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Northwest Territories Municipal and Community Affairs

2014

Northwest Territories Hazard Identification Risk Assessment

Vanguard EMC Inc.

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Affaires autochtones et Développement du Nord Canada
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Statement of Limitations

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Contents

1 Executive Summary

The Northwest Territories (NWT) Hazard Identification Risk Assessment (HIRA) identifies the hazards and examines the risks that pose a threat to the people, property, environment and economy of the NWT. This assessment is a critical part of an emergency management program. Identified hazards should be used in preparedness programs, mitigation strategies, emergency response plan exercises, and training and awareness programs.

Governments have limited resources and planning for every possible hazard is not a realistic approach. However, an informed ranking of hazards provides a cost-effective approach to risk mitigation, emergency planning and response. This assessment identified and rated twenty hazards that could affect the NWT, and then ranked them in order of emergency planning priority.

To support the analysis that culminated in the hazard ranking, extensive documentation and data were provided by stakeholders and supplemented by online research. Six regional workshops and an online survey provided additional information on hazards in the NWT.

This HIRA also looked at current hazards through a climate change lens. In anticipation of the impact of climate change in the NWT, this analysis also projected which hazards could occur more frequently or become more extreme in the future.

The NWT Hazard Summary (inset) provides a list of the hazards ranked into four categories of risk. These rankings are supported by the NWT risk matrix (page 6) and the information outlined in the hazard narratives in Section 5. The rankings were determined using best practices methodology combined with insight from community stakeholders and local experts. With this comprehensive approach, the analysis may not be identical to risks assigned using other methods or criteria.

Very High Hazards

Fire/Explosion and Flood were found to be the highest risk hazards throughout the NWT. These hazards have frequently caused extensive damage to people, property, the environment and the economy. Both of these hazards are also expected to increase in frequency due to climate change, causing more extensive damage to communities in the future.

NWT Hazard Summary

Very High

1. Fire/Explosion
2. Flood

High

3. Weather - Winter Storm
4. Transportation Accidents
5. Critical Infrastructure Failure - Energy Crisis
6. Critical Infrastructure Failure – Other
7. Critical Infrastructure Failure - Water Contamination
8. Weather - Other Extreme

Moderate

9. Industrial Emergency
10. Weather - Wind Storm
11. Human Disease
12. Ice Hazard
13. Snow Load Hazard
14. Earth Movement - Permafrost Degradation
15. Civil Unrest
16. Earth Movement – Other

Low

17. Earth Movement - Earthquake/ Tsunami
18. War/ International Incident
19. Food and Agricultural Emergency
20. Falling Debris

There are a number of reasons that the Fire/Explosion hazard ranked very high. First of all, twelve NWT communities have development areas with an extreme wildfire hazard and seven others have development areas with a high wildfire hazard. Secondly many of the industrial activities in the NWT have a high or moderate forest fire risk classification, including land clearing, timber harvesting, timber processing, mechanical site preparations and other silviculture treatments, gas or oil well operations, mining, highway maintenance and construction, engineering operations, plant harvesting, milling, railroad operations, trenching, and the use of explosives. In addition, urban fires and arson in isolated communities with volunteer firefighters can lead to the loss of critical infrastructure. In NWT communities with professional firefighters, it has been difficult recruiting and retaining resources. The NWT suffers roughly two million dollars' worth of urban fire losses annually (See Table 4). The Fire/Explosion hazard groups together explosions, wildfires, and urban fires. Emergency planners across the NWT should create fire education training and awareness sessions for first responders and the public and enforce fire prevention practices.

Floods have caused many losses in the NWT and are likely to continue to do so. A majority of the population is located on a body of water and nine communities are currently designated flood risk areas. Aklavik, Tuktoyaktuk and Hay River have been particularly hard hit. Emergency planners across the NWT's should develop and exercise plans and programs for watershed management, river/lake/ocean modelling/prediction and monitoring, erosion control, and flood response. In the face of rapid snowmelt and intense rains in spring and summer, communities susceptible to flash flooding should review and improve their drainage facilities and protect vulnerable buildings and facilities.

High Hazards

Six additional hazards fell into the high risk category, including all three Critical Infrastructure Failure hazards – Energy Crisis, Water Contamination and Other. Planners must consider that Critical Infrastructure Failure can combine with any natural hazard to impair response, increase damage to a community and prolong recovery. Critical infrastructure in the NWT can be very vulnerable due to:

- The high construction and operating costs owing to community remoteness and extreme cold temperatures;
- Rapid structural deterioration in extreme environments;
- The high cost of reopening public services, even after a short interruption;
- An existing infrastructure shortfall;
- The lack of options and "backups" in services; and
- Finances and human resource capacity limits.

Energy Crisis is a key risk in the NWT precisely because of community isolation and the extreme weather conditions. For most of the communities, fuel must be shipped in by pipeline, barge, road or air. A shortened ice road season, a disruption to pipelines or barge transportation, or prolonged extreme weather events can lead to shortages of fuel. Inuvik and Norman Wells, which have relied on natural gas-fired power plants in the past, are currently experiencing high exposure to this risk as they try to establish a reliable alternative.

Remote communities are particularly reliant on local infrastructure. Communications and transportation systems, as well as sewage treatment facilities, in the Dehcho Region all face

challenges that may lead to failure. Aging infrastructure across the NWT deepens this risk. For many in the NWT, failure of a critical infrastructure system could leave them without basic necessities or unable to contact other communities. For them, Critical Infrastructure Failure of energy, communication or transportation infrastructure could be catastrophic.

Water Contamination issues are of great concern to the people of the NWT. Most NWT communities depend upon one water source. A sudden and severe water contamination of this source in an isolated community would quickly threaten the health of the population and could lead to deaths and environmental damage. Droughts may contribute to contamination as pollutants become more concentrated.

NWT transportation infrastructure includes a network of roads, ports, airports and a railway connection at Hay River. Transportation accidents pose a significant risk to the people, property, environment and economy of the NWT, particularly when the isolation of many areas, weather conditions, and aging infrastructure are considered. Historically, the NWT has experienced accidents that have cost lives and caused property damage. The transportation of fuel and other dangerous goods through communities increases the potential impact of an accident, demonstrated tragically in the 2013 train derailment in Lac-Mégantic, QC. Climate change is expected to further deteriorate roads and airstrips. New transportation infrastructure projects are underway which may change driving patterns or increase the number of vehicles on NWT roads.

The increased frequency of snowstorms impacts roadway safety and contributes to transportation accidents. Winter storms cause millions of dollars of lost revenue due to the shutdown of operations and slow transportation of goods and services every year.

Weather - Other Extreme events such as electrical storms and drought can cause depletion of municipal water sources, increase in forest fire risk and insufficient water flow through waterways.

Emerging Issues Impacting Hazards in the NWT

A number of issues emerging in the NWT may have an impact on emergency response or alter the NWT's exposure and vulnerability to hazards over the next five years.

Emergency planners should pay close attention to two key issues evolving in the NWT - the growth of natural resource development and the expansion of infrastructure. There are a number of oil, gas and mining projects under development across the NWT at this time. Emergency planners need to create an open dialog with business in order to understand and plan for the possible exposures inherent in these operations. The GNWT is committed to the design, development, construction, and maintenance of a highway extending NWT Highway 1 (the Mackenzie Highway) from Wrigley to the Dempster Highway, and extending NWT Highway 8 (the Dempster Highway) from Inuvik to Tuktoyaktuk. Large scale infrastructure projects have inherent risks in their construction and operation. Emergency planners need to create an open dialog with government and contractors in order to understand and plan for the increased exposure. Other evolving issues are discussed in section 2.4, Emerging Issues.

Climate Change

Climate change strongly affects the hazards of the NWT. Temperatures have already increased by 3 to 4 degree Celsius over the past 50 years in the NWT and the rate of increase is expected to continue or accelerate. Climate change shifts the wind and cloud patterns and has an effect on the frequency of storms and lightning strikes across the region. Northern climate change has

been hard to predict but these are some of the effects that could increase the frequency or impact of hazards in the future:

- Rapidly rising temperatures (Fire/Explosion Hazard, Transportation Accidents Hazard, Critical Infrastructure Hazards, Earth Movement Hazards, Human Disease Hazard);
- Shorter, warmer winters (Transportation Accidents Hazard, Critical Infrastructure Hazards);
- Increased rain and snowfall in many regions (Flood Hazard, Snow Load Hazard, Weather Hazards, Earth Movement Hazards);
- More extreme fall and winter storms (Weather Hazards);
- Less predictable weather (Weather Hazards);
- Increased winds in some areas (Weather Hazards);
- Thinner ice (Ice Hazard);
- Lower water levels in some lakes and rivers (Critical Infrastructure Hazards, Water Contamination Hazard, Transportation Accidents Hazard);
- More forest fires in some areas (Fire/Explosion Hazard); and
- Rising sea levels (Flood Hazard, Earth Movement Hazards).

Qualitative data, definitions and more extensive analysis of each hazard is provided in the 2014 NWT HIRA Section 5 Hazard Narratives. Regional summaries are contained in Appendix 8.7, providing communities with a more locally-focused risk assessment.

Hazards are interconnected and fluid. They are not subject to regional and territorial boundaries and may have unique outcomes in different places. The NWT HIRA should be updated every five years or when new information about hazards that could impact the NWT becomes available.

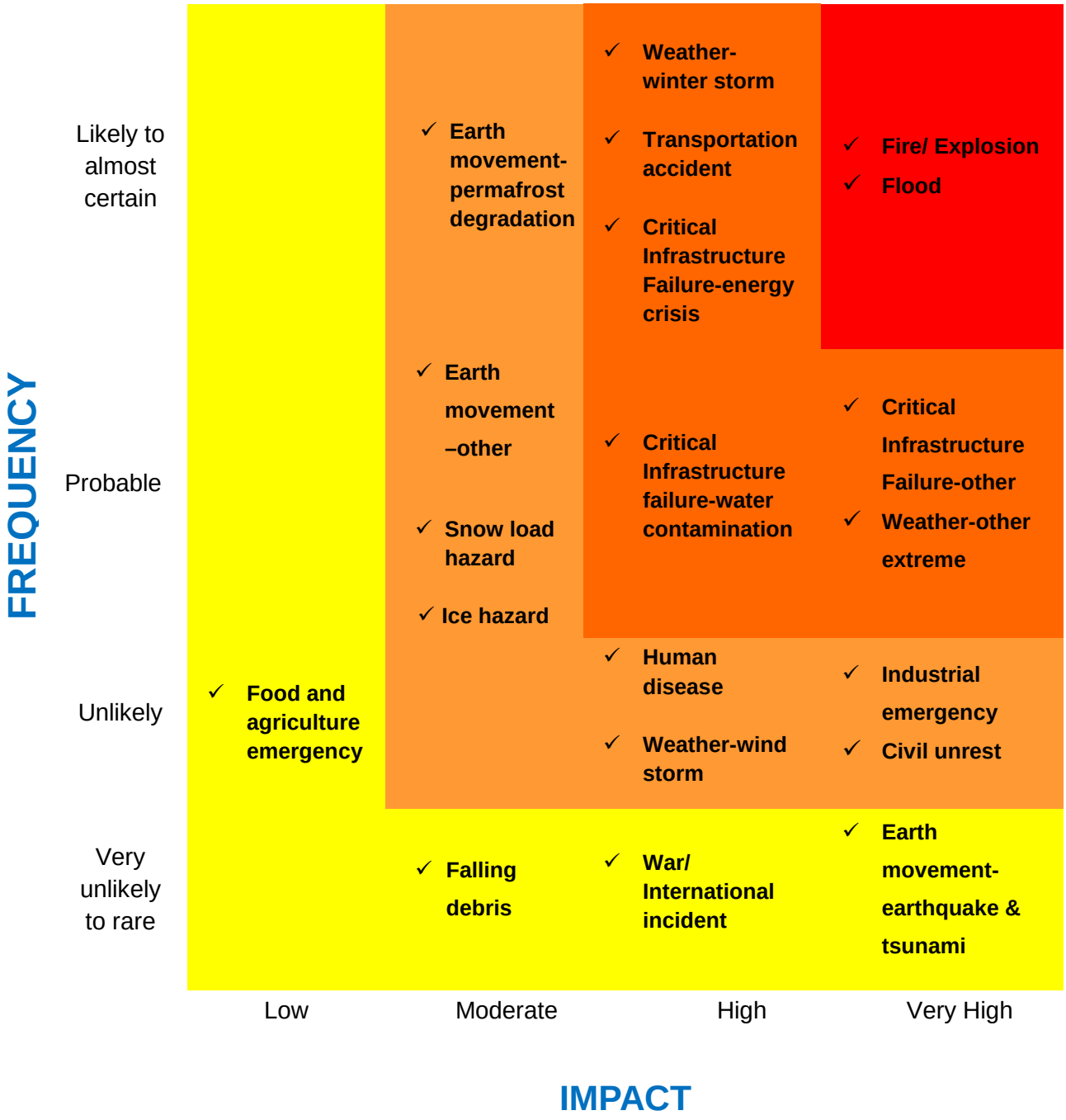


Figure 1: NWT HIRA Risk Matrix

2 Overview of the Northwest Territories

The NWT is a vast, sparsely-populated, northern Canadian territory located north of the 60th parallel, above Saskatchewan, Alberta, and eastern British Columbia, between the Yukon to the west and Nunavut to the east. Approximately one quarter of its land mass and several large islands lie within the Arctic Circle.

2.1 Setting

With a land mass of 1,171,918 square kilometres, the NWT is the third-largest province or territory in Canada.

Key geographical features:

- Great Bear Lake, the largest lake entirely within Canada;
- Great Slave Lake, the deepest body of water in North America at 614 m (2,014 ft);
- Canadian Arctic Archipelago, including Banks Island, Borden Island, Prince Patrick Island, and parts of Victoria Island and Melville Island;
- Mackenzie mountain range near the border with Yukon;
- Highest point is Mount Nirvana at an elevation of 2,773 m (9,098 ft);
- Mackenzie River, which exceeds 4,000 kilometers in length, Canada's longest river, and a major transportation route;

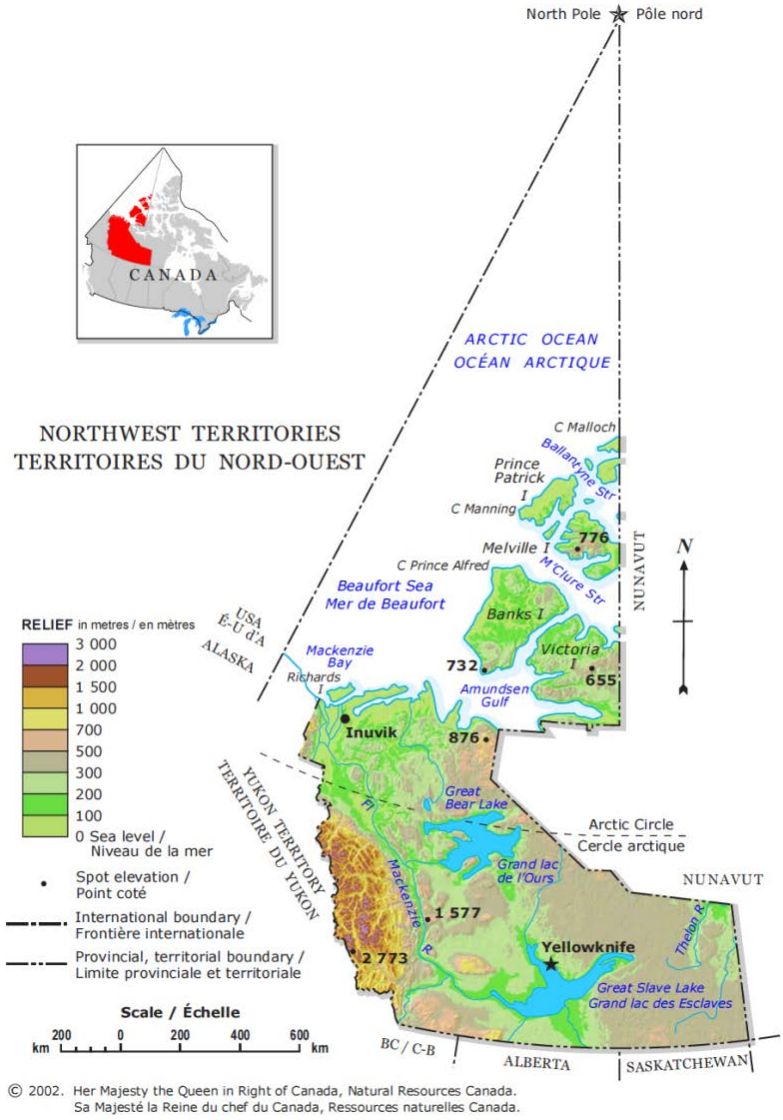


Figure 2: Relief Map of the NWT 2002 (Source: Natural Resources Canada)

- Mackenzie Valley, with rolling hills and boreal forest covering much of the land;
- Tundra in the north, where many of the most isolated communities are located; and
- Over 600,000 square kilometers (half of the NWT) is forested land. Of this, approximately 150,000 square kilometers are considered productive timberland.

