagement, and access to medical care. Young people who cannot drive or afford a car may overcome the lack of transportation options by moving to urban centres (Noxon Associates Limited 2009). The recent trend in the urban landscape of "big box" stores and "power centres" is also having a damaging impact on the traditional village core. The village core, with its cluster of businesses, shops, and housing, was designed for walking and could serve as a hub for public transit services. New retail activity on the outskirts of urban areas, however, deteriorates small village cores (Noxon Associates Limited 2009). For example, Costco located its Greater Sudbury store on the eastern edge of the city in hopes of attracting people from nearby communities such as North Bay, Temiskaming Shore, Sturgeon Falls, Verner, and Markstay-Warren. Accessibility and connection to larger urban centres is an issue for smaller communities (Dirks 2013), as seen in Greater Sudbury.

For some isolated communities and resource projects in Northern Ontario, winter and ice roads create connections to the "outside world" and establish links for the transportation of supplies. For an isolated community, winter and ice roads could be the only connections it has with the rest of the province. With the consequences of climate change, such as warmer temperatures and shorter seasons, freeze-thaw cycles, and extreme storms, winter roads are no longer reliable for First Nations and industries. The importance of reliable all-season roads was the top priority for First Nations and Métis encountered by Dirks (2013). The upgrade of winter roads to all-season roads was also a recommendation made by several industry sectors, including mining, forestry, and even tourism. The mining and forestry sectors stated that the lack of reliable roads negatively impacts access to resource sites. Shorter seasons for winter roads reduced access to northern forest stands and diminished the forestry harvest season (Ontario Centre for Climate Impacts and Adaption Resources 2011). Northern communities, such as Hearst, Kapuskasing, and Smooth Rock Falls, have experienced a decline in their economic output as warmer temperatures have shortened the forestry and tourism seasons (Ontario Centre for Climate Impacts and Adaption Resources 2011). The lack of dependable access acts as a barrier to economic opportunities, development, and growth (Bristow and Gill 2011).

Railways

The railway is in a state of decline in Northern Ontario as the federal and provincial governments have reduced funds for passenger rail and freight providers such as Canadian National Railway (CN). As well, the Canadian Pacific Railway (CP) has decreased the number of rail lines. In 2012, the Ontario Government announced that it would privatize Ontario Northland Transportation Commission (ONTC) (Ministry of Energy, Northern Development and Mines 2012). The result of the decisions was the end of the ONTC passenger rail service between Toronto and Cochrane. The Ontario Government's decision was based on dwindling ridership, high operating costs, and the need to eliminate a $15 billion deficit (Ferguson 2012). However, critics argue that this decision will only have a negative impact on the well-being of Northern Ontarians and the economy. The passenger service offered higher comfort than the motorcoach service, which was favourable for long-distance travel to Toronto. The tentative plan to privatize may also have a negative impact on Northern Ontario's economy because companies have concerns that the uncertainty of the long-term state of the railway will create problems with shipping goods (Drake 2013). This uncertainty has resulted in the inability to make long-term decisions concerning the transportation of their inputs and outputs. In 2014, The Ontario Government relieved some of those uncertainties when they announced that they would continue to operate ONTC. However, in October 2014, ONTC CEO, Paul Goulet, announced that he was stepping down, stating that the "transformation is going to take a long time" (Hamilton-McCharles 2014).

The Algoma Central Railway (ACR), a passenger rail subsidiary of CN, is also in a state of uncertainty. In January 2014, CN announced that federal funding for the passenger service was cut, and as a result, CN would cease ACR as of April 2014. In the same month, Transport Canada announced that the federal government would extend the funding until March 2015. This extension, according to the federal Transport Minister, is "for local stakeholders to come together and figure out a long-term solution" rather than depending on the government for annual support (Kelly 2014). The CN and ACR Passenger Service Working Group are currently receiving formal bids for a company to operate the Algoma Central Railway passenger service (Soo Today 2014).

Private rail freight companies are also reducing their service in Northern Ontario. Canadian National Railway closed several sections of track in Northern Ontario. In 1986, CN abandoned a section of track between Nakina and Calstock, followed by their Ottawa Valley tracks in 1995, and in 1997, tracks between Cochrane and La Serre Québec. In 2010, the CP stopped its service along the Ottawa Valley corridor and is currently removing its

tracks between Mattawa and Smith Falls. CN and CP are now directing all their trains to/from the east through Toronto, increasing the traffic on the busy Southern Ontario network. Diverting all rail traffic through their Toronto rail lines will, according to Chase (2012), result in further congestion in the corridor and worsen the conditions of the corridor if the economy picks up and traffic increases. Gormick (2014) believes that the rise in rail traffic along a single corridor "increases the safety risks," especially with hazardous and volatile materials such as crude oil and ethanol carried by rail. The CN and CP Toronto-Montréal corridor is also the location of numerous Via Rail and GO Transit passenger trains. Thus, the rail lines travel through highly populated areas, which increases safety risks.

The decline of rail service, most notably by CN and CP in Northern Ontario and throughout Canada, is a concern for industry and companies that employ the "just in time" strategy. Industries are increasingly reliant on "on-time" performance. However, the closure of rail lines, particularly in the Ottawa Valley, and the redirecting of all trans-Canada traffic through Toronto has increased travel duration and decreased the efficiency of rail transportation (Gormick 2014). The reduction of rail lines also reduces the reliability of the service, as rail companies are reducing the number of alternate routes available in the case of a disruption. When the January 2014 Plaster Rock, New Brunswick train derailment closed a rail artery, CN was able to reroute their traffic on alternate routes (Gormick 2014). However, even CN does not realize the strategic value of alternate routes because, as noted by Gormick (2014), CN is closing this New Brunswick artery.

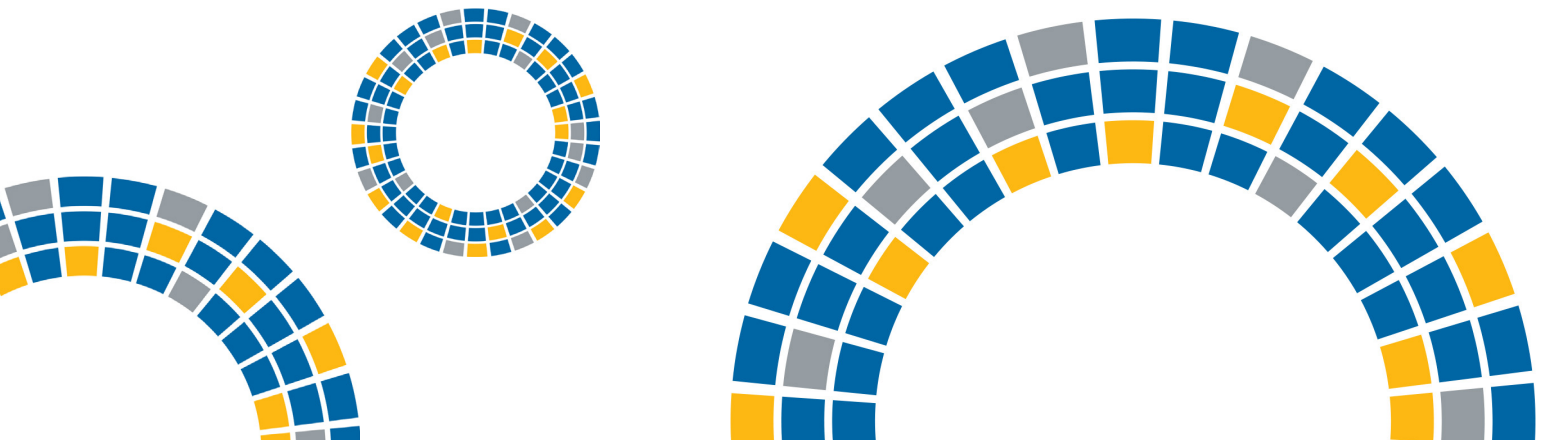
Dirks' (2013) discussions with municipal and industry stakeholders found that upgrading the rail freight service is a priority to improve the Northern Ontario economy. The stakeholders offered numerous suggestions on how rail freight could be improved. These suggestions included examining ONTC service to address the rail shipping rates and tracks restrictions, addressing the availability of freight rail cars, and establishing coordination between different transportation methods (rail, road, air, and marine) (Dirks 2013).