2.2 Population

NWT Population (as of July 2013): 43,537

The NWT contains 33 communities, which break down as follows:

Cities:	1 (Yellowknife)
Villages:	1
Towns:	5
Hamlets:	11
Charter Communities:	3
First Nation:	12

Almost half of the population of the NWT lives in Yellowknife (19,800). Hay River (3,600), Inuvik (3,300), Fort Smith (2,450) and Behchokǫ̀ (2,200) have the next largest populations. Ten of the communities have fewer than 200 residents. The vast majority (94%) of non-Aboriginal residents live in regional centres. By comparison, 52% of Aboriginal residents live in smaller, rural, communities. NWT population growth is closely associated with mineral investment. The Government of the Northwest Territories (GNWT) is proactive in attracting and retaining new residents.

2.3 Economy

Mining, oil and gas are the key economic drivers in the NWT. However, the traditional economy, including harvesting and arts and crafts, still plays an important role in the smaller communities. About 40% of NWT residents over the age of 15 spend time participating in the traditional harvesting activities of trapping, fishing or hunting. Federal transfer payments currently account for 67% of the GNWT's operating budget.

2.4 Emerging Issues

A number of issues emerging in the NWT may have an impact on emergency response or alter the NWT's exposure and vulnerability to hazards over the next five years.

Future resource development and the related infrastructure growth and urban expansion may increase exposure to hazards related to permafrost thaw, flooding and coastal erosion (Ford and Smit, 2004 p. 389-400). Prospective mining development, a change in oil and gas extraction, or a shift in demand for natural resources could have an impact on the NWT's exposure to industrial accidents and other hazards. For example, there would be an increase in Industrial accident hazard exposure if they move forward on the long-delayed Mackenzie Gas Project, a proposed 1,196-kilometre natural gas pipeline system along the Mackenzie Valley. Also, one diamond mine, two gold mines, one zinc mine and two lead-zinc mines are slated for development over the next ten years and there has been a major discovery of oil in shale deposits near Norman Wells.

Many of the industrial activities in the NWT have a high or moderate forest fire risk classification. Future development of these industries in forested areas could increase fire risks over the next ten years.

The present level of preparedness for oil spills response is limited. During community fuel resupply operations there is an initial near shore spill response capacity for land-based oil-handling facilities. The Canadian Coast Guard (CCG) has placed community packs of spill equipment in the region. Because of the low frequency of spills, it is difficult to maintain the training levels of responders. It is anticipated that a drilling program might not occur in the Canadian Beaufort Sea until at least 2018. When a drilling program is approved, increased spill response capacity will be required.

Large scale infrastructure projects have inherent risks in their construction. The GNWT is committed to the design, development, construction, and maintenance of a highway extending NWT Highway 1 (the Mackenzie Highway) from Wrigley to the Dempster Highway, and extending NWT Highway 8 (the Dempster Highway) from Inuvik to Tuktoyaktuk. The construction and maintenance of new highways could affect the hazard ranking presented in this document.

Changes in transportation infrastructure can also lead to new incident patterns. For example, the construction of the Dehcho Bridge has caused changes in driving patterns. Previously, drivers would be forced to rest after the final midnight run of the “Merv Hardie” Ferry. Now the bridge can be used at any time, increasing nighttime travel and the inherent risks that accompany it. Changes in transportation infrastructure could also have an effect on the hazard ranking presented in this document.

Weather and ice conditions are becoming harder to predict, leading to a greater vulnerability to weather and ice hazards in the future. Inexperienced hunters may not be as well equipped to cope with the risks of hunting, and changing climatic conditions may make it even more hazardous for them (Pearce et al, IPY 2007-2009). This could lead to an increased vulnerability to ice hazards and an increased need for search and rescue response.

The NWT Lands and Resources Devolution Agreement was signed on June 25, 2013. This agreement will see responsibility for public land, water and resource management in the NWT transfer from the federal department of Aboriginal Affairs and Northern Development Canada (AANDC) to the GNWT on April 1, 2014. Customization of regulations for the NWT could change the vulnerability to hazards discussed in this document.

2.5 Climate Change

As defined by the Intergovernmental Panel on Climate Change (IPCC), climate change “refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity” (IPCC, 2007).

Science-based evidence indicates that the climate system has been warming since the 1950s. Temperature increases in the north are projected to be greater in comparison with other locations globally, thus more pronounced effects are expected in NWT. Changes that have already been observed include warming oceans and rising sea levels, a reduction of sea ice cover, an increase in precipitation and permafrost degradation (IPCC, 2007).

In order to build resiliency and adequately inform the relevant decision-making processes, climate change implications are an important risk consideration. Climate change has had and will have minor to dramatic impacts on each of the hazards reviewed in this report.

This review has been informed by science and impacts observed at the local level. While climate change impacts are typically considered hydrometeorological in nature, in the NWT they could have wider-ranging implications due to the prevalence of permafrost in the area.

Reduction of sea ice has resulted in easier access to minerals and fossil fuel resources. Sea ice disappearance and the opening of the Northwest Passage to ocean vessel traffic could bring about changes with significant long-term consequences. As the climate warms and commercial activity increases, new opportunities will arise and, with them, new risks to the people, property, environment and economy of the NWT.

3 Introduction

3.1 Hazard Identification Risk Assessment

The intent of the NWT HIRA is to provide a research-based foundation from which the NWT, community governments and first responders can create effective response, mitigation and recovery plans where appropriate and justified.

3.2 Scope

This project identified, described and ranked hazards and vulnerabilities of the NWT. The risk exposure and hazard history included within this report is limited to the geographic region that is part of the NWT in 2013. The results are based on existing information as of October 1, 2013 and limited to research gathered for this project as outlined in Section 8.6 Information Sources. The analysis used both quantitative and qualitative data to determine hazard evaluations.

Five separate regional documents were also created within the scope of this project which contain a regional perspective on the hazards and risk assessment. They include:

- Dehcho Region Hazard Identification and Risk Assessment;
- Inuvik Region Hazard Identification and Risk Assessment;
- North Slave Region Hazard Identification and Risk Assessment;
- Sahtu Region Hazard Identification and Risk Assessment; and
- South Slave Region Hazard Identification and Risk Assessment.

3.3 Methodology

The objectives of the NWT HIRA methodology were:

- To assess different types of hazards, both:
    - natural (i.e. geological, meteorological and biological); and
    - human-induced (i.e. accidental or intentional and technological).
- To determine:
    - how frequently they might occur;
    - how severe their impact may be on communities, critical infrastructure, property and the environment, in the past, now and in the future; and
    - which hazards pose the greatest threat to communities.
- To aid municipal governments in developing local adaptation plans and engaging in similar emergency management planning at a local level.

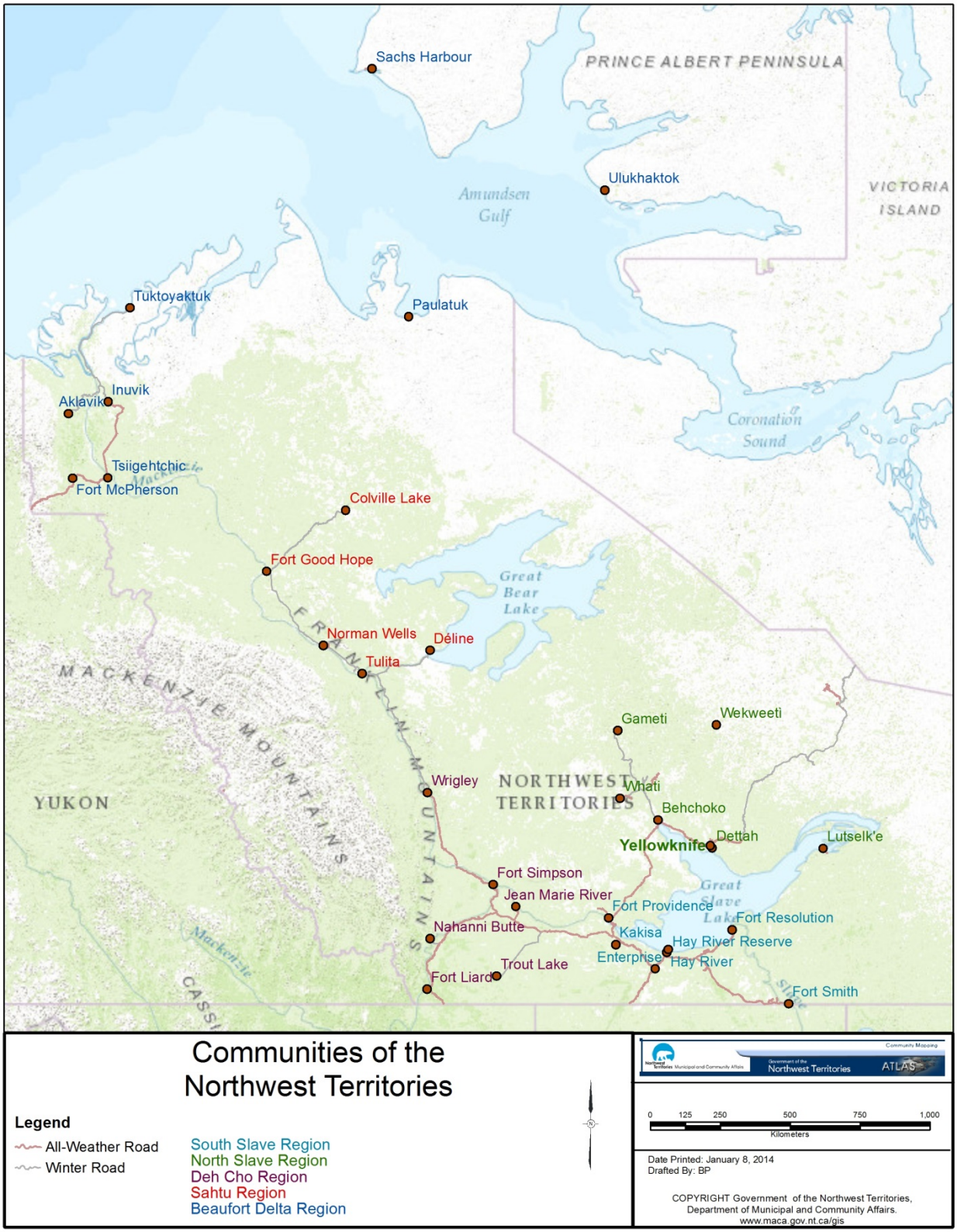


Figure 3: Communities of the NWT by Region (Source: MACA GNWT)

3.3.1 Literature Review

A review of the literature was done to ensure that a methodology was chosen which reflected recommended practices and was useful at the territorial level. The review included HIRAs from Canadian provinces, cities and American states as well as federal guidelines on all hazard risk assessment and Canadian and international standards. The review included:

- NISGA'A VILLAGE OF GITWINKSIHLKW Hazard Risk and Vulnerability Assessment 2008;
- REGIONAL DISTRICT OF FRASER-FORT GEORGE Hazard, Risk and Vulnerability Analysis 2005;
- Manitoba Office of the Fire Commissioner (OFC) and the Manitoba Emergency Measures Organization province wide hazard analysis and risk assessment 2002;
- British Columbia Hazard Risk and Vulnerability Analysis Tool Kit 2004;
- Province of British Columbia The All-Hazard Plan, Emergency Management British Colombia, 2012;
- Hazard Identification and Risk Assessment for the Province of Ontario 2012;
- State of Alaska Hazard Mitigation Plan 2010;
- Washington State Hazard Identification and Vulnerability Assessment 2001;
- State of Nebraska Hazard Mitigation Plan Section #3 Risk Assessment 2011;
- Public Safety Canada All Hazards Risk Assessment Methodology Guidelines 2011–2012;
- Federal Emergency Management Agency Comprehensive Preparedness Guide (CPG) 201, Second Edition, Threat and Hazard Identification and Risk Assessment Guide, (2013);
- Office of Critical Infrastructure Protection and Emergency Preparedness - Scoping of Issues Concerning Risk Reduction to All Hazards in Canadian Non-Urban Communities (2000);
- Canadian Standards Association Z1600-8 Standard on Emergency Management and Business Continuity Programs;
- NFPA 1600; and
- CAN/CSA-ISO 31000-10.

The NWT HIRA is an all-hazards approach and it includes the identification of hazards and the analysis of risks. The literature review supported conclusions that "at the core of all risk assessments is the equation Risk = Frequency X Impact" (EMO, 2012 p. 171). The HIRA Process forms the basis of the NWT HIRA methodology.

Figure 4: HIRA Process

3.3.2 Step #1 - Hazard Identification

The foundation of emergency response planning requires identification of the potential hazards that might affect the NWT. A hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation (MACA, 2011 p.5).

The NWT HIRA used the following methods to identify sources of risk in the NWT:

- A series of regional workshops across the NWT consulting the communities (Summary of Stakeholder Meeting Appendix 8.1);
- An online hazard survey on the GNWT MACA website (Online Survey Result Summary Appendix 8.5);
- An academic and historic literature review (Information Sources Appendix 8.6);
- Consultation with other territorial governments, federal and territorial ministries, and other communities; and
- Review of the NWT territorial, regional, and community emergency response plans.

The hazard identification took into account factors such as threats, frequency, history, trends, and probability. The list of hazards was developed by considering the NWT's:

- Demographics;
- Geography and geology;
- Industries and other technologies;
- Transportation modes and routes; and
- Weather and climate.

3.3.3 Step #2 - Risk Assessment

During the risk assessment, the level of risk for each hazard was examined. Past occurrences, possible scenarios and the current vulnerability of the society and area to each hazard where reviewed. The risk assessment included gathering data on the impact of the risk on people, property, business and the environment.

As the assessment used both qualitative and quantitative data, it is to some degree subjective. Duplication of this assessment by third parties may not yield exactly the same results.

To determine the past impacts of hazards within the NWT, credible sources were used, such as:

- The Canadian Disaster Database;
- Environment Canada;
- GNWT; and
- Various Ministry Reports and Information (See Information Sources Appendix 8.6).

3.3.4 Step #3 - Risk Analysis

The risk analysis determined the frequency and potential impact of hazards on business operations, community, associated stakeholders, related infrastructure, and the environment. Historical occurrences, changing circumstances, outside influences and similar occurrences happening elsewhere are examined when analyzing risks.

Frequency

The NWT HIRA is not intended to be a scientific assessment of the frequency of the different hazards, but is a risk assessment which must consider how likely it is that a hazard will occur with enough strength to result in an emergency situation. Hazards are grouped according to the following frequencies:

Table 1: Frequency Categories

Frequency	Category	Return Period
1	Rare	>201 years
2	Very Unlikely	101-200 years
3	Unlikely	31-100 years
4	Probable	11-30 years
5	Likely	4-10 years
6	Almost Certain	1-3 years

Some hazards do not have a long historical record and their frequencies can be only estimated based on the best sources available. Ideally, the frequency would be calculated based on the number of times that the event has occurred, rather than in years, however the differing lengths of the historical records in the NWT make this impossible. Some hazards may not have occurred in the NWT (or have occurred before recorded history) but will be classified as 1 or 2 in the Frequency Table depending on the information obtained about the future risk in the NWT.