Air Transportation

Air transportation is important for many small remote communities. Given the large geographic area of Northern Ontario, along with the low population density and spatial distribution of communities, it is unrealistic to service every community using land transportation infrastructures such as roads or railways. The complete cost of building, operating, and maintaining low traffic density of all-weather roads or railways is considerable and is not possible given the resources available. The region is also challenged by harsh climate conditions and environmentally sensitive areas that are not suitable for building (Metrass-Mendes, de Neufville and Costa 2011). According to Metrass-Mendes, de Neufville and Costa (2011), air transportation "is the most efficient and economic means" to provide access and reduce the impact of isolation for remote communities due to the low infrastructure cost and the ability to provide service year-round (Metrass-Mendes, de Neufville and Costa 2011). In addition, Jones and Rosenberg (2017) state that air access provides lower travel times and a higher frequency of service for isolated communities compared to land infrastructure.

Air travel increases the mobility of people, the availability of goods and products, as well as access to core services such as health care and fire protection for remote communities without road access. Municipal leaders from Northern Ontario communities believe that an airport is a key component for attracting new economic activities (Sypher 2006). Air transportation has also become increasingly important for resource development and industry. Air transportation is not only used in the early stages of mines (Drake 2013) but also used to transport workers to and from the site (fly-in/fly-out [FIFO]) (Meredith, Rush and Robinson 2014, Millette 2014). Fly-in/fly-out is defined by Storey (2001) as follows:

> *"Fly-in/fly-out mining operations are those which involve work in relatively remote locations where food and lodging accommodation is provided for workers at the worksite but not for their families. Schedules are established whereby employees spend a fixed number of days working at the site, followed by a fixed number of days at home"* (Storey 2001, 135).



In remote northern areas, FIFO is used throughout the entire lifespan of the mine. De Beers' Victor Mine, located in the James Bay Lowlands, is a fly-in/fly-out operation and is expected to continue for the entire 12-year life span of the mine (De Beers 2009). Aircraft give employees working in remote locations the ability to travel home to their families relatively quickly (Gill and Raynor 2013). Aircraft are also used to transport materials such as some precious metals (gold) and non-metallic minerals (diamonds) from the mines (Drake 2013).

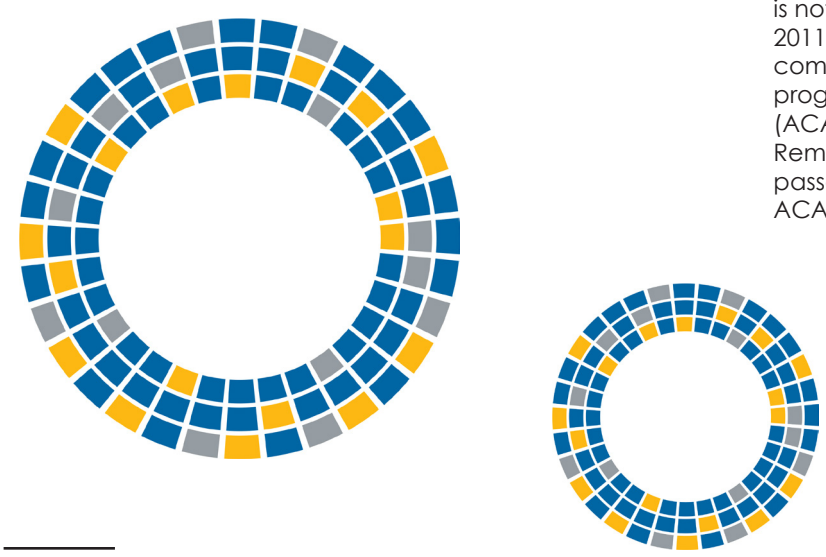
Air transportation and airports are also used to provide access to services like health care. Health Canada was described by Metrass-Mendes, de Neufville and Costa (2011) to have a significant role in air service for remote communities because the Canada Health Act guarantees equal access to health services. Therefore, in communities with no transportation alternative, scheduled flights, charter flights, helicopters, air ambulances, and Medavac are available to guarantee health care services in a timely manner (Metrass-Mendes, de Neufville and Costa 2011). Ontario has the largest air ambulance program in North America, according to the Study of Municipal Airports in Ontario (Sypher 2006). The study states that air ambulance is an essential service for northern and remote communities, and its importance is expected to increase as the health care system moves towards a regional/centralized approach. Additionally, the Ministry of Natural Resources (MNR) is also dependent on aviation for its Forest Fire Management (Sypher 2006). The MNR requires airports to pick up / drop off crews and supplies and to re-fuel. In order to provide an effective response to forest fires, an airport located within 200 km for helicopters and 320 km for water bombers is desired by the MNR (Sypher 2006). Airports also support police services such as the Ontario Provincial Police and the Royal Canadian Mounted Police for emergency response, search and rescue, and surveillance.

In Canada, airports were once public institutions, and airline companies were greatly regulated. However, since the late 1980s and early 1990s, there has been a movement towards deregulation and decentralization in an effort to improve air transportation and make it financially self-sustaining. In 1988, the privatization and deregulation of Canada's major airlines began (Gill and Raynor 2013), followed by the National Airports Policy (NAP) in 1994. Transport Canada created the National Airports Policy to decentralize and privatize airport operations (Sypher 2006, Metrass-Mendes, de Neufville and Costa 2011). The NAP classified the airports into five categories:

1. National Airports System
2. Regional/local airports[4]
3. Small airports[5]
4. Remote airports
5. Arctic airports[6]

The objective of the NAP is to transfer ownership and operation to local authorities and gradually phase out operating subsidies (Sypher 2006), with the goal of providing better service by allowing local authorities the ability to adapt operations to fulfill specific local needs. The adoption of the NAP placed the decision-making process with air carriers, air navigation systems operators, and airports (Gill and Raynor 2013). The consequence, however, was increased user fees, as users were expected to cover the full cost of airport operations.

Due to the importance of air transportation for remote and isolated communities, the NAP and Canada's airport policy have not neglected airports where self-sufficiency is not possible (Metrass-Mendes, de Neufville and Costa 2011). Transport Canada retains ownership of many small community airports and provides financial assistance programs such as the Airport Capital Assistance Program (ACAP) (Metrass-Mendes, de Neufville and Costa 2011). Remote airports are not subject to meet the minimum passenger requirement and automatically qualify for ACAP.



[4] Regional/local airports: service under 200,000 passengers per year.
[5] Small airports do not have scheduled air service.
[6] Remote and arctic airports provide the only year-round transportation link for an isolated community (Metrass-Mendes, de Neufville and Costa 2011).

With the operational transfer to local authorities, the objective was to improve local services. However, the outcome has been debated. Sypher (2006) stated that decentralization had a "neutral to negative impact," and Metrass-Mendes, de Neufville and Costa (2011) state that they found "insufficient evidence" to indicate "efficiency gains." Their reasons included; insufficient funds, lack of skilled or knowledgeable personnel, and intermodal competition. Meanwhile, Gill and Raynor (2013) believe that decentralization has had a favourable impact on airports.

Sypher's (2006) study found that Ontario's municipal airports are suffering financially. The Study of Municipal Airports in Ontario found that 60 per cent of northern airports that responded to its survey could not cover their operating costs. Financial viability and a lack of funding were cited by airport managers as the primary issues facing their airports (Sypher 2006). While the current state of airport infrastructure is believed to be in fair to good condition, the lack of funds is the primary constraint to maintaining or upgrading aging or inappropriately sized infrastructure (Sypher 2006).

According to Sypher (2006), 80 per cent of Ontario's municipal airports are not eligible for ACAP funding. ACAP is only eligible for airports with scheduled commercial passenger service and which have above 1,000 or below 200,000 annual passengers. The federal government also provides funds to Northern Ontario airports through FedNor. Meanwhile, the Ontario Government, through the Ministry of Transportation, currently owns and operates 29 northern (remote) airports (Sypher 2006). However, since 1998, the Province of Ontario (with the exception of Northern Ontario Heritage Fund Corporation, which does not generally fund airport projects), no longer funds municipal airports (Sypher 2006). Airports are also subject to election cycles (every four years or less), forcing airport management to re-inform and re-establish support for their airports (Sypher 2006). This re-education is particularly important for local councils that are significant contributors to the well-being of airports because they provide funds and develop economic strategies that include the airports. Some airports (but not all) paid property taxes. However, Sypher (2006) found four cases where the airport paid property taxes to a different municipality than the airport owner. In these cases, the taxes paid are not being re-invested in the airports.

Map 2. Location of Eligible ACAP-Funded Municipal Airports in Ontario

Source: Study of Municipal Airports in Ontario (Sypher 2006).

With decentralization, airports are also burdened by safety and security responsibilities (Metrass-Mendes, de Neufville and Costa 2011). In Canada, air transportation security is completely funded by users. However, air travel security is recognized as a matter of national security, and critics argue that security and safety funding should come from other sources (Gill and Raynor 2013).

Airports are largely dependent on funds raised through commercial airliners and private sector contributions. Airports are resorting to creative methods to increase revenue, including selling or leasing under-utilized land for industrial, agricultural, or recreational activities (Sypher 2006).

The Study of Municipal Airports in Ontario argues that most airports have streamlined their operations and cut their operating budgets as much as possible. Airports are staffed at minimum levels, the average number of full-time employees for northern airports was 5.05, and some airports do not have any full-time dedicated staff (Sypher 2006). Metrass-Mendes, de Neufville and Costa's (2011) study of 11 remote and Arctic Canadian airports found the lack of knowledgeable employees in the airport industry was hindering efficiency improvements. Financial strains on airports have led to a trend of decertification, according to Sypher (2006). De-certification reduces the airports' standards and operating procedures because there are fewer regulations and inspections by Transport Canada. This trend is a concern for users (pilots and passengers) as the operational and infrastructure standards are lower and inconsistent between airports.

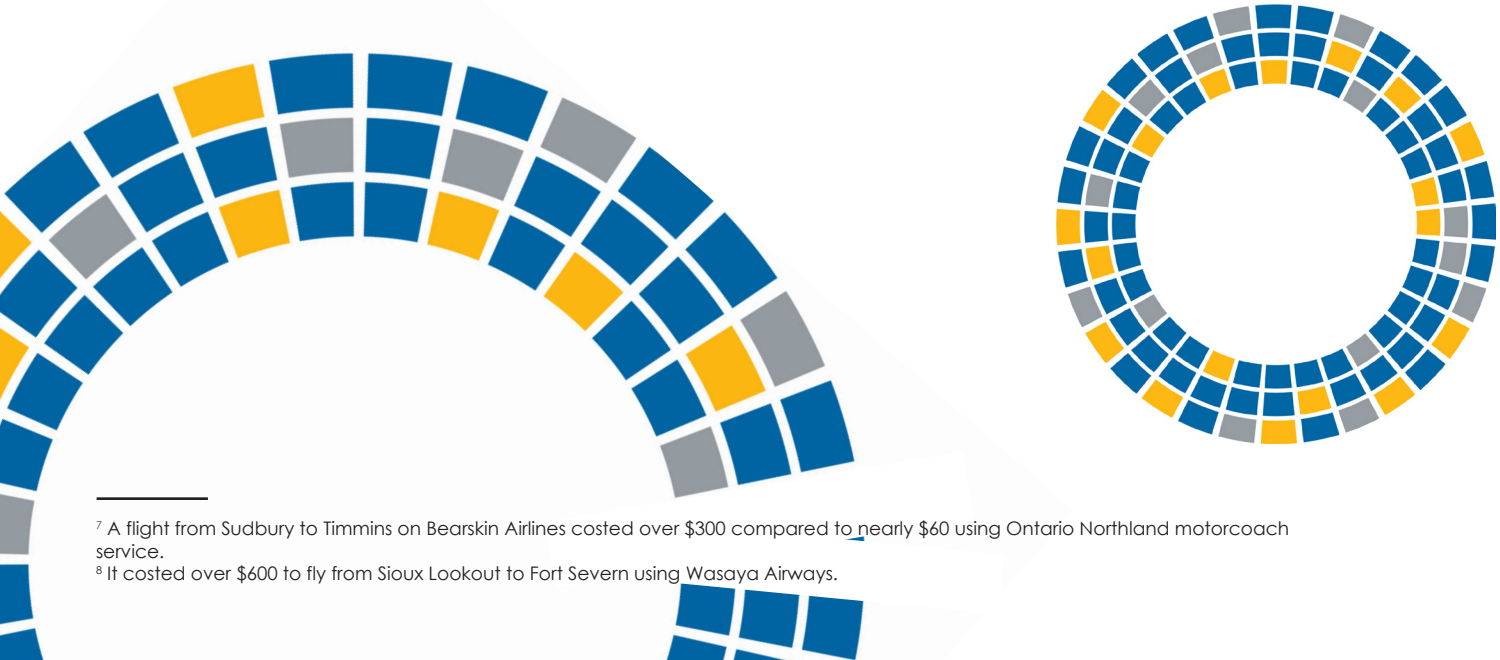
With the exception of some remote and isolated communities, air transportation is not the only transportation mode available. Most communities are serviced by multiple transportation modes or, at the very least, have road access. The study by Metrass-Mendes, de Neufville and Costa (2011) suggests that intermodal competition is a factor hindering the well-being of airports. A respondent to their survey stated, "it is cheaper to drive than to fly" (Metrass-Mendes, de Neufville and Costa 2011, 16). According to Drake (2013), airfares for Northern Ontarians remain high.[7] Dirks (2013) also found that First Nations and Métis thought air travel in Northern Ontario was too expensive.[8]

Not all research suggests that decentralization and privatization of Canadian airports have been negative. For example, Gill and Raynor (2013) found it to be "very positive," arguing that airports have gone from "money-loser to money maker for governments" (Gill and Raynor 2013, 44). The previous centralized approach operated on a "one size fits all" system. However, airports fulfill a different role in each community. Policies and regulations that might be efficient for one airport may not be efficient for another airport. It is unrealistic for larger airports to operate to the same standard and regulations as small airports. A centralized system was burdensome and slow to respond to market changes because decisions and investments were subject to political initiatives and government budget cycles (Gill Raynor 2013). Gill and Raynor (2013) believe that decentralization allows airports to "become more productive and responsive to demand" (Gill and Raynor 2013, 44). Local airport authorities are directly related to their users, which allows airports to customize their services in response to the demand. Gill and Raynor (2013) found that while the management and operation of Canadian airports have improved greatly over the past 20 years, there are still improvements required. The authors acknowledge the importance of small airports to the vitality of the community but state that their sustainability is an "ongoing concern" (Gill and Raynor 2013, 46).