Impact

Different hazards have different potential impacts. The Information Sources in Appendix 8.6 were consulted to determine the impact of historical hazardous events in NWT. Six regional

workshops and a survey were conducted in order the obtain information on events in the NWT that might have not been captured in the literature. The information from this research was gathered and analyzed. Past impacts and current mitigation measures were considered to determine to the extent possible whether comparable damages could be expected in the NWT in the future if similar events were to occur.

Impact was split into five groups:

- Human Impacts - The direct negative effects of an incident on the health of people including; fatalities, injuries or evacuations.
- Property Impact - The direct negative effects of an incident on buildings, structures and other forms of property.
- Business Impact - The negative economic or social losses due to an incident.
- Critical Infrastructure Service Disruptions/Impact - The negative effects of an incident on the networks of institutions, services, systems and processes that meet vital human needs, sustain the economy, protect public safety and security, and maintain continuity of and confidence in government. This category is divided into two; Damage to Critical Facilities and Damage to Lifelines.
- Environmental Damage - The negative effects of an incident on the environment, including the soil, water, air and/or plants and animals.

The following table outlines the rating of the potential impact criteria:

Table 2: Impact Criteria

Extent of Death	Extent of Injury	Damage to Critical Facilities	Damage to Lifelines
1 (0-4 people) 2 (5-10 people) 3 (11-25 people) 4 (26 + people)	1 (0-4 people) 2 (5-25 people) 3 (25-50 people) 4 (51 + people)	1 (Temp Relocation) 2 (Closure few days) 3 (Loss 50% Capability) 4 (Permanent Loss)	1 (Temp Interruption) 2 (Interruption days) 3 (Interruption 1 week) 4 (Interruption greater than 1 week)
Evacuation	**Damages to Property**	**Damages to Environment**	**Business Impact**
1 (>10 people) 2 (10-50 people) 3 (51-100 people) 4 (100+ people)	1 (Minimal Damage) 2 (Local Damage) 3 (Local/Severe) 4 (Widespread/Severe)	1 (Minimal Damage) 2 (Local Damage) 3 (Local/Severe) 4 (Widespread/Severe)	1 (Temp Impact) 2 (Temp/ Widespread) 3 (Extended/Widespread)

3.3.5 Step #4 - Monitor and Review

A HIRA is part of the emergency management process. The risk assessment will be used to prioritize which risks require further development of treatments to prevent, mitigate, accept, or transfer the risks associated with hazards or threats.

Each HIRA provides information on which hazards should be considered a priority for emergency management programs at a particular point in time. Reduction in hazard frequency or stronger mitigation practices may reduce the risk of a particular hazard and should shift mitigation efforts to another hazard. Hazards and risks should be monitored and reconsidered on a regular basis. At least, a five year review of this HIRA is recommended.

4 Hazards Identified

A hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation (MACA, 2011 p.5). These are hazards which have occurred or may occur within the NWT.

4.1 Natural Hazards

Natural hazards are caused by a naturally occurring phenomenon which has its origins within the geophysical or biological environment.

- Earth Movement - Earthquake/ Tsunami
- Earth Movement - Permafrost Degradation
- Earth Movement - Other
- Fire/Explosion
- Flood
- Food and Agricultural Emergency
- Human Disease
- Ice Hazard
- Snow Load Hazard
- Weather - Wind Storm
- Weather - Winter Storm
- Weather - Other Extreme

Important

Any list of hazards must be used with care. Each hazard is not independent.

A hazard may be caused or complicated by another hazard in the list. Some links between hazards are discussed in the hazard narratives.

Hazards are not static. This means that they can change. New hazards and risks can develop, or unknown hazards that existed in the past before records were kept can reoccur.

4.2 Human-induced Hazards

Human-induced hazards are hazards that occur because of human action or error, whether malicious or unintentional, including technological failures.

- Civil Unrest
- Critical Infrastructure Failure - Energy Crisis
- Critical Infrastructure Failure - Other
- Critical Infrastructure Failure - Water Contamination
- Falling Debris
- Industrial Emergency
- Transportation Accidents
- War/International Incident

5 Hazard Narratives

5.1 Guiding Principles

Emergency managers need to have a basic understanding of their community's hazard exposure and be aware of the potential effects of extreme events in order to be fully prepared.

The following hazard narratives:

- Define and classify the hazard;
- Explain the hazard including the type of events included within the hazard type;
- Describe the relevant circumstances surrounding the hazard;
- Report on the history of this hazard in the NWT including, where relevant, near misses and lower impact events that support consideration;
- Include both qualitative and quantitative information; and
- Include scientific information and local knowledge.

5.2 Very High Hazard

5.2.1 Fire/Explosion

Figure 5: Wood Buffalo Park Wild Fire - June 2013 (Source: GNWT, MACA)

Definition	**Class**
Uncontrolled burning and/or a sudden, violent release of gas under pressure which causes or threatens loss of life and property and environmental damage	Natural and Human-induced

NWT greatest impacts to date
Fatalities 2
Evacuated 950
Cost $12,044,118

Climate Change
Projected to increase both frequency and consequence

Type	Cause/Explanation
explosion	Ignition of a flammable substance resulting in instantaneous combustion.
forest fire, grass, bush and brush fire	Uncontrolled burning in relatively unpopulated grassland, brush or woodlands.
wild land/urban interface fire	Fires that have encroached on a developed and populated area.
urban fire	An uncontrolled fire in an urban area affecting residential or commercial properties.
peat fire	Wildfire in bogs or fens (muskeg) (can smolder beneath ground for long periods of time and create smoke hazards to surrounding populations).
fuel tank explosion	An explosion resulting from the leak, in the presence of an ignition source, of fuel from a storage container.

Vulnerability	Description
People	High injury and fatality potential from the immediate threat of the fire and the blast as well as an increased mortality rate and respiratory symptoms due to smoke.
Infrastructure	Total loss or damage to most infrastructure including public buildings, roadways, rail-lines, power facilities and water treatment plants. Smoke can impede evacuation of remote communities by air.
Communications	Any existing power lines can be damaged and destroyed by fire/explosion cutting off communication links. The same holds true for microwave towers in regions without in-place power lines.

NWT Exposure/History

Table 3: Wildfires and Urban Fires with Losses of $500,000 and Over

Where	When	Impact
Port Radium	1951	Urban fire – Mine. Estimated Total Cost $4,000,000
Inuvik	1968	Wildfire – Fire guards built around town, 35,120 HA burnt ($160,000 of timber in 1968$). Communication to CFB was cut due to destruction of poles and CFB communications tower, roads closed. Estimated Total Cost $54,000 in labour and equipment.
Fort Smith, Pine Point, and Hay River	1982	Wildfire - Highway closed and Hay River prepared for evacuation.
Norman Wells	1993	Wildfire - Community threatened.
Sahtu region of the NWT (Fort Norman (in the Hamlet of Tulita), Norman Wells, Yellowknife and Déljne)	June 6-15, 1995	Wildfire - Damage was incurred by provincial, municipal and private property. Fort Norman was evacuated on June 6, and Norman Wells was evacuated on June 9. Norman Wells was under a State of Emergency from June 8-14. Evacuated 950 Estimated Total Cost $3,432,310
Fort McPherson	Jan 1996	Urban fire – School. Estimated Total Cost $7,000,000
Norman Wells	March 1996	Urban fire – Dormitory. Estimated Total Cost $1,000,000
Fort Resolution	March 1997	Urban fire. Injured 1 Estimated Total Cost $700,000
Yellowknife	Aug 1997	Urban fire - Department store. Estimated Total Cost $1,050,000
Tibbitt Lake	July 22-31, 1998	Wildfire - State of Emergency declared and the area closed to traffic and residents. Reached 140000 HA in size. Destroyed three vacation cabins. Evacuated 5 Estimated Total Cost $12,044,118
Fort McPherson	April 1998	Urban fire – Hotel. Estimated Total Cost $1,200,000
Déljne	May 1998	Urban fire – Store. Estimated Total Cost $1,400,000
Tsiigehtchic	1999	Wildfire - Town threatened, highway closed.

Where	When	Impact
Behchokǫ̀(Edzo)	1999	Wildfire - Community evacuated.
Fort Providence	2002	Urban fire - Big River Service Restaurant Estimated Total Cost $500,000
Norman Wells	July 21, 2003	Wildfire - Declared a state of emergency. About 100 people were evacuated due to thick smoke. Estimated Total Cost $121,846
Yellowknife	March 2005	Urban fire - Old Airport Road hardware store. Fatalities 2
Tulita	Oct 2007	Urban fire - Chief Albert Wright school. Estimated Total Cost over $500,000
Inuvik	Nov 2010	Urban fire – A hangar and three planes, King Air, B99 and Twin Otter.
Yellowknife	May 2010	Urban fire - Coast Fraser Tower blaze significantly damaged two apartments on the 14th floor, and units on the 12th and 13th floors had smoke and water damage.
Déljne	2011	Wildfire - Community Evacuation. Evacuated 103
Inuvik	2012	Urban fire - Lions Club loss of building.
Wrigley	2013	Wildfire - Community Evacuation. Evacuated 40
Inuvik	Aug 2013	Urban fire - Building that houses the NWT Housing Corporation offices, Inuvik Gas, and the Inuvialuit Development Corporation offices. Estimated Total Cost between $500,000 and $750,000

Table 4: Urban Fire Losses in NWT 1999-2007 (Source: Council of Canadian Fire Marshals and Fire Commissioners)

Year	Number of Fires	Deaths	Injuries	Losses
1999	97	0	3	$3,206,808
2000	116	1	7	$1,754,097
2001	85	1	5	$2,137,285
2002	148	0	9	$2,780,735
2003	111	2	8	$1,269,887
2004	73	1	0	$1,464,140
2005	158	2	3	$1,954,580
2006	81	1	1	$1,818,345
2007	57	1	0	$2,327,895

Wildfire

Lightning activity over the Mackenzie Basin region is short but intense, with a strong peak in cloud-to-ground lightning during July. The maximum area of lightning activity is influenced by local moisture sources and by topography. Lightning causes up to 80% of the forest fires in the NWT (Black, et al. 2010, Annex). In a ten-year period from 2002 to 2011, there were 250 wildfires within a 10 kilometre radius of Yellowknife. The following communities throughout the NWT have a wildfire FireSmart hazard of High or Extreme:

Table 5: FireSmart Hazard Areas of High or Extreme in NWT According to Community CWPP

Community	Development Area	FireSmart Hazard
Fort McPherson	East Cabins	High-Extreme
Inuvik	Shell Lake	Moderate-Extreme
	Airport Lake Remote Cabins	Extreme
Déljne	Proposed Residential Area	Extreme
Fort Good Hope	High potential fire behaviour within the community interface and the vast areas of similar fire behaviour immediately west of the community. High wildfire risk.	
Norman Wells	Moderate to high for wildfire.	
Tulita	New residential subdivision	Extreme
	North and east perimeter developments in the main townsite area	High to Extreme
Behchokǫ̀	Eastern residential area of Rae	Extreme
	Western residential area of Edzo	Extreme
	Sah Naji Kwe Lodge	High
Dettah	Deton'Cho Training Centre and along the north perimeter of the main community	Extreme
Łutselk'e	Łutselk'e East	High
	Fishing Lodge	Extreme
Whatì	Whatì East	High
Yellowknife	Engel Industrial/DND FOS	Moderate-High
	Yellowknife Bay East	High-Extreme
Enterprise	High risk of wild fires.	
Fort Providence	Very low to High risk of wildfires.	
Fort Resolution	Fort Resolution South-End	High Extreme
	Little Buffalo River Village Area East-end	High Extreme
	Little Buffalo River Village Area Det'an Cho (Eagle) Tourist Camp	High
Fort Smith	Town East	High - Extreme
	Town West	High - Extreme

Community	Development Area	FireSmart Hazard
	Towering Pines	High - Extreme
	Bell Rock	Extreme
Hay River	Smith's Road	Moderate - High
	Delancy Estates	Extreme
	Kelly's Lane	Extreme
	West Point	Low - Extreme
	Hay River Indian Reserve Rural Developments	High - Extreme
	Hay River Indian Reserve Main Townsite	Moderate - High
	Riverwoods CR Subdivision	Extreme
Fort Liard	New Subdivision	Moderate - High
	Beaver Enterprises – Hwy 7 (bulk fuel tank site)	High
Fort Simpson	Wildrose Acres	High - Extreme
	Nogha Heights	High - Extreme
	Bannock Land	Moderate - High
Jean Marie River	Moderate to High risk to wildfire.	
Wrigley	New subdivisions on the south-end and for scattered structures on the east perimeter of the town site	High

Many of the industrial activities in the NWT have a high or moderate forest fire risk classification including land clearing, timber harvesting, timber processing, mechanical site preparations and other silviculture treatments, gas or oil well operations, mining, highway maintenance and construction, engineering operations, plant harvesting, manufacturing, milling, railroad operations, trenching, and the use of explosives.

Peat Fire

The NWT has the largest deposit of peat in Canada with 250,000 km/2 of peat (Lappalainen, 1996).

Explosion

Many communities have large fuel tanks needed to prepare for the winter months. This large fuel load can result in an explosion if an ignition source is presented nearby. Nearby forests increase the fire load and the risks to the communities.

Figure 6: Tulita Fire - 1995 (Source: GNWT, MACA)

Climate Change Impacts

Over the next fifteen years, due to climate change, the NWT may experience a 46% percentage increase in the total number of fires (Wotton, 2010). Climate change could mean:

- The melting of permafrost and more droughts which suggest peat fires will be more common (Flannigan, 2009).
- Warmer temperatures, changes in precipitation, atmospheric moisture, wind, and cloudiness could increase the number and size of wildfires.
- Longer fire season (Black, et al. 2010, Annex).
- Shorter ice road availabilities could mean more fuel stored in communities.

The area burned by forest fires has been growing along with average temperatures. The length of the fire season in the NWT is expected to increase by up to 50 days this century (Black, et al. 2010, Annex).

Increasing threats of forest fires, especially in the Mackenzie basin require action by forest agencies to reduce risks, and preparedness by emergency managers in communities that may be in the potential path of major fires (Black, et al. 2010, Annex).

Community Feedback from Meetings

Summers are becoming hotter and drier. The isolated nature of the many NWT communities, lack of adequate fire-fighting resources and bulk fuel storage in or close to the community increases the fire risk. Bulk storage of fuels could lead to explosions which would have disastrous effects on many communities throughout the NWT. In many cases, bulk fuel storage containers are very close to, or within the community. Urban fires in isolated communities with volunteer firefighters can lead to the loss of critical infrastructure. Explosives are stored very near the community of Norman Wells and any accident involving these supplies could impact the community.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (especially explosion);
- Smoke can complicate evacuation by air;
- Current and historical experience in the NWT;
- High damage potential if near or in a community;
- Potential to affect any community in the NWT;
- Isolation of communities; and
- Difficulties training and retaining firefighting resources.

5.2.2 Flood

Figure 7: Nahanni Butte Flood - June 2012 (Source: GNWT, MACA)

Definition	**Class**
An overflow or surge of water which causes or threatens loss of life and property and environmental damage	Natural Hazard

NWT greatest impacts to date

300 Evacuated

Estimated Total Cost $3,500,000

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
local flood	Local flooding is an increase in water level associated with an extreme hydrological event, such as record rainfall or poor / blocked drainage.
seiche	Rhythmic oscillation of water in a lake or a partially enclosed coastal inlet, such as a bay, gulf, or harbour which may be caused by the ground shaking in an earthquake or local changes in atmospheric pressure.
rain storm	A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours.
snow melt	River floods can also be caused by snow melts (freshets) which cause significant elevations in river levels.
ice jam	Accumulation of ice fragments in a waterway that builds up and restricts the flow of water causing a temporary obstruction.
storm surge	Strong wind stress on the water surface that creates a strong net displacement of water pushing lake or ocean water up onto the land.
lake burst	Rapid accumulation of water in glacial lakes can result in a sudden discharge of large volumes of water and debris and causing flooding in the downstream.

Vulnerability	Description
People	Evacuation of communities due to flood events is common. Deaths and injury due to flooding can occur during heavy rainstorm events which can interfere with evacuation attempts. Deaths in the NWT due to flooding are rare.
Infrastructure	Personal property damage can be extensive. Contamination by floodwaters, structural damage, and mold can destroy buildings. Roads can be damaged or washed away. Damage to infrastructure can be extensive. Flooding can also negatively affect utilities and critical infrastructure. Utilities such as wastewater treatment, electricity and gas

Vulnerability	Description
	may be disrupted in the event of a flood. Emergency ground vehicles may be unable to respond if roads and bridges are flooded, washed out or covered by debris.
Communications	Communication towers can be damaged by flooding events.