The current state of airport infrastructure requires upgrading, according to Sypher (2006), Dirks (2013) and Drake (2013). Sypher (2006) found that 25 of 38 airports cited "aging/deteriorating or inappropriately sized infrastructure" as a weakness. Dirks' (2013) discussions with First Nations and Métis found that they want their runways to be paved and require upgrades to navigation systems. The mining industry also wants upgrades to airport infrastructures, such as extended runways and larger warehousing facilities (Drake 2013). Some suggestions that were made in order to help fund upgrades included (Sypher 2006, Gill and Raynor 2013, Dirks 2013):

- broadening the scope of the ACAP program to include airports that do not have scheduled passenger service
- re-investing portions of the aviation fuel tax revenue
- adjusting the current federal rental formula to provide greater incentive for growth
- implementation of new federal-provincial-municipal programs

Gill and Raynor (2013) state that challenges include not only building the necessary air infrastructure (hangers, runway) in remote communities but also having adequate aircraft available. The Study of Municipal Airports in Ontario has found the same challenges to be true. The study states that much of the Air Canada fleet is not suited for northern airports because of the length and surface of the runways, and Weber (2013) adds that modern airplanes cannot land on gravel runways. Gill and Raynor (2013) state that many remote communities rely on small aircraft such as the Beechcraft 1900D, but this aircraft has been out of production for over a decade, and no suitable replacement is currently available.



[7] A flight from Sudbury to Timmins on Bearskin Airlines costed over $300 compared to nearly $60 using Ontario Northland motorcoach service.
[8] It costed over $600 to fly from Sioux Lookout to Fort Severn using Wasaya Airways.

Sea

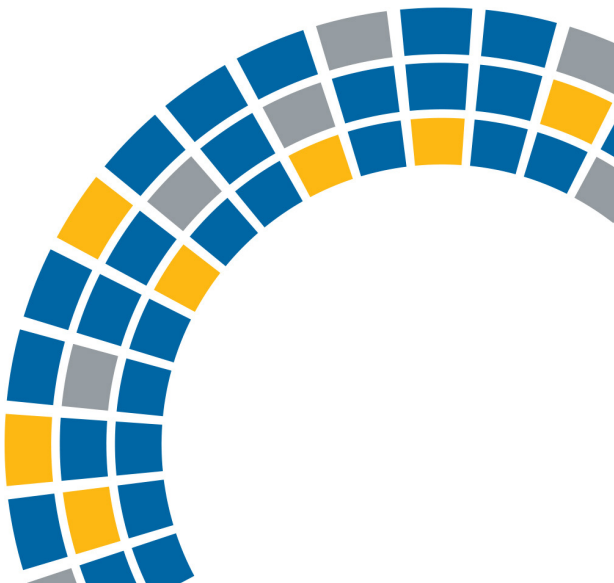
The Great Lakes-St. Lawrence Seaway is a significant link in the transportation of goods and materials. The Seaway has 15 major ports and 50 regional ports and is connected to more than 40 provincial and interstate highways and nearly 30 railway lines (Febbraro and Mitchell 2006). The Seaway allows the transportation of products within Canada (Ontario, Québec, and the Atlantic provinces), the United States, and throughout the entire world.

Seaports are used in Northern Ontario for mining, manufacturing, and agriculture. The Port of Thunder Bay is the only port authority in the region. However, there are other privately owned and operated ports. Drake (2013) shows the volume of material transported to ports in the region. The Great Lakes are used for transporting aggregates to and from Northern Ontario. Lafarge, a supplier of construction material, has several aggregate pits in Northern Ontario and uses the Great Lakes for transporting its products. Lafarge ports include Meldrum Bay on Manitoulin, which according to Drake (2013), in 2010, had the largest tonnage loaded of mining material of all Northern Ontario ports, Whitefish River, Spragge, and Heron Bay. Other aggregate ports included Badgeley Island in the Sudbury District.

The vast majority of manufacturing shipping is accomplished at Sault Ste. Marie's Essar Steel Algoma-owned port (Drake 2013). Meanwhile, virtually all agriculture shipping is located in Thunder Bay, with east-bound grain from the Prairies destined for export to foreign markets loaded in the Thunder Bay Port (Drake 2013). Febbraro and Mitchell (2006) discuss the increase of containerized cargo or shipping containers, largely from Asia-Pacific ports. The use of shipping containers to ship freight eases the ability to use a number of different transportation methods (Febbraro and Mitchell 2006). Transshipment is the shipment of products using an intermediate location before arriving at their final destinations (Febbraro and Mitchell 2006). The transportation mode often changes at an intermediate location; for example, from sea to road transport. According to Febbraro and Mitchell (2006), the Port of Vancouver, a gateway to Asia-Pacific trade, is severely backlogged with containers, which delays the transportation of goods throughout Canada. Other Canadian ports, such as the Port of Montreal, have also experienced an increase in traffic.

The Great Lakes is also an important location for tourism and recreational boating. There are many marinas in Northern Ontario, including Prince Arthur's Landing in Thunder Bay, Roberta Bondar Marina in Sault Ste. Marie, Spider Bay Marina in Little Current, Blind River Marine Park, and Big Sound Marina in Parry Sound. However, Drake (2013) suggests that "regulatory barriers" obstruct recreational cruising on the Great Lakes. The Great Lakes located on the boundary of Canada and the United States have additional security regulations to ensure lawful border crossing.

Commercial shipping, marine, and boating activities are subject to seasonal conditions. Recreational boating peaks during the summer months, and the Great Lakes - St. Lawrence Seaway System locks are available between mid-June to mid-September. Outside this time, the locks are available on a "best-effort" basis depending on the schedule of commercial ships that have priority (Great Lakes - St. Lawrence Seaway System 2014). The Great Lakes – St. Lawrence Seaway System is also generally closed to all activities from late December to late March (The St. Lawrence Seaway Management Corporation 2015).