NWT Exposure/History

When	Where	Impact
1937	Aklavik	Flooding.
1944	Tuktoyaktuk	Storm Surge 3 m above MSL.
1961	Aklavik	Flooding.
May 3, 1963	Hay River Township	Major flooding caused by ice jamming required evacuation of the community of Hay River. Evacuated 1800
Sept 1970	Tuktoyaktuk	Storm Surge 3 m above MSL.
May 2, 1974	Hay River Township	Flooding caused by ice jamming required evacuation of West Channel residents.
Jan 1, 1982	Hay River	Flooding. Estimated Total Cost $572,824
1982	Aklavik	Spring runoff and ice jams cause flooding and extensive damage. Estimated Total Cost $141,412
May 3, 1985	Hay River Township	Record high flows of the Hay River and ice jams caused serious flooding, requiring the evacuation of West Channel residents. Ice jams, spring runoff, minor damages, one injury. Estimated Total Cost $1.1 million
June 29 - July 3 and July 11-15, 1988	Norman Wells	Two severe flood events occurred in the Liard and Mackenzie River Basins of southwestern NWT.
May 1-9, 1989	Liard River	Severe ice jams near 3 Mile Island, flooded the community of Fort Liard. A local State of Emergency was declared. Fort Simpson was also damaged. Personal, municipal and territorial property was damaged and riverbanks were eroded. Over 50 homes were affected by the flooding. Evacuated 125 Estimated Total Cost $1,094,778
1992	Aklavik	Flooding.
April 25, 1992	Hay River	Hay River flooding caused by a 10-kilometre-deep ice jam. Evacuated 100

When	Where	Impact
Sept 22, 1993	Tuktoyaktuk and Mackenzie Delta	A severe storm with winds from the northwest of up to 96 km/h generated a 1.68 m surge and raised water levels to 2.2 m above chart datum. Coincident with approximately 90% open water offshore, waves were relatively powerful and, together with the high water levels, resulted in damage to or destruction of about half the shore protection at Tuktoyaktuk, and flooding in the community and parts of the Mackenzie Delta.
2003	Hay River	An ice blockage at the mouth of the Hay River where it enters Great Slave Lake caused localized flooding in the community of Hay River and Hay River Reserve. A number of residences in both communities had to be evacuated due to the floodwaters. Estimated Total Cost $100,000
May 11-14, 2005	Fort Good Hope	Jackfish Creek and Rabbitskin River rose to the point that 50 people were evacuated from Fort Good Hope. A state of emergency was declared. Estimated Total Cost $920,000
May 27, 2006	Aklavik	Infrastructure was damaged after the Peel River Channel overflowed its banks swamping the town under several feet of water. Evacuated 300 Estimated Total Cost $3,500,000
May 5 and 6, 2008	Hay River	Overland flooding due to snow melt and the spring backup of Hay River resulted in damages to public and private property. Estimated Total Cost $460,000
June 9 2012	Nahanni Butte	The South Nahanni River flooded low-lying parts of the community. The flood caused extensive damage to a number of buildings including the band office, the community's store and the community gymnasium. Evacuated 72

In the NWT, ice jam is the main type of flooding. Rivers break up much earlier than lakes and these bottlenecks can cause ice jams. In the Mackenzie Delta, the risk is higher as the larger channels maintain year-round flow but smaller channels may freeze to the bottom. Spring flooding occurs within the Mackenzie Delta, at the horseshoe bend on the middle channel at Tununuk and in the channel junctions north of Aklavik, Hay River, as it nears the shores of Great Slave Lake and the Mackenzie River, in the Fort Simpson area. High spring flows and major ice jams in the Middle Channel of the Mackenzie Delta can cause widespread flooding, affecting the community of Aklavik. As much as 95% of the delta can be covered by water in some years (e.g., 1961, 1982 and 1992). Environment Canada field staff advises and assists local flood watch committees in Hay River, Fort Simpson, and Aklavik (Environment Canada, 2013).

In Norman Wells, overtopping of islands in the Mackenzie River (used as production bases for ESSO Resources Canada Ltd. oilfields) by ice and water necessitates the shutdown of wells during breakup. This is to prevent wellhead damage and oil spills. The community itself is not flood prone (Environment Canada, 2013).

In the mountainous areas of the west, rainstorms or glacier melt waters cause major summer floods. The most extreme summer floods often exceed spring runoff flows, and sometimes exceed the maximum breakup water levels observed on area rivers and the mainstream of the Mackenzie River (Environment Canada, 2013).

During the late summer and fall when the pack ice retreats 100 km or more from the shore, Beaufort Sea storm surges cause flooding in Tuktoyaktuk (Environment Canada, 2013).

A majority of the NWT population is located on a body of water.

Nine communities are designated flood risk areas:

- Hay River;
- Fort Simpson;
- Fort Liard;
- Nahanni Butte;
- Tulita;
- Fort Good Hope;
- Fort McPherson;
- Aklavik; and
- Tuktoyaktuk

Climate Change Impact

- All models and scenarios project that Arctic rain and snowfall will increase (AMAP, 2012) leading to more frequent and severe flooding events.
- Greatest relative increases in rain or snowfall will be in winter and autumn, and the smallest in summer (AMAP, 2012).
- A 10-25% increase in precipitation by 2050 (40% increase in snowfall) (IBC, 2012).
- Changing precipitation already linked to flooding in Aklavik and Fort Good Hope (NWT CC. 2008 p. 10).
- Increased frequency of flash flooding, with a combination of snowmelt and intense rain in the spring (Auld, 2007).
- Potential increases in flooding, flash flooding require review of drainage systems, and may also increase demands on emergency response (Auld, 2007).
- Increasing snowmelt, rain runoff and flooding risks will potentially increase disaster risks, resulting in a need for greater emergency response capacity (Auld, 2007).

Community Meeting Feedback

This issue was discussed at all meetings except Yellowknife. Virtually every community in the Dehcho has been affected by flooding as have many in the South Slave and Sahtu. In the Inuvik

Region, Aklavik has an issue with seasonal flooding. Fort McPherson and Tsiigehtchic have been threatened as well.

Key Risk Analysis Considerations

- Potential to cause multiple deaths;
- Current and frequent historical experience in the NWT;
- High damage potential when near or in a community; and
- Potential to affect any community in the NWT.

5.3 High Hazard

5.3.1 Weather – Winter Storm

Figure 8: Blizzard Damage to Inuvik Airport Roof - January 2012 (Source: GNWT, MACA)

Definition	**Class**
Strong weather characterized by ice, snow and freezing rain	Natural Hazard

NWT greatest impacts to date

- Infrastructure damage (power failure, airport damage)
- Property damage

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
polar low	An intense storm system that usually forms in polar regions during outbreaks of very cold air, over relatively warmer ocean waters. Typically spanning from 400 to 800 kilometres across, and usually existing for only one or two days, polar lows can result in severe blizzard-like conditions, with heavy snow and gale force winds over affected marine areas.
snow storm	The accumulation of several centimeters to meters of snow that covers roads and infrastructure.
ice fog and ice storm	An ice storm combines high wind, freezing temperature and freezing rain or drizzle.
freezing rain	Freezing rain occurs when the air in an upper–air layer has an above – freezing temperature, passes through a layer of cold air and the temperature at the surface is below freezing.
blizzard	Combines low temperatures, blowing snow and wind speeds ranging from 90 to 130 km/hour. Conditions are most severe in open or deforested areas where there are no trees or structures to act as wind breaks.

Vulnerability	Description
People	Heavy winds and cold temperatures can combine with power loss to cause injury and death that could be extensive. Blowing snow creates hazardous driving and working conditions (see Transportation hazard).
Infrastructure	Heavy winds and snow can cause damage to buildings, loss of power and water and sewage systems. Snow build-up on roofs can cause collapse (see Snow-load hazard).
Communications	Snow and heavy winds can knock out communications systems.

NWT Exposure/History

Winter storms render millions of dollars of lost or delayed revenue due to shut down of operations and slow transportation of goods and services every year. The increased frequency of snowstorms has had an impact on roadway safety. More snow removal is necessary to allow for safe travel, and the transportation of goods (Pryor, 2007 p.18).

Recent Blizzard Events

When	Where	Impact
March 5, 2003	Norman Wells	Prior to that Norman Wells had not had a blizzard in 20 years.
March 11, 2003	Norman Wells	This blizzard also stranded nine northern residents on the Tuktoyaktuk ice road in the Mackenzie Delta.
Jan 2005	Tuktoyaktuk	Temperatures dipped below -30°C and winds topped 117 km/h. Some homes lost power for 5 days, and water and sewage services were unavailable. Five houses froze solid, likely with burst pipes and ruined pumps.
March 2011	Inuvik	Winds reached 70 km/h. The blizzard also knocked out the internet, cell-phone service, bank machines, Interact card service and any calls other than local calls for three-and-a-half days.
Jan 17 and 18, 2012	Inuvik, Norman Wells	Winds at Inuvik peaked at 100 km/h, while more isolating blizzard conditions endured for over 24 hours. At Norman Wells it was an even longer 38 hours, blowing any previous records for blizzard duration by 7 to 21 hours respectively. Winds took off several roofs, including one at the Inuvik Airport, and lifted and shifted other items all around the region.

Climate Change Impact

- More intense and frequent winter storms, and greater unpredictability (Pryor & Cobb, 2007).
- Significant further increases in snowfall (IBC, 2012 p.53).
- Increases snowpack, earlier melting, and rain on snow are prevalent with climate change
- Increase in precipitation of 25 to 35 % in the high Artic since the 1950s. A mixture of snow and rain, increasing snow loading on buildings (CSA, 2010) (See Snow load hazard).
- More freezing rain is expected (Pryor & Cobb, 2007).
- Increased snowpacks, earlier melting, warmer winter temperatures, rain on snow, are all prevalent in the North with climate change (Auld, 2011).

- Approximately one fifth of buildings in the NWT are under watch or renovation for increased snow loads (Auld, 2011) (See Snow Load Hazard).
- Accumulated snow increases spring run-off and lead to wash-outs (NWT, 2008. p.10).

Community Meeting Feedback

There was a general consensus amongst participants at all meetings that while the NWT was experiencing milder winters on the whole, the winter weather was becoming more extreme in terms of storms and temperature variance.

Key Risk Analysis Considerations

- Annual economic loss;
- Potential to spontaneously cause multiple deaths and injuries;
- Potential loss of communications and air support can leave communities isolated;
- Current and historical experience in the NWT;
- High damage potential;
- Potential to effect any community in the NWT; and
- NWT communities particularly resilient to winter storms.

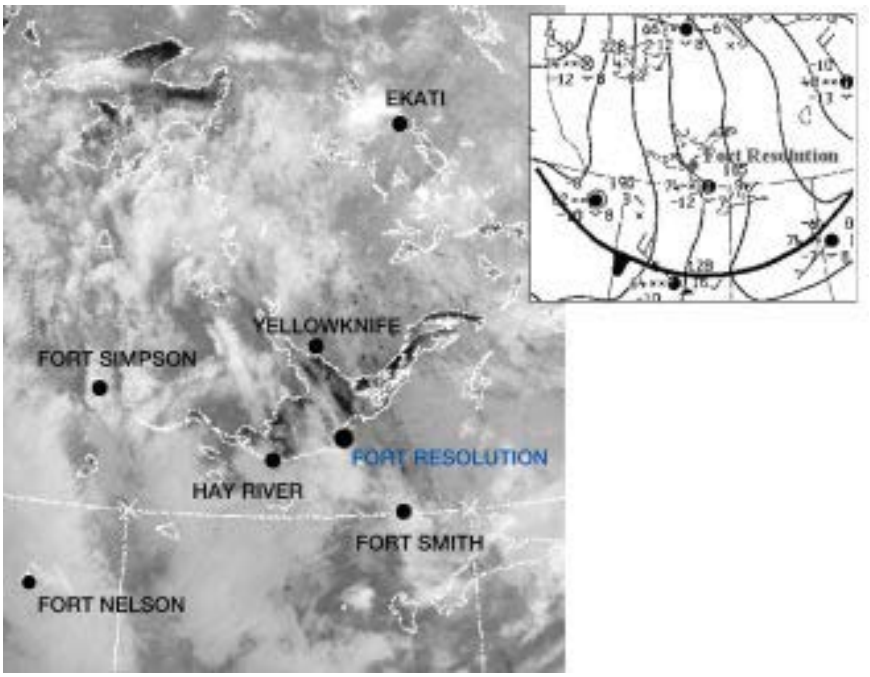


Figure 9: About 40 centimetres of snow fell on Fort Resolution overnight 9 into 10 November 1998. (Source: NAV CANADA, Satellite photo 1229 UTC 10 November 1998)

5.3.2 Transportation Accidents

Figure 10: Highway 3 Accident - February 2013 (Source: GNWT, MACA)

Definition
All vehicle accidents which involve large loss of life and property damage

Class
Human-induced Hazard

NWT greatest impacts to date

- Fatalities 32
- Infrastructure damage (power failure, airport damage)
- Property damage

Climate Change
Projected to increase both frequency and consequence

Type	Cause/Explanation
ice roads accidents	Ice road accidents occur when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree or utility pole. Speeding on ice roads over water can produce waves which can be strong enough to force its way up, blowing a hole through the ice. Truckers travel at 15 miles per hour, potentially for up to 30 hours, over frozen lakes.
aircraft accident	An aircraft accident where a person is fatally or seriously injured, the aircraft sustains damage or structural failure or the aircraft is missing or is completely inaccessible.
motor vehicle accident (including bison collisions)	When a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree or utility pole. Traffic collisions may result in injury, death, vehicle damage, and property damage.
marine accident	Any incident on water which involves a collision, fire/explosion, grounding or foundering of a vessel.
sonic boom	A loud explosive noise caused by the shock wave from an aircraft or other object travelling faster than the speed of sound.
dangerous goods transportation	The movement of dangerous goods by vehicle, train, vessel or aircraft. Dangerous goods are solids, liquids or gasses that can harm people, other living organisms, property, or the environment.
Vulnerability	**Description**
People	Accidents, specifically motor vehicle accidents, are one of the highest causes of death and injury to Canadians every year. Amongst young Canadians (below age 25) vehicular accidents are the number one cause

Vulnerability	Description
	of death in the country. Largest loss of life in one accident usually occurs on passenger flight accidents.
Infrastructure	Any accident which occurs on a roadway has the ability to damage the roadway and therefore leave already isolated areas without any road access. The same holds true for aircraft accidents which may close down an airport making it virtually impossible to gain access to several communities in the NWT.
Communications	Given that communication hubs are serviced by a single communication line, especially in the southern NWT, any accident may cut these lines leading to loss of communications.

NWT Exposure/History

When	Where	Impact
Oct 30, 1974	Rae Point	A Pan-Arctic Oils Lockheed Electra crashed. Fatalities 32
Jan 12, 2000	Near Fort Providence	A Northbound Super-B-Train truck hauling diesel fuel crashed through the Mackenzie River ice crossing. Driver was treated for hypothermia.
Jan 3, 2007	From Yellowknife,	3 fishing lodge employees died when a bush plane went down in restricted weather. A fourth person survived the crash. His survival was aided by temperatures of -16°C, mild for that time of year in the North.
Feb 20, 2007	Parry Peninsula	A hunter went adrift on an Arctic ice floe when winds caused his land tether to break. A Canadian Forces helicopter search and rescue team made a daring jump onto the ice floe and stayed with the stranded hunter overnight. It was below -50°C with the wind chill.
July 24, 2008	North of Inuvik	Members of three generations of an Inuvik family, on their way to take part in a traditional beluga whale harvest, perished after their six-metre boat capsized in the Mackenzie River. Fatalities 4
Dec 8, 2010	20 kilometers north of Enterprise	Two transport trucks collided head-on near McNally Creek. The highway was closed for four hours until the accident site could be cleaned up and traffic allowed to safely pass. Fatalities – 1 Injuries – 2
Sept 23, 2011	Yellowknife	An Arctic Sunwest Twin Otter float plane crashed in a parking lot after unsuccessfully attempting to land at the float base near Latham Island. The plane attempted to abort the landing but was unable to gain sufficient altitude before clipping power lines and spiraling nose first into the empty lot between two buildings. Nobody on the ground or in the buildings was injured in the accident. Fatalities–2 Injuries–7
Oct 7, 2011	Pethei Peninsula	An Air Tindi Cessna 208B crashed into a cliff. Fatalities – 2 Injuries – 2

When	Where	Impact
	along the coast of Great Slave Lake	
Sept 9, 2013	McClure Strait north of Banks Island on the opposite side of the island from Sachs Harbour	Helicopter operating with the Canadian Coast Guard research icebreaker Amundsen crashed into the Arctic Ocean. Fatalities 3

NWT transportation infrastructure includes a network of roads, ports and airports and a rail connection to Hay River.