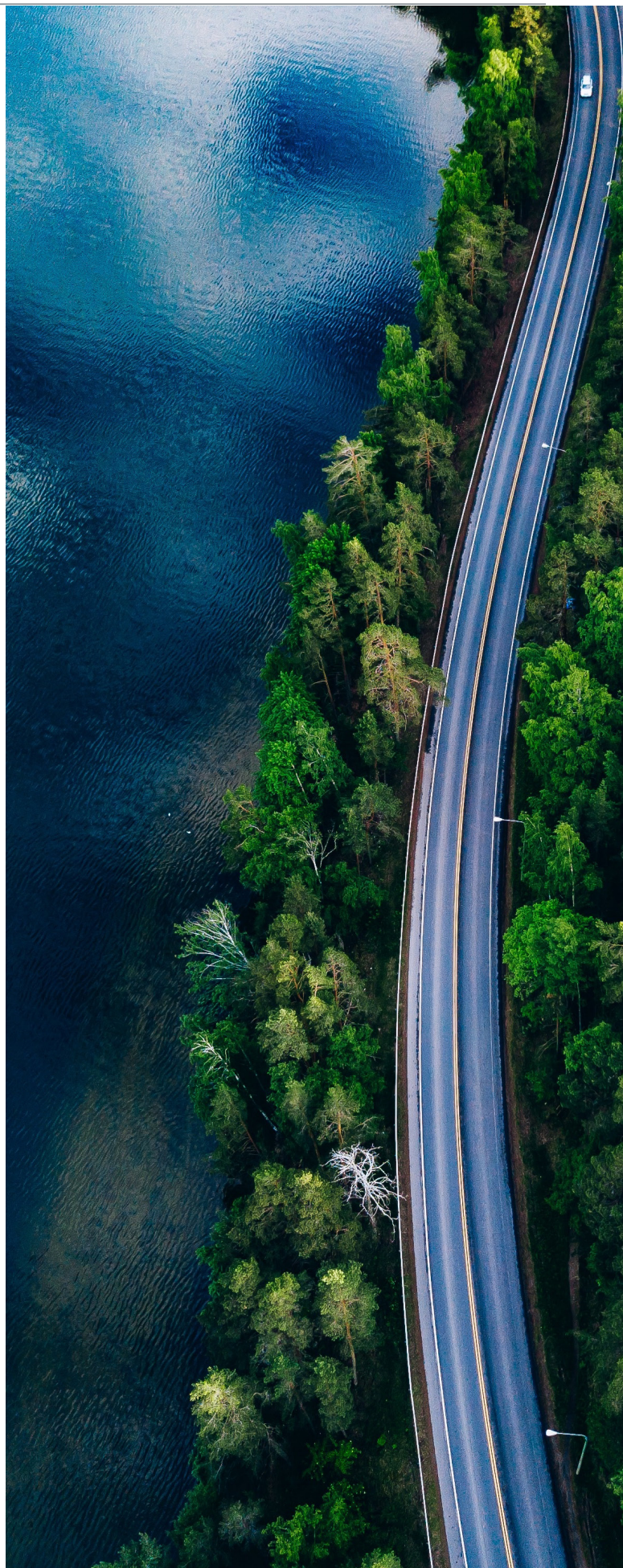
Conclusion

This paper has presented a literature review of Northern Ontario's transportation infrastructure, its issues, and its challenges. The body of literature presented in this paper indicates that the low population density of Northern Ontario, combined with its vast geography, poses challenges in providing adequate transportation infrastructure. The great distance between communities, the region's rugged terrain and extreme weather conditions decrease accessibility for all transportation infrastructure.

Other challenges are seen in the economic cost of infrastructure, which is related to limited funds for construction and maintenance. There are also social and environmental costs, for example, noise, congestion, and high CO2 emissions by vehicles that use roads and highways. Railroads present other types of costs, such as not allowing flexibility for its users on when to depart from their origin or when to arrive at their destination. Air transportation may be too monetarily costly to be attractive for freight transport. Lastly, sea transport is slow and dependent on other modes of transportation to connect goods and passengers to their destinations.

However, each transportation infrastructure also has its strengths. Roads and highways are highly versatile, allowing users to depart whenever they wish and choose their own routes. Railroads help to alleviate road congestion and are the safest and most environmentally friendly mode of transportation. Air transportation offers a fast travel time and is critical for remote communities. Lastly, sea transport is inexpensive for large volumes of goods, presenting an essential economic advantage.

Estimating these costs and advantages is relevant because transportation infrastructure is critical for Northern Ontario's economic development and social well-being. Therefore, this paper has highlighted the costs, advantages, weaknesses, and challenges of modes of transportation in Northern Ontario. This literature review will inform the next paper in this series, which will present empirical evidence and analysis of the state of transportation infrastructure in Northern Ontario



References

Agawa Canyon Tour Train. 2014. Algoma Central Railway/CN. Accessed August 27, 2014. http://agawatrain.com/content/tours/canyontour/index.html.

—. n.d. Route Map. Accessed 2015. http://agawatrain.com/content/general/route_map.html.

—. n.d. Summer Timetable. Accessed 2015. http://agawatrain.com/content/tours/passenger/summer_timetable.html.

airCreebec. n.d. Carte. Accessed 2015. http://www.aircreebec.ca/sites/AirCreebec3/images/Carte.jpg.

—. 2014. Flight Schedule. Accessed September 08, 2014. https://www.aircreebec.ca/sites/Aircreebec3/horaire_vols2011.aspx.

Airportdatabase.net. n.d. All airports. Airportdatabase.net.

Bearskin Airlines. n.d. Route Map. Accessed 2015. http://www.bearskinairlines.com/route_map.shtml.

Bird, Malcolm G. 2009. "Where is VIA Going? A Brief Analysis of a Crown Corporation." Presented at the Annual Conference of the Canadian Political Science Association, Policy Section at Carleton University, from May 27 to 29. Ottawa, Ontario. https://www.cpsa-acsp.ca/papers-2009/Bird.pdf.

Bristow, Marta, and Vijay Gill. 2011. Northern Assets: Transportation Infrastructure in Remote Communities. Ottawa, Ontario: The Conference Board of Canada. https://www.conferenceboard.ca/e-library/abstract.aspx?did=4567.

Brown, Ron. 2007. Ontario's Ghost Town Heritage. Edition 3rd. Erin, Ontario: Boston Mills Press.

Chang, Kang-tsung. 2006. Introduction to Geographic Information Systems. 3rd edition. New York: McGraw-Hill Education.

Chase, S. 2012. "The Train 'Tracks' Are Leaving the Station." The Daily Observer, July 19.

Côté, Fran. 2013. "North Working to Grow Agriculture." The Daily Press Timmins. March 21. https://www.timminspress.com/2013/03/21/north-working-to-grow-agriculture.

Cowan, Liz. 2012. "New deal and port for ONTC?" Northern Ontario Business. October 19.

Datla, Sandeep, and Satish Sharma. 2008. "Impact of Cold and Snow on Temporal and Spatial Variations of Highway Traffic Volumes." Journal of Transport Geography 16 (5): 358-372. doi:https://doi.org/10.1016/j.jtrangeo.2007.12.003.

Datla, Sandeep, Prasanta Sahu, Hyuk-Jae Roh, and Satish Sharma. 2013. "A comprehensive Analysis of the Association of Highway Traffic with Winter Weather Conditions." Procedia Social and Behavioral Sciences 104: 497-506. doi:https://doi.org/10.1016/j.sbspro.2013.11.143.

De Beers Canada. 2009. "De Beers Canada Victor Mine named 'Mine of the Year'." Media Release. Toronto, October 09.

Dirks, Tija. 2013. "Next Steps: Strategy Development." In Northern Ontario Multimodal Transportation Strategy. Ministry of Transportation, Ontario.

Drake, Elizabeth. 2013. "Transportation Requirements for Economic Sector Development in Northern Ontario: Presentation of Draft Final Report." Paper presented at Stakeholder Workshop, Sudbury. Sudbury: CPCS. https://northernontariommts.files.wordpress.com/2015/06/cpcs__sudbury-workshop-presentation_-20130212.pdf.

Earth Tech. 2005. City of Greater Sudbury Transportation Study Report. Sudbury, Ontario: Earth Tech (Canada) Inc. https://www.greatersudbury.ca/linkservid/E3DA24FD-D013-59F1-2D3A02F3D848E8F6/showMeta/0/.

Febbraro, John, and Don Mitchell. 2006. "How Sault Ste. Marie Can Make a Difference in Addressing the Multimodal Challenges of Finding Fast and Reliable Transportation Alternatives that will Ensure the Smooth and Efficient Flow of Goods between Canada and the U.S." Paper presented at Annual Conference & Exhibition of the Transportation Association of Canada, 2006. Charlottetown, Prince Edward Island: Transportation Association of Canada. https://trid.trb.org/view/794968.

Ferguson, Rob. 2012. Ontario Northlander train to make its last run Sept. 28. August 16. Accessed July 02, 2014. https://www.thestar.com/news/canada/2012/08/16/ontario_northlander_train_to_make_its_last_run_sept_28.html.

FindLaw UK. 2012. Pros and Cons of Different Modes of Transport. Accessed May 30, 2014. http://www.findlaw.co.uk/law/small_business/starting_a_business/running_your_business/transport_logistics_for_business/10586.html.

Forkenbrock, David J. 2001. "Comparison of external costs of rail and truck freight transportation." Transportation Research Part A: Policy and Practice 35 (4): 321-337. https://doi.org/10.1016/S0965-8564(99)00061-0.

Genesee & Wyoming Inc. n.d. Huron Central Railway (HCRY). Accessed August 27, 2014. https://www.gwrr.com/operations/railroads/north_america/huron_central_railway.

Gill, Vijay, and R. Neil Raynor. 2013. Growing Canada's Economy: A New National Air Transportation Policy. Ottawa, Ontario: The Conference Board of Canada.

Gillis, Len. 2015. "Possible Rail Solution in Ring of Fire." The Daily Press Timmins. February 26. http://www.timminspress.com/2015/02/26/grand-chief-to-propose-new-ring-of-fire-rail-plan.

Gormick, Greg. 2013. "A Wedding Band of Confederation: Restoring Rail Passenger Service to Ontario's North Shore and Across Canada." https://ontario.transportaction.ca/wp-content/uploads/2013/06/BruceHyer_PassengerRailReport-120603.pdf.

—. 2014. "Fixing Canada's ailing rail system." Toronto Star. January 25. https://www.thestar.com/opinion/commentary/2014/01/25/fixing_canadas_ailing_rail_system.html.

Government of Ontario. 2011. Growth Plan for Northern Ontario 2011. Queen's Printer for Ontario. https://www.ontario.ca/document/growth-plan-northern-ontario.

—. 2005. Highway 69 Action Plan. Ministry of Energy, Northern Development and Mines, News Release. June 28. https://news.ontario.ca/en/backgrounder/7100/highway-69-action-plan#resources.

—. 2014a. Moving Ontario Forward With Large New Investment. Office of the Premier, News Release. April 14. https://news.ontario.ca/en/release/29170/moving-ontario-forward-with-large-new-investment.

—. 2014b. Ontario Investing in the Ring of Fire. Ministry of Finance, News Release. April 28. http://news.ontario.ca/mof/en/2014/04/ontario-investing-in-the-ring-of-fire.html.

—. 2014c. Province Moving Forward With High Speed Rail Plans. Ministry of Transportation, News Release. April 30. http://news.ontario.ca/mto/en/2014/04/province-moving-forward-with-high-speed-rail-plans.html.

—. 2014d. The Official Road Map of Ontario - Map Information. Ministry of Transportation. May 09. Accessed September 04, 2014. http://www.mto.gov.on.ca/english/publications/official-road-map/.

Great Lakes – St. Lawrence Seaway System. 2014. Lockage Schedule. Accessed September 04, 2014. https://greatlakes-seaway.com/en/recreational/lockage_schedule.html.

—. 2014. Seaway Opening and Closing Information. Accessed September 04, 2014. http://www.greatlakes-seaway.com/en/commercial/opening-closing.html.

Grengs, Joe, Chuang-Chung Hu, and Mari Weitz. 2009. Intercity Bus and Passenger Rail Study. Ann Arbor, MI: Michigan Department of Transportation, College of Architecture and Urban Planning, University of Michigan. https://www.swmpc.org/downloads/intercitybusrailstudy_revised_final_120409_part1.pdf.

Greyhound. n.d. Schedule Details. Accessed 2015. https://www.greyhound.ca/en.

Hall, Heather, and Betsy Donald. 2009. Innovation and Creativity on the Periphery: Challenges and Opportunities in Northern Ontario. Working Paper REF. 2009-WPONT-002 . Martin Prosperity Institute Working Paper Series: Ontario in the Creative Age . http://www-2.rotman.utoronto.ca/mpi/wp-content/uploads/2009/02/Innovation_and_creativity_on_the_Periphery-H_Hall-B_Donald.pdf.

Hamilton-McCharles, Jennifer. 2014. ONR President Steps Down. October 06. Timmins Times.

Haustein, Sonja, and Marcel Hunecke. 2007. "Reduced Use of Environmentally Friendly Modes of Transportation Caused by Perceived Mobility Necessities: An Extension of the Theory of Planned Behavior." Journal of Applied Social Psychology 37 (8): 1856-1883.

Hubpages. 2008. The Pros and Cons on Four Different Methods of Travel. Accessed May 28, 2014. http://xepoleas.hubpages.com/hub/Pros-Cons-Four-Different-Methods-of-Travel.

IBI Group. 2013. Northern Ontario Commercial Vehicle Travel Profile. Ministry of Transportation, Ontario. https://northernontariommts.files.wordpress.com/2015/05/ttr_north_on_cv_profile_2013-10-30.pdf.

Jay, Paul. 2013. "Twinning of 'Death Highway' a Slow Work in Progress." CBC News. November 19. https://www.cbc.ca/news/canada/ottawa/twinning-of-death-highway-a-slow-work-in-progress-1.2431276.

Jenelius, Erik. 2009. "Network structure and travel patterns: explaining the geographical disparities of road network vulnerability." Journal of Transport Geography 17 (3): 234-244. doi:https://doi.org/10.1016/j.jtrangeo.2008.06.002.

Jones, Joseph, and Mark W. Rosenberg. 2017. "Regional Development, Remote Communities and Alternative Transportation Services." Geografiska Annaler: Series B, Human Geography 74 (3): 199-209. doi:https://doi.org/10.1080/04353684.1992.11879643.

Kelly, Lindsay. 2014. Feds extend funding for Algoma passenger rail. April 14. Accessed December 08, 2014. http://www.northernontariobusiness.com/Industry-News/transportation/2014/04/Feds-extend-funding-for-Algoma-passenger-rail.aspx.

Lafarge. 2014. Building Better Cities. April. http://www.lafarge.com/wps/portal/1_2_1-Lafarge_en_un_clic.

Leeson, Ben. 2015. "Sudbury Accent: Highway 69 by 2017' Seems unlikely." The Sudbury Star. January 02. https://www.thesudburystar.com/2015/01/03/sudbury-accent-highway-69-by-2017-seems-unlikely.

Levinson, David M., and David Gillen. 1998. "The Full Cost of Intercity Highway Transportation." Transportation Research Part D: Transport and Environment 3 (4): 207-223. doi:https://doi.org/10.1016/S1361-9209(97)00037-0.

Levinson, David. 1996. "The Full Cost of Intercity Travel: A Comparison of Air, Highway, and High-speed Rail." Access Magazine, University of California Transportation Centre 9: 21-25. https://www.accessmagazine.org/wp-content/uploads/sites/7/2016/07/access09-05-the-full-cost-of-intercity-travel.pdf.