Motor vehicle accident / Ice roads accidents

Overall, the NWT has 2,200 kilometers of all-weather roads complemented by 2,100 kilometers of ice roads. As may be expected, the areas with the heaviest traffic and the largest populations (e.g., Yellowknife) have the highest number of accidents. Accidents in the Inuvik and Fort Simpson areas are more likely to end in injury or death than those of North and South Slave Regions. Highway Rescue units are only available in the North and South Slave regions. This is most likely the reason that they have a lower percentage of accidents that end in injury or death.

Winter access roads are open in winter, usually from about mid-December to late March, but may vary with weather conditions and locations. Some of them are privately operated and maintained, and offer no services, emergency or otherwise. Unleaded gas, diesel and propane are available in most communities on the highway system, with repair facilities in larger towns. Distances between these services may be significant, however, and hours of operation limited.

Figure 11: Fuel Truck Broke Through Ice Near Aklavik NWT – April 2012 (Source: CBC News, Francis Gruben)

To improve on safety, all trucks on ice roads must be equipped with two way radios and drivers must report as they approach the numbered portages to alert each other of their presence on the same portage.

Each year, collisions with wildlife, particularly bison, cause vehicle damage and injuries on NWT highways. Most incidents occur along Highways 3 and 5. Bison can also be found on and alongside Highway 7.

Marine Accident

There is also a well-developed marine freight route along the Mackenzie River to the Arctic Ocean. Within the Mackenzie watershed there are five sectors: the Mackenzie River from Hay River to Tuktoyaktuk, including the Peel River; the western Arctic coast (Beaufort Sea area); the Athabasca River and Lake Athabasca system; Great Slave Lake; and the Liard River and Fort Nelson River System. Navigation problems on the Mackenzie River include a short shipping season (beginning of June to mid-October), ice conditions, low water levels (especially in the fall), four sets of rapids and decreasing daylight in the fall. Because of the rapids, barge tows must stop and each barge must be carefully moved through a channel to protect the cargo.

Aircraft Accident

Statistically, approximately 30% of aviation accidents are weather related and up to 75% of delays are due to weather (NAV, 2005). The NWT experiences a number of aviation weather hazards including icing, poor visibility, wind shear and turbulence, weather fronts and thunderstorms. Aging infrastructure at some airports increases the community hazard exposure.

Climate Change Impacts

- Infrastructure associated with transportation is expected to be affected by climate change (see 5.3.4 Critical Infrastructure Failure – Other).
- There could be a shift in means of travel, for instance from driving to flying, with reduction in the availability of ice roads and bridges.
- Accidents can be expected with thinning ice conditions on ice roads and ice bridges, which could result in the need for more search and rescues.
- More intense and frequent snowstorms impact the transportation of goods and services in the region increasing vulnerability to other hazards and leading to economic loss (Pryor and Cobb, 2007 p. 2).
- Increased Arctic shipping in the Northwest Passage (Lemmen and Warren, 2004 p.135).

Community Meeting Feedback

The issue of transportation accidents was raised at several of the meetings held throughout the NWT. There is concern for poor highway infrastructure and the transportation of dangerous goods. The issue of aircraft accidents has been front and center in the NWT over the past few years with several accidents involving the loss of life over the past two years.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT;
- High damage potential if near or in a community; and
- Potential to affect any community in the NWT.

5.3.3 Critical Infrastructure Failure – Energy Crisis

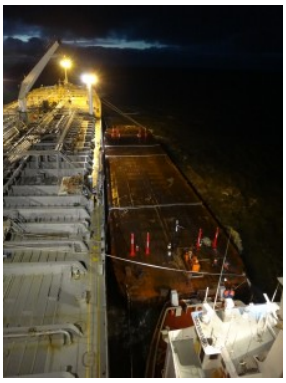


Figure 12: Fuel Barge from Hay River (Source: 2014 Northern Transportation Company Ltd. Shane Sadoway)

Definition	**Class**
Failure to provide energy required to meet basic human needs, sustain the economy, and protect public safety and security	Human-induced Hazard

NWT greatest impacts to date

Declared state of emergency

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
energy emergency	A situation where energy supplies are insufficient to maintain minimal levels of service to an area or region.
oil and natural gas shortage	Oil and natural gas are an energy source used for heating, cooking, and electricity generation.

Vulnerability	Description
People	Given the severe weather in the north, the population relies on a steady and safe supply of energy to provide heating in the winter. Most areas of the NWT are extremely isolated and the health hazards of being left without energy/power are both physical and mental.
Infrastructure	Water lines and sewage lines can freeze and break in severe winter weather without heat or flowing water. Loss of power can cause a situation where pipes burst in the colder temperatures.
Communications	Loss of electrical power can cause disruption to communication systems such as radio and television which people rely on for information.

NWT Exposure/History

When	Where	Impact
May 31, 2011	Norman Wells	Due to an Enbridge pipeline malfunction, the town nearly ran out of natural gas. There are 268 households and over 100 businesses which would be directly impacted by the shortage. A determination was made that, if necessary, supply would be cut-off to commercial users first in order to preserve as much gas as possible for the households.
Jan 28, 2013	Norman Wells	The town of declared a state of emergency as gas shortages became acute.

In the NWT, there are three main energy sources used to generate electricity: natural gas, diesel fuel and hydro resources. Hydroelectric generation is used in eight communities in the Great Slave Lake area, while natural gas-fired power plants provide electricity to the community of Norman Wells. The remaining 24 communities have electricity provided by diesel-fired power plants. Alternative Energy Programs are being put in place such as a waste-heat recovery system in Holman, wind turbines in Sachs Harbour and a solar wall in Fort Smith. Fuel must be shipped into the communities by road, pipeline, barge, ice road or air. A shorter ice road season, barge or pipeline disruption, or prolonged extreme weather events can lead to shortages of fuel in communities.

Since 1999, residents and businesses in the Town of Inuvik have had their energy provided by two natural gas wells at the Ikhil site. In November 2010, one of the two wells had an unexpected inflow of water, resulting in the well no longer being able to produce natural gas. Efforts to repair the well (K-35) were unsuccessful (Inuvialuit Petroleum Corporation, 2007). It is no longer in operation. The second well (J-35) currently provides part of the town's energy supply, although an independent reserve report confirmed that the recoverable reserves are significantly less than previously estimated (Inuvialuit Petroleum Corporation, 2007). As a result, Ikhil can no longer provide a long-term natural gas supply. As an interim measure, the town of Inuvik is using a mix of propane and air, referred to as synthetic natural gas (SNG), which is now being injected into the gas distribution system for customers.

In November of 2013, Inuvik, was cut off from new shipments of propane because the ferry was not operating and ice roads had not opened yet. The town was able to switch from propane to natural gas from the Ikhil Natural Gas Facility but this option will not be available in the future.

Climate Change Impact

- Shortened ice road seasons could reduce the time available for transportation of fuel leading to shortages.
- Energy transportation systems (roads and pipelines) built in or on permafrost could be damaged due to climate change.
- Climate change caused drought could strand or limit the passage of fuel barges on the Mackenzie River.

Community Meeting Feedback

This issue was addressed at each community meeting. In most cases the concern was the remoteness of much of the NWT and the difficulty in ensuring reliable energy infrastructure was in place. Residents in the South Slave spoke of the "single" supply of fibre optic cables and power lines and the fact that an accident, fire or storm could severely impact the region. The issue was most acutely felt in the Beaufort Delta where Inuvik has dealt with gas shortages in the past few years. Inuvik is introducing the transportation of liquefied natural gas this coming year as a way to alleviate their reliance on the natural gas pipeline. Residents confirmed that Norman Wells was close to declaring a state of emergency due to gas shortages in 2011 and 2013.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths if complicated by weather (shortage combined with blizzard or extreme cold);
- Current and historical experience in the NWT; and
- Potential to affect many communities in the NWT.

5.3.4 Critical Infrastructure Failure - Other

Figure 13: Bluefish Dam (Source: NWT Power Corp)

Definition

Failure of services that meet basic human needs, sustain the economy, and protect public safety and security

Class

Human-induced Hazard

NWT greatest impacts to date

- Power failures
- Road Damages

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
airport	Incidents such as accidents, weather and systems failure could be the cause of an airport shut down.
sewage	Collapse of sewage facilities could lead to water contamination and bacterial concerns.
telephone	Disruption to land line or cell phone (where available) service would further isolate communities which would then have to rely on satellite phone service.
satellite	Satellite failure could lead to a loss of telecommunications links.
microwave towers	Microwave towers are used to relay phone and internet signals in remote areas where cables and fibre optics do not exist.
dam failure	Dam failure can disrupt power supply to those areas of the NWT which rely on this source of power.
structural collapse	Building collapse is a concern throughout the NWT where buildings are situated on pilings, some of which are showing serious deterioration causing the buildings to shift.
ice road collapse	Many communities are serviced by ice roads during the winter season. These roads allow necessary materials to be transported to isolated areas at a more affordable cost than is usual with air transportation. Warmer winters directly impact the length of time these roads are open.
bridge collapse	Bridge collapse would isolate communities with little to no alternative travel routes.
road sluffing	Due to shifting ground many roads are “sluffing” or collapsing.
low water levels limiting barges ability to reach community	Many communities rely on summer barge supplies to restock for long winters. Low water levels make it difficult, if not impossible in some cases, for barges to unload their cargo of material and fuels to many communities. This leaves the communities dangerously exposed in the winter without adequate supplies of fuel in particular.

Vulnerability	Description
People	People in the NWT live rely on infrastructure to keep them supplied and in touch with other communities. Any infrastructure collapse could be catastrophic given the harsh nature of most areas where people live.
Infrastructure	Airports are subject to closure regularly in the winter, ice roads rely on a consistent pattern of cold weather and all weather roads are also subject to closure during winter season. Any infrastructure collapse is also exacerbated by the fact that the isolated nature of these communities makes it extremely difficult to repair failed infrastructure. Given the isolated nature of most of the communities within the NWT, any incident which closes down an airport could be severe.
Communications	Communications break downs are common throughout the north as severe weather can shut down facilities and “power bumps” often hamper effective communications. Again, given the isolated nature of the area, repair of these systems is often extremely difficult.

NWT Exposure/History

When	Where	Impact
Jan 2003	NWT-wide	Mid-winter temperatures ranging from -1°C in Yellowknife to an incredible 7°C in Fort Smith. The mild El Nino weather put winter road and ice bridge construction behind schedule by a few weeks and created problems for mining and oil and gas industries, which rely on the frozen roadways to transport yearly supplies.
Oct 16, 2009	Yellowknife	The Mackenzie Valley Land and Water Board granted an emergency exemption to the NWT Power Corporation (NTPC) to replace the failing Bluefish dam. Evidence provided by the corporation and EBA Engineering Consultants Ltd. indicated that the dam was in a critical condition. Leakage from the dam's walls had increased almost 400 per cent in two years and accelerated the decay of the dam's timber spillway and crib.
Oct 2011	Wekweètì	Days of dense fog meant flights couldn't land. Effectively cut the community off from groceries, supplies and travel for a week and stranded other community members in Yellowknife until the fog cleared. Many airports, like the one in Wekweètì, don’t have GPS help on approach. Instead, pilots must be able to see the runway in order to land.
Oct 6, 2011	10 communities	Telesat’s Anik F2 satellite suddenly ceased operating. Remote northern locations were the most affected, with 10 of 33 NWT communities served by NorthwesTel seeing disruptions from the outage. First Air airline cancelled 48 flights, stranding about 1,000 passengers just before the Thanksgiving long weekend.

When	Where	Impact
Feb 14, 2012	Yellowknife	A Canadian Armed Forces Griffin helicopter struck a power line on its way to Yellowknife airport causing power outages to the city. The power outage lasted over an hour and the city relied on diesel generators to get the city powered up. The damage caused was significant and Northland Utilities warned of rotating outages for the next day while asking commercial users with backup generators to use those to lessen power needs.
Jan 30, 2013	Behchokǫ̀	Malfunction of a piece of equipment out at the Snare Hydro substation caused 200 to 250 homes in Behchokǫ̀, and 8,200 homes in Yellowknife to lose power for up to 12 hours. Caused property damage due to frozen pipes.
Sept 18, 2013	Dehcho Region	A damaged NorthwesTel fibre optic cable cut off long-distance calling and Internet services. People had to deal with paying only by cash, having no cellphone access and no Internet. Using cash was the sole method of payment accepted at Fort Simpson's Northern Store during a region-wide Internet and long-distance phone disruption. A melted fibre terminal caused by a forest fire at the Morrisey Microwave Site was the reason for the disruption, the company confirmed.

Consequences Classification for the failure of the Duncan and Bluefish dams is considered to be low - no increase in loss of life; low social, economic and/or environmental losses.

Climate Change Impact

- The safe travel season on winter roads is shortening (IPCC, 2013 p.5).
- Overuse of ice roads due to a shortening of the ice road season could lead to dangerous conditions.
- Ice roads provide necessary infrastructure for shipment of food that is not produced locally (Infrastructure Canada, 2006 p.13).
- Increases in the number of freeze-thaw cycles could have major impacts on roads, bridges and other infrastructure in the north.
- Delayed freeze-up in the fall, thinner ice and an earlier spring melt, result in a shorter winter road season despite improved technology and more time and effort being applied to construct and maintain roads (NWT MENR, 2008 p.9).

Community Meeting Feedback

The issue of infrastructure failure was discussed at all of the regional meetings. The biggest concern commented upon was the present state of the highways and roads throughout the NWT and the reliance on seasonal roads. The span of time these seasonal roads could be accessed was believed to be directly affected by climate change according to many residents. The reliance on air transportation and the implications of an airport closure anywhere in the Territories was also commented upon. At the South Slave regional meeting there was also

mention of the fact that any infrastructure failure in Alberta, be it road or airport, would also have an immediate impact on the NWT as the Territory relies on Alberta for supplies and also for emergency response in some areas.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (especially structural collapse);
- Current and historical experience in the NWT;
- Potential to affect any community in the NWT;
- Aging infrastructure;
- Rapid structural deterioration of critical infrastructure in the extreme environment; and
- Lack of options and “backups” in services.

5.3.5 Critical Infrastructure Failure - Water Contamination

Figure 14: Water Treatment Plant – Łutselk'e, September 2012 (Source: GNWT, MACA)

Definition	**Class**
Serious contamination of drinking water or loss of supply, that presents a danger to the general health of the public	Human-induced Hazard
NWT greatest impacts to date Boil water advisories	
Climate Change Projected to increase both frequency and consequence	

Cause/Explanation

Water contamination is a result of biological or chemical contamination of the community water system.

Vulnerability	Description
People	The levels of contaminants in drinking water are seldom high enough to cause acute (immediate) health effects. Examples of acute health effects are nausea, lung irritation, skin rash, vomiting, dizziness, and even death.
Infrastructure	Disasters that destroy infrastructure may result in water contamination by sewage. Chloride ions, usually found in seawater or acid rain, increase the conductivity of water and accelerate corrosion. Chloride can penetrate and deteriorate concrete on bridge decking and parking garage structures, and damage reinforcing rods, compromising structural integrity. It damages vehicle parts such as brake linings, frames, bumpers, and other areas of body corrosion. It impacts railroad crossing warning equipment and power line utilities by conducting electrical current leaks across the insulator that may lead to loss of current, shorting of transmission lines, and wooden pole fires.
Communications	Chloride ions from acid rain significantly aggravate the conditions for pitting corrosion of most metals by enhancing the formation and growth of the pits through a process which weakens them over time.