Litman, Todd. 2003. "Social Inclusion as a Transportation Planning Issue in Canada." Contribution to the FIA Foundation G7 Comparison Paper, presented at the European Transport Conference held in Strassbourg in June, 2003. Strassbourg: Victoria Transport Policy Institute. https://www.researchgate.net/profile/Todd-Litman-2/publication/37183839_Social_Inclusion_as_a_transport_planning_issue_in_Canada/links/544a94ca0cf24b5d6c3ccb25/Social-Inclusion-as-a-transport-planning-issue-in-Canada.pdf.

Mackenzie, Robert. 2010. "Greyhound Canada Canceling Several Ontario Routes." Transit Toronto. January 18. https://transittoronto.ca/archives/weblog/2010/01/18-greyhound_.shtml.

Maoh, Hanna, William Anderson, and Charles Burke. 2012. "Modeling the Resilience of Surface Freight Transportation Systems: An Application to Ontario, Canada." Paper presented at the 47th Annual Canadian Transportation Research Forum Conference. Calgary, Alberta: Cross-Border Transportation Policy Centre, University of Windsor. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.433.6580&rep=rep1&type=pdf.

Meredith, Veronica L., Penelope Rush, and Elly Robinson. 2014. Fly-in Fly-Out Workforce Practices in Australia: The Effects on Children and Family Relationships. Melbourne, Australia: Child Family Community Australia. Paper no. 19. https://www.researchgate.net/publication/261634376_CHILD_FAMILY_COMMUNITY_AUSTRALIAINFORMATION_EXCHANGE_Fly-in_fly-out_workforce_practices_in_Australia_The_effects_on_children_and_family_relationships.

Metrass-Mendes, Alda, Richard de Neufville, and Álvaro Costa. 2011. Air Accessibility In Northern Canada: Prospects And Lessons For Remote Communities. European Regional Science Association. https://www.researchgate.net/publication/241769030_AIR_ACCESSIBILITY_IN_NORTHERN_CANADA_PROSPECTS_AND_LESSONS_FOR_REMOTER_COMMUNITIES.

Milan, Janic. 2007. "Modelling the Full Cost of an Intermodal and Road Freight Transport Network." Transportation Research Part D: Transport and Environment 12 (1): 33-44. doi:https://doi.org/10.1016/j.trd.2006.10.004.

Millette, Rick. 2014. Will the Ring of Fire Create a New Community for Ontario? Northern Policy Institute. Accessed December 09, 2014. https://northernpolicy.wordpress.com/2014/11/10/will-the-ring-of-fire-c.

Ministry of Agriculture, Food and Rural Affairs Ontario. 2013. Northern Ontario Agriculture Facts and Figures in Brief. July 09. http://www.omafra.gov.on.ca/english/livestock/beef/news/info_vbn0713a4.htm.

Ministry of Energy, Northern Development and Mines. 2012. Ontario Northland Transportation Commission. March 23. https://news.ontario.ca/en/release/20571/ontario-northland-transportation-commission.

Ministry of Northern Development and Mines. 2012. Northern Highways Program 2012 – 2016. Ministry of Northern Development and Mines, Ontario. http://www.mto.gov.on.ca/english/highway-bridges/pdfs/northern-highways-program-2012-2016.pdf.

Ministry of Northern Development and Mines. 2013. Northern Highways Program 2013 – 2017. Ministry of Northern Development and Mines, Ontario. http://www.mto.gov.on.ca/english/highway-bridges/pdfs/northern-highways-program-2013-2017.pdf.

Mongeau, Claude. 2014. "An Inside View of Railway Economic Regulation in Canada." C.D. Howe Roundtable, Toronto, April.

National Geospatial-Intelligence Agency. 2014. "World Port Index (PUB. 150)." https://msi.nga.mil/Publications/WPI.

Natural Resources Canada. 2013. CanVec Feature Catalogue. Edition 1.1.4. Sherbrooke, Quebec.

Northern Ontario Business. 2014. CN to Cut Passenger Service to Hearst. January 28. http://www.northernontariobusiness.com/Industry-News/transportation/2014/01/CN-to-cut-passenger-service-to-Hearst.aspx.

—. 2009. Lake Superior Aggregates Quarry Gets Green Light. July 20. http://www.northernontariobusiness.com/Industry-News/mining/Lake-Superior-aggregates-quarry-gets-green-light231.aspx.

Noxon Associates Limited. 2009. Improving Travel Options in Small & Rural Communities. Ottawa, Ontario: Transport Canada. https://www.publichealthgreybruce.on.ca/Portals/0/Topics/HealthyCommunities/Conference/Active_Trans/Resources/Improving_Travel_Options_for_Small_and_Rural_(Industry_Canada).pdf.

Ontario Centre for Climate Impacts and Adaption Resources. 2011. Climate Change Impacts and Adaptation in Northern Ontario – Workshop Report. Ontario Centre for Climate Impacts and Adaption Resources. http://www.climateontario.ca/doc/workshop/NorthernOntarioWorkshop/ClimateChangeImpactsAndAdaptationInNorthernOntario_WorkshopReport.pdf.

Ontario Northland. n.d. Buy Tickets / Acheter des billets. Accessed 2014. https://on.betterez.com/full-page/tickets/on/52f862392433e2310400004d/en-US/52f862392433e23104000052?sessionId=TDZ8UO0CC7NTNAKJA06ENT43R.

—. n.d. Map. Accessed 2015. http://www.ontarionorthland.ca/index.php/en/map.

Pickard, Arron. 2014. "New aircraft service companies on the horizon?" Northern Ontario Business. January 9. https://www.northernontariobusiness.com/regional-news/sudbury/new-aircraft-service-companies-on-the-horizon-370117.

Port of Thunder Bay. 2015. Port of Thunder Bay. Accessed 2015. https://www.portofthunderbay.ca/.

Rail Association of Canada. 2011. Rail Facts. Accessed June 02, 2014. http://www.railcan.ca/education/facts.

Reuters. 2012. Genesee & Wyoming to Buy Rail America for $1.4 Billion. July 23. http://in.reuters.com/article/2012/07/23/genesseewyoming-railamerica-idINL4E8IN4PY20120723.

Ross, Ian. 2013. ""Can do, Must Do" On Expanded Sault Port." Northern Ontario Business. February 4. http://www.northernontariobusiness.com/Regional-News/sault-ste-marie/2013/01/%E2%80%9CCan-do,-must-do%E2%80%9D-on-expanded-Sault-port.aspx.

—. 2013. "Entrepreneurial Thinking Drives Airport's Success." Northern Ontario Business. May 8. http://www.northernontariobusiness.com/Regional-News/thunder-bay/2013/05/Entrepreneurial-thinking-drives-airport-s-success.aspx.

—. 2011. "Funds in Place, Short-Line Reconstruction Begins." Northern Ontario Business. October 22. http://www.northernontariobusiness.com/Industry-News/construction/Funds-in-place,-short-line-reconstruction-begins.aspx.

—. 2009. "Manitoulin Harbour Lease Renewal Draws Controversy." Northern Ontario Business. July 22. http://www.northernontariobusiness.com/Industry-News/government/Manitoulin-harbour-lease-renewal-draws-controversy825.aspx.

—. 2010. New Lease on Life for Northeastern Ontario Short-Line Railroad. October 04. http://www.northernontariobusiness.com/Industry-News/transportation/New-lease-on-life-for-northeastern-Ontario-short-line-railroad.aspx.

—. 2014a. "Ontario Government Will Keep Ontario Northland." Northern Ontario Business. April 4. http://www.northernontariobusiness.com/Industry-News/transportation/2014/04/Ontario-government-will-keep-Ontario-Northland.aspx.

—. 2014b. "Passenger Rail Service Cut Mobilizes MP, Tourism Industry CN's Timing "Despicable"." Northern Ontario Business. January 31. http://www.northernontariobusiness.com/Industry-News/transportation/2014/01/Passenger-rail-service-cut-mobilizes-MP,-tourism-industry.aspx.

—. 2010. "Wawa Trap Rock Miner Searches for a Partner." Northern Ontario Business. February 25. http://www.northernontariobusiness.com/Industry-News/mining/Wawa-trap-rock-miner-searches-for-a-partner674.aspx.

Scott, Darren M, David Novak, Lisa Aultman-Hall, and Feng Guo. 2006. "Network Robustness Index: A new method for identifying critical links and evaluating the performance of transportation networks." Journal of Transport Geography 14 (3): 215-227. doi:https://doi.org/10.1016/j.jtrangeo.2005.10.003.

Shlozberg, Reuven, Rob Dorling, and Peter Spiro. 2014. Low Water Blues: An Economic Impact Assessment of Future Low Water Levels in the Great Lakes and St. Lawrence River. The Mowat Centre. https://munkschool.utoronto.ca/mowatcentre/wp-content/uploads/publications/89_low_water_blues.pdf.

Soo Today. 2014. New Train Operator Could Be Announced Soon. December 04. https://www.sootoday.com/content/news/details.asp?c=82533.

Statistics Canada. 2011. "Boundary Files, Reference Guide, First edition, 2011 Census." Catalogue no.92-160-G. https://www150.statcan.gc.ca/n1/pub/92-160-g/92-160-g2011001-eng.htm.

—. 2016. "Census subdivision (CSD)." Dictionary, Census of Population, 2016. November 16. https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/geo012-eng.cfm.

—. 2014a. Geography. Accessed September 04, 2014. http://www12.statcan.gc.ca/census-recensement/2011/geo/index-eng.cfm.

—. 2012. "Population and dwelling counts, for Canada and economic regions, 2011 and 2006 censuses (table)." Population and Dwelling Count Highlight Tables. 2011 Census. https://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-Tableau.cfm?LANG=Eng&T=101&S=50&O=A.

—. 2014b. "Population and dwelling counts, for Canada, provinces and territories, 2011 and 2006 censuses." Population and Dwelling Count Highlight Tables, 2011 Census. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-Tableau.cfm?LANG=Eng&T=101&S=50&O=A.

—. 2014c. "Population and dwelling counts, for Canada, provinces and territories, and economic regions, 2011 and 2006 censuses." Population and Dwelling Count Highlight Tables, 2011 Census. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-Tableau.cfm?LANG=Eng&T=1402&PR=35&S=51&O=A&RPP=25.

—. 2015. "Shipping in Canada 2011." 54-205-X. November 27. https://www150.statcan.gc.ca/n1/pub/54-205-x/2011000/part-partie1-eng.htm.

Storey, Keith. 2010. "Fly-in/Fly-out and Fly-over: Mining and regional development in Western Australia." Australian Geographer 32 (2): 133-148. doi:https://doi.org/10.1080/00049180120066616.

Sypher . 2006. Study of Municipal Airports in Ontario. Airport Management Conference of Ontario.

Taylor, Darren. 2014. "Port Has Huge Potential, Says Essar Steel Algoma CEO." Soo Today. September 26. https://www.sootoday.com/local-news/port-has-huge-potential-says-essar-steel-algoma-ceo-11-photos-176025.

TGR Rail. 2015. Press Release: Landmark Breakthrough for the Ring of Fire. January 26.

The St. Lawrence Seaway Management Corporation. 2015. Seaway Opening and Closing Information. Accessed January 09, 2015. http://www.greatlakes-seaway.com/en/commercial/opening-closing.html.

—. 2014. The Seaway: A Vital Waterway. Accessed September 08, 2014. http://www.greatlakes-seaway.com/en/seaway/vital/index.html.

The Sudbury Star. 2014. "Bus depot blues in Sudbury." The Sudbury Star. September 26. https://www.thesudburystar.com/2014/09/27/bus-depot-blues-in-sudbury.

—. 2006. "Sustainable Transportation in Small and Rural Communities." Urban Transportation Showcase Program: Case Studies in Sustainable Transportation, Issue Paper 61. Transport Canada, June. https://www.ruralontarioinstitute.ca/uploads/userfiles/files/Sustainable%20Transportation%20in%20Small%20and%20Rural%20Communities%20Transport%20Canada%202006.pdf.

Vansteenwegen, Pieter, and D. Van Oudheusden. 2007. "Decreasing the Passenger Waiting Time for an Intercity Rail Network." Transportation Research Part B: Methodological 41 (4): 478-492. doi:https://doi.org/10.1016/j.trb.2006.06.006.

Via Rail. 2014. RDC Economy class. http://www.viarail.ca/sites/all/files/media/360/Rail_diesel_car/index.html.

Wasaya Airways LP. n.d. Destinations. Accessed 2015. http://www.wasaya.com/destinations/.

Weber, Bob. 2013. Canada's aging Arctic airports reducing service to northerners: pilots. June 02. https://www.ctvnews.ca/canada/canada-s-aging-arctic-airports-reducing-service-to-northerners-pilots-1.1307708.

Young, Gord. 2012. "Highway 11 four-laning complete." North Bay Nugget. August 10. Accessed 2014. https://web.archive.org/web/20140714185022/http://www.nugget.ca/2012/08/10/highway-11-four-laning-complete.

Appendix A: Definitions

Census agglomeration: the core must have a population of at least 10,000.

Census division: a unit of regional government (such as a county or regional district) or an area treated as equivalent for statistical purposes. Census divisions are the geographic areas between the province/territory level and the municipality (census subdivision).

Census metropolitan area: the core must have a population of at least 50,000 and the entire census metropolitan area must have a total population of at least 100,000.

Census subdivision: a municipality or an area treated as equivalent to a municipality for statistical (e.g., as an Indian reserve or an unorganized territory).

Designated place: normally a small community or settlement that does not meet the criteria established by Statistics Canada to be a census subdivision (an area with municipal status) or a population centre.

Dissolved municipality (DMU): A municipality that no longer exists.

Economic region: a grouping of complete census divisions (with an exception in Ontario) created as a standard geographic unit for analysis of regional economic activity.

Local Service Board (LSB): is a volunteer organization that has the authority under the Northern Services Boards Act to deliver services to residents. These boards are set up in rural areas where there is no municipal structure to deliver services such as fire protection or garbage collection. Area residents vote to determine an LSB's boundaries.

Population centre: a minimum population concentration of 1,000 persons and a population density of at least 400 persons per square kilometre, based on the current census population count

Provinces and territories: the major political (legislated) areas of Canada.

Unincorporated area: a region that is not governed by its own local municipal corporation, but rather is administered as part of a larger administrative municipal government.

About Northern Policy Institute

Northern Policy Institute is Northern Ontario's independent think tank. We perform research, collect and disseminate evidence, and identify policy opportunities to support the growth of sustainable Northern Communities. Our operations are located in Thunder Bay, Sudbury, and Sault Ste. Marie. We seek to enhance Northern Ontario's capacity to take the lead position on socio-economic policy that impacts Northern Ontario, Ontario, and Canada as a whole.

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