NWT Exposure/History

The responsibility for ensuring safe drinking water is vested with the Government of the NWT, which has passed specific public health legislation designed to ensure the safety of drinking water supplies. The Department of Health and Social Services is the regulator and is responsible for enforcing the *Public Health Act*, *Water Supply System Regulations*, and *General Sanitation Regulations* as well as ensuring the *Guidelines for Canadian Drinking Water Quality* are met.

Community governments have the authority and responsibility to provide safe potable water to their residents. In communities where the community government is the owner and operator of the water treatment facilities, the community government is responsible for the treatment and safety of the water supply in those operations. Responsibilities include treatment of water to meet the *Guidelines for Canadian Drinking Water Quality*, the submitting of water samples to a laboratory for bacteriological and chemical analysis, and maintaining records of raw water quality, finished water quality and the amounts of chemicals used in treatment.

NWT Exposure/History

When	Where	Impact
2004	Colville Lake	Had no operating water treatment plant. The community has been under a boil water advisory since 2004. The boil water advisor will remain in place until the EHO is satisfied with the regulatory sampling regime.
Spring 2006	Tulita	A precautionary boil water advisory issued because of problems with the filters at the WTP. No bacteria was found in the treated water. The advisory was lifted when the filters were fixed.
2007	Hay River	Boil water advisory during spring break up due to high turbidity.
	Wekweètì	Boil water advisory due to broken chlorine pump.
	Paulatuk	Boil water advisory due to positive bacteriological sample.
2008	Hay River	Boil water advisory during spring break up due to high turbidity.
July 2008 to March 2009	Sachs Harbour	The community spent more than eight months under a boil water advisory after chlorination pumps failed at the local water treatment plant.
2009	Hay River	Boil water advisory during spring break up due to high turbidity.
	Tulita	Boil water advisory during spring break up due to high turbidity.
May 2009	Most of the NWT communities	Oil sands development in the Wood Buffalo Region threatens the water supply to most of the NWT 33 communities which are located on water directly downstream from the oil sands. The main area of concern is that contaminants may be getting into the water system which would directly affect the drinking water of virtually all residents of the NWT.
June to Nov 2011	Sachs Harbour	Boil water advisory for five months due to problems with the hamlet's water treatment plant. No related illnesses were reported.
July 13, 2012	Town of Inuvik	Boil water advisory. There were no illnesses associated with drinking water reported.

Climate Change Impact

- Climate change is expected to result in increased siltation in water systems (Pryor and Cobb, 2007, p. 34) and increased water volumes due to precipitation. This will require adjustment in capacity of water treatment and sewer systems to handle the volume.
- The structural aspects of water systems could be affected by climate change impacting permafrost (Auld, 2007 p. 26).
- Literature indicates that greater bio accumulation of contaminants is expected with climate change, particularly POPs and mercury.

Community Meeting Feedback

The issue of water contamination and the need for clean sources of water was brought up at all community meetings, save those held in Yellowknife. South Slave residents are concerned with what is being put in the water in Northern Alberta by industry as these waters feed the rivers of the South Slave region. Also raised was the contamination of water in the Hay River area by waste from the NTCL yard as well as a chicken barn which is located south of town directly on the Hay River. Throughout the South Slave and Dehcho regions issues were raised over how the placement of sewage lagoons and poor sewage infrastructure could affect the quality of drinking water. In some cases, such as Fort Resolution, the sewage lagoon was built above the water supply which means that any seepage could directly impact the community's water supply.

Oil spill contamination was a concern in Fort Good Hope where the water supply was located directly adjacent the Enbridge pipeline. Any incident with the pipeline would have an immediate impact on the water supply. Tulita and other communities in the Sahtu Region have to boil water each and every spring as hazardous materials are left on the ice during the winter and fall into the water during spring break-up.

Residents of the Beaufort Delta spoke of the isolated nature of their water supply and the need for an improvement to the local infrastructure in order to ensure a safe supply of water.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT; and
- Potential to affect any community in the NWT.

5.3.6 Weather – Other Extreme

Figure 15: Radiation fog, Inuvik airport tower from weather instrument site, September 2001 (Source: NAV Canada, Ken Kehler)

Definition

All weather related hazards excluding wind storm and cold weather storms

Class

Natural Hazard

NWT greatest impacts to date

- Power failures
- Road Damages

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
extreme cold	Temperatures of -40 or lower for a period of at least seven days.
frost	A deposit of ice crystals that forms through a process called sublimation.
drought	Abnormal shortage of water, typically occurring throughout the summer months over an extended period of time.
fog	A cloud based at the earth's surface, consisting of tiny water droplets, or under very cold conditions, ice crystals or ice fog found in calm or low wind conditions.
geomagnetic storm	Disturbances in the geomagnetic field caused by gusts in the solar wind that blows by Earth. Energetic particles thrown out from the sun interact with the earth's magnetic field producing magnetic disturbances and increased ionization in the ionosphere, 100 to 1000 km above the earth.
heat wave	Significant rise in ambient temperature above the mean for an extended period of time, or by a combination of high humidity and lack of air motion.
lake effect storm	Lake-effect storms occur along the lake shore caused by the modification of cold, subfreezing air by the relatively warmer lake water.
lightning and thunder storm	Ascending moisture laden unstable air leads to the formation of thunderclouds which transmit electrical charges of up to 100 million volts of electricity from cloud to cloud or ground.
hail storm	Precipitation in the form of ice balls of five millimeters or more in diameter.
Vulnerability	**Description**
People	Extreme cold temperatures can cause injury and death. Temperatures of -55 and colder have an extremely high risk of causing injury as exposed skin can freeze in less than 2 minutes. Temperatures of -48 to -54 have a very high risk of causing injury as exposed skin can freeze in 2 to 5 minutes. Temperatures -40 to -47 have a high risk of causing injury as

Vulnerability	Description
	exposed skin can freeze in 5 to 10 minutes. Under foggy conditions, visibility is reduced to less than 1 kilometre and vehicle accidents can result (see Transportation Accidents Hazard). Ocean and lakes areas, and in particular the large lakes such as Great Bear Lake and Great Slave Lake, are cloud and fog prone through the fall until they freeze over completely (see Transportation Accidents Hazard).
Infrastructure	Extreme cold temperatures can cause significant property damage, mechanical malfunctions and burst pipes. Drought can cause crop failure, depletion of municipal water sources, increase in forest fire risk (see Fire/Explosion Hazard) and insufficient water flow through waterways. Lighting storms can lead to fires (see Fire/Explosion Hazard). Combining heat wave with the dry climate of the Arctic creates ideal conditions for wildfires (see Fire/Explosion Hazard).
Communications	A geomagnetic storm can knock out communications and have a variety of effects on technology. Radio waves used for satellite communications or GPS navigation are affected by the increased ionization with disruption of the communication or navigation systems. The high energy particles affect satellites causing failure or equipment damage. The magnetic disturbances directly affect operations that use the magnetic field, such as magnetic surveys, directional drilling, or compass use. Magnetic disturbances also induce electric currents in long conductors such as power lines and pipelines causing power system outages or pipeline corrosion.

NWT Exposure/History

When	Where	Impact
January 2008	Yellowknife, Norman Wells and Fort Simpson	Cold snap of nine straight days of -40°C temperatures. Lingering ice fog obscured entire neighbourhoods, caused several flight disruptions, lengthened work commutes, and halted mail delivery. The -50°C wind chill and freezing fog caused a 90 minute power failure and impelled the homeless to fill emergency shelters. Schools were closed.
July 20, 2008	Yellowknife	An intense 20-minute storm dumped enough hail and rain to flood streets and grounds in a metre of water in some areas. Drains were unable to keep up with the hail-chocked flow and backed up. During the peak of the storm, residents were seen canoeing across some streets. The golf-ball size hail forced construction workers and others to flee for cover.
January 2013	Behchokǫ̀	Cold weather was blamed for a power outage in Behchokǫ̀ which resulted in half the community without power for about 12 hours. That was the second major power outage in the territory that week. That same week , Norman Wells prepared to evacuate the town as its natural gas service failed, leaving about half of that community without heat in cold temperatures.

Climate Change Impact

- A decrease in extreme cold events is projected. Mean temperature will rise by 4-8 ^{o}C by 2050, and an increase in heat waves are likely.
- Little change in frost events projected to 2050 (Bruce et al, 1992).
- Increase in intensity and frequency of rain events, 5 to 10% increase (of 10mm events) to 2050.
- Increase fog events, with increased humidity.
- Increase in lake affect storms.
- Temperature increases are likely to increase lightning.

Community Meeting Feedback

There was much discussion amongst residents at all meetings regarding the increase in extreme weather. This mostly included higher temperatures in the summer months and a shifting in seasons. Whereas in the past summer weather deteriorated in late August, recent years have seen warmer weather lasting into late September. There was also a general agreement that, although the NWT is not as consistently cold has it has been in the past, there are wilder swings and more extreme storms than in the past.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (especially lightening and extreme cold);
- Current and historical experience in the NWT; and
- Potential to affect any community in the NWT.

5.4 Moderate Hazard

5.4.1 Industrial Emergency

Figure 16: Diavik Diamond Mine Site (Source: Photo Courtesy of the Diavik Diamond Mine, www.diavik.ca)

Definition	**Class**
Emergencies involving businesses that handle dangerous goods, hazardous wastes or chemicals or engage in potentially hazardous activities	Human-induced Hazard

NWT greatest impacts to date

Environmental Damage

Climate Change

Projected to increase both frequency and consequence

Type	**Cause/Explanation**
mine emergency	A situation involving an accident or incident at a mine site which causes potential threat to health, environment or property. Can include explosions/fire, cave-in's, or personal injury.
oil spill	The release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution.
gas leak	A leak of natural gasses from a pipe or other containment, into a living area or any other area where the gas should not be.
contamination	The improper presence of a harmful substance in the natural environment, or at a workplace.
hazardous material spill	A spill involving any material which can be hazardous to the people or the environment.
radiological emergency	An emergency where radioactive material in significant concentrations escapes into the environment. If the concentrations of the materials are high enough, they could be dangerous to health.
Vulnerability	**Description**
People	Industrial accidents have an enormous impact on the health of workers and on the economy in general, which is reflected in the death, disability and personal suffering of workers on one hand, and in absence from work, loss of productivity and health costs on the other.
Infrastructure	Industrial accidents can have a dramatic negative affect on physical and virtual systems which are considered critical. This would include fires or explosions, oil spills which could impact water treatment and dam failure which could impact power supply.
Communications	Communications hubs in small communities could be damaged by an industrial accident in the community.

NWT Exposure/History

Mining and oil and gas industries are the most common hazardous industries in the NWT. In mining, traumatic injury remains a significant problem. Common causes of fatal injury include rock fall, fires, explosions, mobile equipment accidents, falls from height, entrapment and electrocution. Less common but recognized causes of fatal injury include flooding of underground workings, wet-fill release from collapsed bulkheads and air blast from block caving failure. The systematic application of risk management techniques has contributed to a substantial decline in injury frequency rates (Donoghue, 2004).

When	Where	Impact
From 1943 to 1945	Norman Wells, NWT, to Whitehorse, Yukon Territory	CANOL Crude Oil Pipeline No. 1 lost approximately 17,838,500 L of oil through spills and 9,864,400 L was left in the line and storage tanks. Although some burning was done during salvage operations, most residual oil was drained onto the soil surface.
April 06, 1975	High Arctic Islands	Pan-Arctic Oils, Jet/Turbine Oil, Drake D-73 Well Site - 22,817 Gallons (Hazardous Materials Spill Database).
Sept 18, 1985	Beaufort Sea	Esso, Diesel Fuel/ Heating Oil, Esso Rig #7, W. of Pelly Island - 103,000 Gallons Spill (Hazardous Materials Spill Database).
Sept 07, 1986	Norman Wells	Esso Resources Canada Ltd. Crude Oil, Imperial Oil Tank #53 Mainland, Sahtu Region - 21,136 Gallons.
Aug 20, 1991	Unknown	Production Processing Facility, Esso Resources Canada Ltd. Crude Oil, Imperial Oil Tank #53, Mainland Facility - tank leak and equipment damage 16,800 Gallons (Hazardous Materials Spill Database).
May 04, 1992	Norman Wells	Interprovincial Pipelines, Crude Oil, Norman Wells Pipeline, 25 km N of Ft Simpson - 26,420 Gallons (Hazardous Materials Spill Database).
May 05, 1997	Norman Wells	Imperial Oil, Crude Oil Transfer line, CPF to tank 401 - 63,000 Gallons (Hazardous Materials Spill Database).
April 02, 2003	300 kilometres northeast of Yellowknife	BHP Diamonds Inc. NSL-Fox Fuel Tank Farm – 62,500 L Diesel Fuel (Hazardous Materials Spill Database).
May 10, 2011	North of Fort Simpson	An Enbridge pipeline leaked oil into the environment near Willowlake River. Approximately 1500 barrels of oil were spilled.
2012	Norman Wells	Imperial Oil Resources NWT Ltd. Norman Wells – 80,000 L Oil Emulsion (Hazardous Materials Spill Database).

Other Hazard Specific Information

The Radiation Protection Bureau of Health Canada operates a network of radiological air monitoring stations across Canada. Each site is equipped with a high-volume air sampler, a precipitation collector, and a thermo-luminescent dosimeter for gamma radiation measurements. The Yellowknife site has equipment for the measurement of radioxenon.

There are several abandoned and decommissioned uranium mines in the NWT. A number of shipping points along the Northern Transportation Route were contaminated with low levels of natural radionuclides from the loading and unloading of uranium ores (AMAP Assessment, 2009).

Climate Change Impact

- Permafrost melting could cause mine tailing ponds to degrade (Auld, 2007) or lead to the failure of mine water retention dams.
- Industrial activity is expected to increase with easier access to natural resources afforded by climate change.
- May alter table impacts of frozen arsenic encapsulation at a decommissioned gold mine (Pryor and Cobb, 2007, p.34).

Community Meeting Feedback

During the community meetings there was little in the way of information received regarding industrial accidents. Community members in the South Slave region discussed the need for clean-up at the Northern Transportation Company Ltd. (NTCL) yard in Hay River. Residents of the Sahtu and Beaufort Delta also spoke of their concerns with the oil and gas industry which operates in those regions. Much of the discussion centered on prior industry and what was buried or left in dumps throughout all of the regions. Included in this discussion were arsenic in the Yellowknife area and contaminated materials buried or stored throughout the Sahtu and Beaufort Delta.

Also discussed at length at each of the meetings was the transportation of dangerous goods throughout all regions and the lack of knowledge among residents as to what was actually being transported through their community.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT;
- High damage potential if near or in a community;
- High environmental potential impact; and
- Potential to affect any community in the NWT but mainly the industrial mining and oil and gas operations.

5.4.2 Weather – Wind Storm

Figure 17: Microburst Damage to Trees in Fort Smith, September 2012 (Source: Northern News Services)

Definition	**Class**
Strong weather characterized by damaging movement of air	Natural Hazard

NWT greatest impacts to date

- Property Damage (drill rig)
- Infrastructure (transmission tower)

Climate Change

Projected to increase both frequency and consequence

Type	**Cause/Explanation**
wind storm	Weather event that includes wind speeds that exceed what is expected for a particular area.
hurricane/cyclone	Large storms with winds of greater than 110 kilometres per hour.
tornado and water spout	A funnel cloud of rapidly rotating air, with an intense low pressure of rising air at the centre.
dust and sand storms	When blowing dust covers a large area, the event is termed a dust storm.
microburst	Pattern of intense wind that descends from rain clouds, hit the ground, and fan out horizontally.

Vulnerability	**Description**
People	All wind storms have the potential to cause injury or death due to structural damage, flying debris or storm surges. Hurricanes also can cause flooding (see Flood Hazard). Tornados can cause many injuries and death but are very rare across the NWT.
Infrastructure	Heavy winds can cause great damage to buildings and infrastructure, and knock out power across large areas. Tornados can cause heavy damages but are very rare across the NWT.
Communications	Heavy winds are often responsible for damage to communications towers.

NWT Exposure/History

When	Where	Impact
July 30, 1978	Near Yellowknife and near Behchokǫ̀	A tornado toppled a tower near Yellowknife and then ripped up a transmission tower near Behchokǫ̀. It was the third tornado reported in the NWT since 1960.
1985	Beaufort Sea	An Oil rig on the Minuk I-53 sacrificial beach island was lost during a severe storm in the Beaufort Sea. The drill rig, modules, camp and ancillary equipment were destroyed.
Sept 14, 2012	South of Fort Smith	A thunderstorm was accompanied by both windshear and micro-bursts. The wind event affected a vast area, including Pine Lake, 60 km in Wood Buffalo National Park, where thousands of trees were downed, with a few damaging cottages (LADIK, 2012).
Aug 2012	Beaufort Sea	A very strong cyclone developed over eastern Siberia and strengthened rapidly over the central Arctic Ocean north of Alaska. It reached near-hurricane wind speeds and, at its peak on August 6, covered two-thirds of the Arctic Ocean. The storm brought warm winds and in the end was likely responsible for a very rapid loss of ice in the western Arctic. On three consecutive days, sea ice extent dropped by nearly 200,000 square km per day.

On July 19, 2012 at 9:30 p.m. photographic evidence from a cell phone was taken of a funnel cloud near the Inuvik Airport. This was one of the most northern sightings of a funnel cloud anywhere in the world. It did not touch down.

Climate Change Impact

- Tornado activity is expected to move further north, with warming temperatures.
- Observations show strengthening of storms and strong winds over time.
- Strengthening of cyclone activity in the Artic has occurred and is expected to continue (CSA, 2010).

Arctic cyclone activity has increased during the second half of the twentieth century (NASA/Goddard Space Flight Center, 2008). Warming temperatures could bring more tornado activity further north. Low-pressure systems from mid-latitudes are moving further North, particularly in the noted time period from 1950 to 2006 (Cassano et al., 2006; Hakkinen et al., 2008). From a risk management perspective, the assumption should be made that there will be more frequent windstorm and tornado events in the future (IBC, 2012).

Community Meeting Feedback

There was agreement among the residents of all meetings that the NWT was seeing more extreme windstorms in recent years. Residents of the South Slave spoke of seeing an increase in micro-bursts over the past few years.

Key Risk analysis considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Some historical experience in the NWT;
- High damage potential if in a community; and
- Potential to affect any community in the NWT.

5.4.3 Human Disease

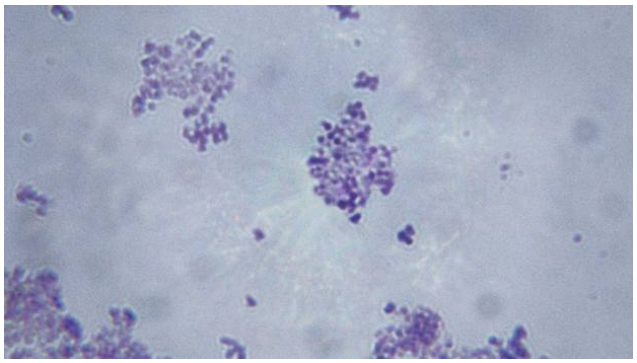


Figure 18: Staphylococcus aureus (Source: Canadian Press, 12 Oct 2012)

Definition	**Class**
A grave or widespread illness that presents a danger to people's health	Natural Hazard

NWT greatest impacts to date

Fatalities 600

Climate Change

Projected to increase both frequency and consequence

Type	**Cause/Explanation**
epidemic	An epidemic is a situation where a disease affects many people in a given area, resulting in illness and potential death. Yearly epidemics cause serious illness and death, especially among those who have weakened immune systems due to age or underlying medical conditions.
pandemic	A pandemic refers to an epidemic that spans a large geographic area and can become a global health emergency.
anthrax	Anthrax is a disease resulting from inhalation of the naturally occurring bacteria of the same name. It is endemic in northern bison, with periodic outbreaks that have killed at least 2,196 bison since the first confirmed outbreak in 1962. Risk of exposure to the disease by humans is most likely to occur through direct contact with infected animals, carcasses or animal parts (e.g. meat, hide, hair, etc.).
Vulnerability	**Description**
People	Injury and death from human disease can severely impact an isolated community where continual medical care is limited.
Infrastructure	While human diseases do not impact infrastructure directly, some disruption in critical services could occur when enough of the population is affected. Support services to remote communities could be cut off during a pandemic or severe epidemic.
Communications	N/A

NWT Exposure/History

When	**Where**	**Impact**
Between 1890 and 1910	Tuktoyaktuk	Between 1890 and 1910 the population was destroyed by influenza.

When	Where	Impact
1902	Fort Resolution, Behchokǫ̀	Measles epidemic killed 60 people in Behchokǫ̀,and 66 in Fort Resolution.
1928	Mackenzie District	Influenza epidemic sweeps through the Mackenzie District, killing about 600 people. Approximately 10 to 15% of the population of each village.
1952	Wood Buffalo National Park	Cutaneous anthrax was retrospectively diagnosed in two wardens who developed skin lesions after they handled a bison carcass. Both responded to antibiotic therapy.
Summer 1962	Hook Lake	Two people working with infected bison carcasses during the Hook Lake outbreak contracted anthrax. One was exposed while performing a necropsy without the use of appropriate safety precautions, and the second was exposed while working on heavy equipment that had been used in the outbreak response. Both individuals received prompt medical attention.
Since 2008	NWT wide	Methicillin-Resistant Staphylococcus Aureus (MRSA) infections. 55 hospitalizations (5 of them had to be flown south for treatment). Fatalities 2
Nov 2009	NWT wide	H1N1 - 45 hospitalizations. Fatalities 1

Pandemic

Worst case scenario in the GNWT Pandemic plan – each community may be completely isolated and little or no extra resources (human or material) will be available from the Region, Territory, or Nation during the Pandemic period.

Climate Change Impact

- Potential for increasing levels of infectious disease, malnutrition and pandemics.
- In the past diseases might not have survived in the cold temperatures and the ice of the Arctic but as the region warms new diseases could be introduced.

Community Meeting Feedback

Residents believe there is a higher risk of a pandemic hitting the North Slave region due to the influx of travellers and tourists to the city of Yellowknife. There was also concern for the lack of formal coordination for medical evacuation.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths;
- Pandemic can impact evacuation or treatment;
- Current and historical experience in the NWT; and
- Potential to affect any community in the NWT.

5.4.4 Ice Hazard

Figure 19: Mackenzie River Breakup near Tulita (Source: GNWT, MACA)

Definition	**Class**
Formations or movements of ice which cause loss of life, property and/or environmental damage	Natural Hazard

NWT greatest impacts to date

- Property Damage (houses)
- Infrastructure (roads)

Climate Change

Projected to decline

Type	Cause/Explanation
seabed gouging by ice, strudel scours	Occurs when floating ice features (typically an iceberg or sea ice) drift into shallower waters and their keel comes into contact with the seabed.
ice override (ivu)	An ice shove, Ivu, or shoreline ice pileup is a surge of ice from an ocean or large lake onto the shore.
ice flow, iceberg, ice island, sea ice	Sea ice is any form of ice found at sea which has originated from the freezing of water and can pose a hazard due to its growth, decay and drift. An iceberg is a piece of glacial ice which has broken off and become free-floating. Ice islands are large tabular icebergs with thicknesses ranging up to 60 meters and lateral dimensions ranging upward to approximately 40 x 40 km. Because of their relatively great thickness, they have often been observed grounded at water depths greater than 20 meters, and may represent the strongest variety of ice in the Arctic Ocean.

Vulnerability	Description
People	Injury and loss of life can occur when oil rigs, boats or ships are damaged or sunk by ice (see Transportation Hazards).
Infrastructure	Icebergs still threaten offshore oil rigs, fishing boats and ships. Ice shoves can damage buildings that are near to a body of water. Seabed gouging or strudel scour can damage off shore oil rigs or pipelines (see Industrial Hazards).
Communications	None

NWT Exposure/History

When	Where	Impact
Jan 12, 2000	Near Fort Providence	A Northbound Super-B-Train truck hauling diesel fuel crashed through the Mackenzie River ice crossing. Driver

When	Where	Impact
		was treated for hypothermia.
Feb 20, 2007	Parry Peninsula	A hunter went adrift on an Arctic ice floe when winds caused his land tether to break. A Canadian Forces helicopter search and rescue team made a daring jump onto the ice floe and stayed with the stranded hunter overnight. It was below -50°C with the wind chill.

Elders and hunters have developed a detailed understanding of the ocean and weather conditions that may cause sudden changes in ice conditions, and generally try to avoid unnecessary risks when traveling on the sea ice. The sea ice can be dangerous to navigate because it is constantly shifting and can be a hazard to offshore structures. It can be either fast ice, which stays close to shore, or drift ice, which moves around and grinds together with great force to form ridges.

Icebergs can represent a serious threat to shipping, because they are difficult to see and avoid. Historically, numerous ships were lost due to iceberg collisions. In the modern era, ships avoid bergs by taking advantage of tracking data about especially large icebergs, along with utilizing technology, which can be used to identify upcoming bergs in the path of a ship.

Climate Change Impact

- A decline sea ice cover is associated with climate change (IPCC, 2013).
- Navigation and shipping is more risky with sea ice becoming less predictable.
- Opening of areas previously covered with sea ice, brings security issues, and makes passage or access to natural resources easier.

Community Meeting Feedback

The issue of ice hazards was mentioned specifically during the regional meeting held in the Sahtu. There have been incidents where ice has damaged pipes along the shore of the river which are intended to off-load fuel from barges. The same commentary was also heard from residents of the South Slave. There have also been occurrences in Tulita where ice has moved on-shore during break-up causing considerable damage to houses and roads. The other impact of ice has been felt in the span of time seasonal roads can be used. Climate change shortening the winter road season would have a dramatic effect upon many NWT communities.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (especially to watercraft);
- Current and historical experience in the NWT; and
- Potential to affect some communities in the NWT.

5.4.5 Snow Load Hazard

Figure 20: Municipal Garage Roof Collapse in Enterprise, January 28, 2013 (Source: Paul Bickford/NNSL Photo)

Definition	**Class**
Potential collapse of buildings due to the weight of build-up or drifting of snow	Natural Class

NWT greatest impacts to date

Property Damage (Roofs)

Climate Change

Projected to increase both frequency and consequence

Cause/Explanation

Structures are built using historical snow load standards. When the snow load exceeds the standards, due to wetter, heavier, more frequent or drifting snow, structures can collapse.

Vulnerability	Description
People	High numbers of injuries or deaths could occur if an occupied community building or school were to collapse.
Infrastructure	Loss of the building and contents plus loss of the use of this building until repairs or a new structure can occur.
Communications	Potential collapse of microwave towers due to snow load could impact the community's communications.

NWT Exposure/History

When	Where	Impact
May 5, 2004	Inuvik	Samuel Hearne Secondary School roof of the foyer collapse caused by a record-breaking build-up of snow. Due to the timing of the event, no one was hurt in the collapse.
Jan 28, 2013	Enterprise	The roof of an Enterprise municipal garage collapsed under the weight of snow.

Other Hazard Specific Information

Studies show that approximately one fifth of public buildings (22%) in the NWT are at risk of collapse due to changing/increasing snow loads. Public buildings at risk include schools, hospitals, community centers and medical centres. Of those buildings at risk, about 10% have been retrofitted since 2004, and another 12% are under a snow load watch status. While studies are being completed on snow loads in the NWT, an adjustment of required snow load

calculation for new buildings has increased by 20% over the National Building Code of Canada, now a Territorial Building Code requirement (Auld and Klaassen, 2010).

Public Works and Services/GNWT has issued a roof snow overload risk estimation checklist that can be used to identify which GNWT structures are potentially at risk of developing snow overloading during any one winter, applicable to every community in the NWT. Ten NWT communities, located in the Dehcho and Sahtu Region, have a high Community Snow Load Risk Factor.

Climate Change Impact

- Change in precipitation patterns.
- Since the 1950s, precipitation has increased by 25 to 35% (Zhang et al., 2000: updated in 2005; CSA, 2010).
- Increase in the days per year of snowfall and a rise in the number of heavy snowfall events (Vincent and Mekis, 2006: updated in 2008).
- The snow/rain mix is changing due to warmer temperatures, and results in a heavier wetter snow thus higher snow loads (Pryor, 2007 p.2).

Community Meeting Feedback

Response amongst participants at regional meetings was mixed on this issue. While many residents agreed that weather was, in general, becoming more extreme, with higher temperatures and more intense winds, there was no agreement on snow loads. Residents of the South Slave spoke of the increased amount of snow they were seeing and the fact that it was heavier and wetter than in the past. Residents of Yellowknife and Dehcho spoke of the decrease in the snow load and residents in the Beaufort Delta were split. The representative of Sachs Harbour spoke of the large amount of snow they received last winter while the representative of Ulukhaktok commented that they received so little snow it was extremely hard to get out for the spring hunt.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT;
- High property damage potential; and
- Potential to affect any community in the NWT.

5.4.6 Earth Movement – Permafrost Degradation

Figure 21: Permafrost degradation of highway (Source: NWT Climate Change Impacts and Adaptation Report, 2008)

Definition	**Class**
Movement of the ground causing wide spread damage caused by loss of permafrost	Natural Hazard

NWT greatest impacts to date

- Power failures
- Road Damages

Climate Change

Projected to increase both frequency and consequence

Cause/Explanation

Permafrost is frozen soil, sediment, or rock that remains at or below 0° Celsius for at least two years. Frozen soils lose strength as they warm, and ice loses all its strength when it thaws. This change in land strength increases the risk of mass movements of land, such as erosion, landslide and riverbank collapse. The flow of water in karst topography due to permafrost melting increases the risk of sink holes. Permafrost thawing may result from natural processes and related environmental disturbance such as wild fire, human activity (such as the clearing of vegetation), extreme climatic events or ongoing climate change (CSA, 2010).

Vulnerability	Description
People	Injury and death could result from the unexpected collapse of land or a building.
Infrastructure	Permafrost has always figured heavily into Arctic infrastructure design, construction, and maintenance (NRTEE, 2009; CSA, 2010). Infrastructure systems in permafrost have depended on the stability of permafrost as a foundation material. Permafrost erosion along streams and rivers is threatening dikes, bridges and culverts.
Communications	Some damage to communication towers possible.

NWT Exposure/History

Ground movement caused by melting permafrost has resulted in the cracking or sloping of building walls and foundations. It has also resulted in heaving, slope failure, sinkholes and potholes, affecting all forms of infrastructure. An example of the effect of permafrost degradation is the roadway buckling on Franklin Avenue hill in Yellowknife. This road was rebuilt after only 3 years in service due to excessive buckling. The cause was a subsurface with variable degrees of support along the length and width of the road (Pryor & Cobb, 2007 p.17).

Permafrost erosion along streams and rivers is threatening dikes, bridges and culverts. Slope failures, in communities such as Sachs Harbour, are becoming unmistakable.

A mixture of different types of permafrost is found under all of the NWT including: continuous, extensive discontinuous and sporadic discontinuous permafrost. In Inuvik (continuous), 40-75% of the existing buildings are likely to incur foundation damage during the buildings' lifetime due to permafrost melting (CSA, 2010). Inuvik, because of its size and location, has been identified as particularly vulnerable. The Factor of Safety (actual or design strength / required strength or loaded stress) has dropped from 1.5 to 1.0 in Inuvik since ground temperatures started increasing. For the widespread discontinuous permafrost zone (where communities of Norman Wells and Tulita are located), the ground temperatures could increase sufficiently to cause fairly strong impacts on building foundations. In Norman Wells, 14-26% of existing buildings could incur foundation damage due to permafrost degradation while the projected impacts on Tulita's buildings were found to be somewhat less severe. (Couture, et al, 2000) Communities in the sporadic permafrost zone are the least vulnerable as most buildings there are not founded on permafrost.

Climate Change Impact

- Thawing of permafrost expected with climate change, top two to three meters will have thawed by 16-20% by 2100 (AMAP, 2012. p.45).
- Planning should include expecting this trend of changes in permafrost to continue in the future. This applies to construction (and thus building codes) and shoreline setback on developments.

Infrastructure adaptation is occurring in the NWT. The Yellowknife airport runway required extensive restoration after the permafrost below began to thaw. A new insulating liner was installed four metres beneath a 100 metre section of the runway. Portions of the Canadian northern highway from Yellowknife to Fort Providence have been abandoned and rebuilt over more stable permafrost.

Community Meeting Feedback

The issue of permafrost degradation was brought up in all meetings held. There was specific mention from Norman Wells in the Sahtu regarding the need to relocate certain buildings which had begun to shift dramatically due to this issue. The same commentary was made in regards to Inuvik. Residents of the South Slave and the Dehcho spoke of the degradation of the permafrost from the point of view that trees and grass were drier during the summer possibly leading to increase fire risk.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (due to building collapse);
- Current and historical experience in the NWT;
- Spontaneous property damage potential (although likely to be gradual); and
- Potential to affect most communities in the NWT.

Figure 22: Permafrost Zones (Source: Atlas of Canada Permafrost Map)

5.4.7 Civil Unrest

Figure 23: Idle No More protesters at the Dehcho Bridge near Fort Providence, NWT, 5 Jan 2013 (Source: Randall McKenzie/CBC)

Definition	**Class**
People breaking the law in order to bring attention to their cause	Human-induced Hazard

NWT greatest impacts to date

- Fatalities 9
- Property Damage (Mine)

Climate Change

Projected to increase both frequency and consequence

Type	**Cause/Explanation**
arctic security	Establishing Canadian sovereignty in the arctic region guarding against the illegal use of Canadian lands, water and resources in the region.
terrorism	The use of violent acts to frighten people in an area as a way of trying to achieve political goals. The systematic use of terror to create a climate of fear in a population.
riot	A situation in which a large group of people behave in a violent and uncontrolled manner. A public tumult or disorder involving violence.
demonstration	An event in which people gather together in order to show that they support or oppose something or someone. A public display of group feelings towards a person or cause.
rampage	To act in a wild and usually destructive way.
Vulnerability	**Description**
People	Civil unrest can directly impact the safety and security of individuals or groups of persons whether or not they are targeted by the unrest. There is also a threat of injury to public responders and those persons involved in the unrest.
Infrastructure	Damage to public and private property is almost always a staple of civil unrest. Acts of terrorism are often targeted against utilities which regulate a society, such as power installations or communication facilities. There is also an increase in cyber terrorism which targets computer systems which control defense establishments as well as public utilities.
Communications	Acts of civil unrest or terrorism can impact communications which disrupt public authorities' ability to deal with the unrest.

NWT Exposure/History

When	Where	Impact
Sept 18, 1992	Yellowknife	A rail car in the Giant Yellowknife gold mine, 230 metres below ground, was destroyed by an explosion. RCMP investigators said a deliberately-planted home-made bomb caused the blast. During the strike there had been picket line violence, deliberately set fires and at least two earlier, non-fatal, explosions. Fatalities 9
Dec 21, 2012	Yellowknife	Idle No More rally - more than 200 people gathered and proceeded to march to a downtown intersection where a ceremony was held. Traffic was disrupted for approximately an hour but there were no incidents.
Jan 05, 2013	Fort Providence	About 150 Idle No More activists blocked traffic across the NWT's Dehcho Bridge Saturday afternoon for about 40 minutes.

Climate Change Impact

Any changes that are predicted to occur due to climate change (all hazards) may be viewed by the public or groups as needing attention, leading to civil unrest.

Community Meeting Feedback

None.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries (especially explosion);
- Current and historical experience in the NWT;
- High damage potential if near or in a community; and
- Potential to affect any community in the NWT.

5.4.8 Earth Movement - Other

Figure 24: Sinkhole near Fort Resolution, 24 Jul 2012 (Source: CBC News/Carol Collins)

Definition

Movement of the ground causing wide spread damage not involving permafrost degradation or earthquake

Class

Natural Hazard

NWT greatest impacts to date

- Fatalities 1
- Property damage $1,000,000
- Infrastructure (Police detachment)

Climate Change

Projected to increase both frequency and consequence

Type	Cause/Explanation
submarine slide	The underwater down slope movement of slope materials under the influence of gravity.
mass movements, landslide, debris avalanche, debris flow and torrent, riverbank collapse	Mass movement or mass wasting of masses of bodies of soil, bed rock, rock debris, soil, or mud which usually occur along steep-sided hills and mountains because of the pull of gravity. This slipping of large amounts of rock and soil is seen in landslides, mud slides, and avalanches. The influence of forest fires appear to be significant in landslide triggering. It has been observed that more active layer detachments occur in areas impacted by forest fires (Dyke 2004).
snow avalanche	Gravitational movement of snow and ice down a sloped surface that commonly results from dense, wet snow falling on dry, loosely packed snow. Ambient temperature and wind conditions are also critical factors.
erosion	“The wearing away and removal of soil particles by running water, waves, currents, moving, ice or wind…” (Maine, The Hazards We Face, p. 17, 2001). Erosion is an ongoing natural process and is only considered to be a hazard when it threatens humans, property or the environment.
expansive soils	Certain clay soils are able to take on water and subsequently expand when they come into contact with it.
land subsidence and sink holes,	The sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by a loss of subsurface support. The risk level for land subsidence depends on several factors: the type of soil and/or rock (areas with carbonate karst are more susceptible), the natural and human induced fluctuations of groundwater, underground human mining activities and the natural processing of rock.

volcano/falling ash	Tephra (volcanic ash) fallout from a large eruption composed of pulverized rock, accompanied by a number of gases, sulphuric acid, and hydrochloric acid. It can be carried by wind for many hundreds or thousands of kilometres.
Vulnerability	**Description**
People	Injuries or even death could occur from riverbank collapse or sinkholes.
Infrastructure	Damage to buildings, roads and other infrastructure has and is being caused by these earth movements including erosion, riverbank collapse and sinkholes. Also increase in maintenance costs associated with landslides and avalanches, even where no infrastructure damage occurs.
Communications	Falling ash from Alaska could impact communications or air travel.

NWT Exposure/History

When	Where	Impact
1908	Fort Smith	A riverbank collapse caused many of the oldest buildings to be dragged down in the mud. Riverside docking facilities were battered and a warehouse burned to the ground.
1950's	Aklavik	Erosion was partially responsible for the relocation of government and businesses from Aklavik (for further information see Flood Hazard).
Aug 9, 1968	Fort Smith	A landslide some 3,300 by 990 ft (1,000 by 300 m) broke away from the riverbank causing property damage and killing one person. It destroyed four homes. Estimated Cost $1,000,000
1982	Tuktoyaktuk	Caused the relocation of an RCMP detachment, the undermining and destruction of a curling rink and the abandonment of an elementary school, which was dismantled in 1996.
May 11, 2008	164 kilometres from Fort Smith, near the Nyarling River	A large section of the road collapsed. Officials with the Transportation Department described the collapsed area as a crater-like hole about six metres wide and six metres deep — large enough to swallow a car. No injuries.
July 24, 2012	Near Fort Resolution	An entire cabin vanished into a massive sinkhole. No injuries.

Across the NWT, people have experienced losses from various earth movement hazards.

Coastal erosion has been severe on Territorial north-western shores, especially near Tuktoyaktuk. This is due to sea level rise, increased storminess with less protective shore ice, land subsidence and permafrost thaw, which are all likely to continue. Erosion has been a long term problem in Tuktoyaktuk.

In Tsiigehtchic, riverbank erosion is threatening two churches and a cemetery. If either church is occupied when further earth movement occurs, there is a high risk of property damage, injury or even loss of life.

Landslides also pose a threat in the NWT. In the Mackenzie Valley, there is an average of one landslide per 5 km. The dominant landslide types are retrogressive thaw flows (28%) and active layer detachments (26%) and about 47% of all landslides took place in moraine deposits (Couture, 2004).

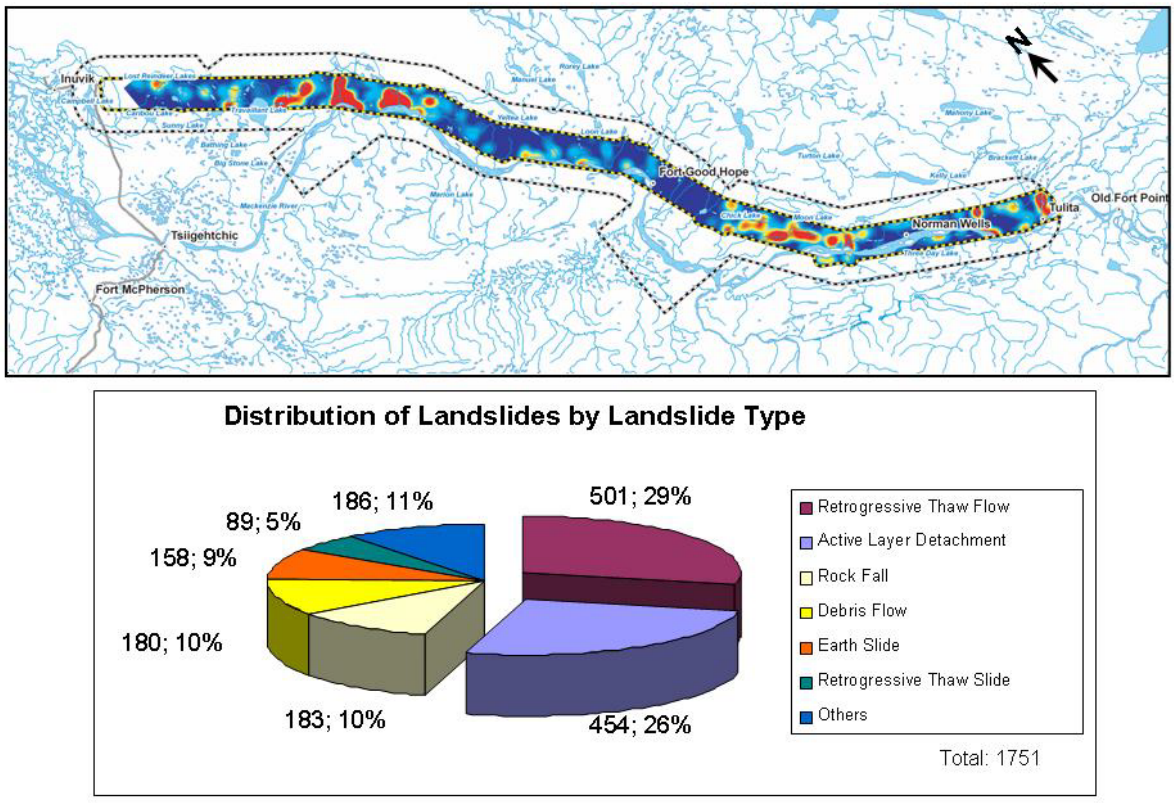


Figure 25: Upper figure—Landslide density map along the proposed pipeline corridor with some "hot spots" of higher density of landslides. These are situated near Travaillant Lake, Thunder River, between Fort Good Hope and Norman Wells, and in the vicinity of Tulita

Lower figure: Distribution of landslide types in the study area (Source: Couture et al., 2007).

Climate Change Impact

- Increased landslides are expected, with thawing of permafrost, reducing soil strength (CIER, 2010).
- Increased avalanches associated with increases in temperature and precipitation (CIER, 2010).
- Warming along with unstable snowpack can lead to more avalanches.
- Excess water draining as permafrost thaws can also lead to subsidence, and excess water creating ponds or draining away (CSA, 2010 p.26).

- Disappearing ice and sea level rise, associated with climate change, is leading to more coastal erosion (Auld, 2011).

Community Meeting Feedback

Residents at several regional meetings spoke of sink holes and slumping as being issues which were affecting road infrastructure.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT;
- High damage potential when near or in a community; and
- Potential to affect many communities in the NWT.

5.5 Low Hazard

5.5.1 Earth Movement – Earthquake/Tsunami

Figure 26: Rock avalanche triggered by October 5, 1985 Nahanni earthquake (Source: Geoscience Canada, 2009/R Horner)

Definition	**Class**
A slip along a fault in the earth causing the ground to shake and/or the large wave caused by it	Natural Hazard

NWT greatest impacts to date

Minor Property damage 1985

Climate Change

Could increase impact

Type	**Cause/Explanation**
Earthquake	Violent shaking of the earth's surface accompanying movement along a fault rupture. Seismic energy traveling in waves may cause damage to structures, generate tsunamis, trigger landslides, liquefaction or other geologic events. There are three types of damaging seismic categories: • Crustal Earthquakes -typically low magnitude ground movement occurring along faults at an average depth of 10 – 20 km; • Sub-crustal Earthquakes - occur at a depth of 30 – 70 km are produced by fracturing and frictional slipping of pre-existing faults along a tectonic plate; and • Subduction Earthquakes - the most powerful type of earthquake, these occur when there is a massive shift at the junction of multiple tectonic plates.

Tsunami	Large wave events generated by water surface impacts or when the floor of a water body moves suddenly, displacing the water above it. Tsunamis can be classified into three categories: • Telegenic Tsunami - a distant, underwater earthquake induced wave which can originate along subduction zones. These events are rare and often cause little or no damage; • Local Marine Tsunami - typically a very large wave induced by a local tsunamigenic earthquake along shallow offshore fault zones; and • Local Terrestrial Tsunami - a large wave induced by a terrestrial and submarine landslide in oceanic and freshwater regions. The impact of the land mass in the water creates the water movement.

Vulnerability	Description
People	Some injury and possible death may occur due to landslide or structural collapse caused by a major earthquake in the western part of the territory or a tsunami in the Arctic ocean.
Infrastructure	Structural damage to buildings and infrastructure could be caused by a major earthquake in the western part of the territory or a tsunami in the Arctic ocean.
Communications	Communications could be disrupted by a major earthquake in the western part of the territory or a tsunami in the Arctic ocean.

NWT Exposure/History

When	Where	Impact
October 5, 1985	Mountains west of Fort Simpson	A magnitude 6.6 earthquake. No injuries or damage was reported.
December 23, 1985	Mountains west of Fort Simpson	The largest earthquake recorded in the NWT was a magnitude 6.9 event. No injuries or damage was reported. Wrigley, Fort Simpson, Nahanni Butte and Fort Liard experienced this earthquake. Vehicles bounced on the road and trees and power lines whipped back and forth. Sections of the banks of the Mackenzie River slumped into the water. Inside homes, furniture moved, dishes fell from cupboards, unsupported shelves toppled over, liquids slopped out of containers, doors swung open and shut and walls flexed in and out.

The northern Rocky Mountain region is a seismically active area. Communities in the west of the NWT experience minor earthquakes each year which are rarely felt.

Large tremors do occur. In 1985, a tremor shook the mountains west of Fort Simpson. The lack of serious damage can be attributed to the sparse population and type buildings near the epicentre.

The town of Inuvik has a short-period hazard designated as the “stable Canada” region. There is a low-probability of moderate-sized earthquakes (Halchuk and Adams, 2004). For example, in January 2008, a 5.8 magnitude earthquake shook buildings but did not cause real damage. This earthquake actually took place in the northern Richardson Mountain range, about 40 kilometres northwest of Fort McPherson. Earthquakes can be felt in Inuvik about once every two years. Inuvik could see earthquakes approaching magnitude 7 at a distance of about 150 km (Halchuk and Adams, 2004).

A small risk of tsunami on the Arctic Ocean exists.

Climate Change Impact

- No direct correlation between climate change and an increase in the number of earthquakes (ICLR, 2010 p.5).
- Sea ice breakage (calving of glaciers and ice shelves) could cause Arctic tsunami-type waves, and, with less sea ice, these could have a larger, visible impact.
- Increase in sea level would increase potential damage during a tsunami.
- Increased impact of an earthquake on warmer permafrost soil and frozen soil can lead to greater damages due to soil liquefaction (Hazirbaba and Hulsey, 2009).

Community Meeting Feedback

None

Key Risk Analysis Considerations

- Small potential to spontaneously cause multiple deaths and injuries;
- Little historical experience in the NWT;
- High damage potential if near or in a community;
- Potential to affect some communities in the NWT; and
- Because of very low population density, around the Canadian Arctic, at present, there is no priority for a tsunami warning system for Arctic Canada.

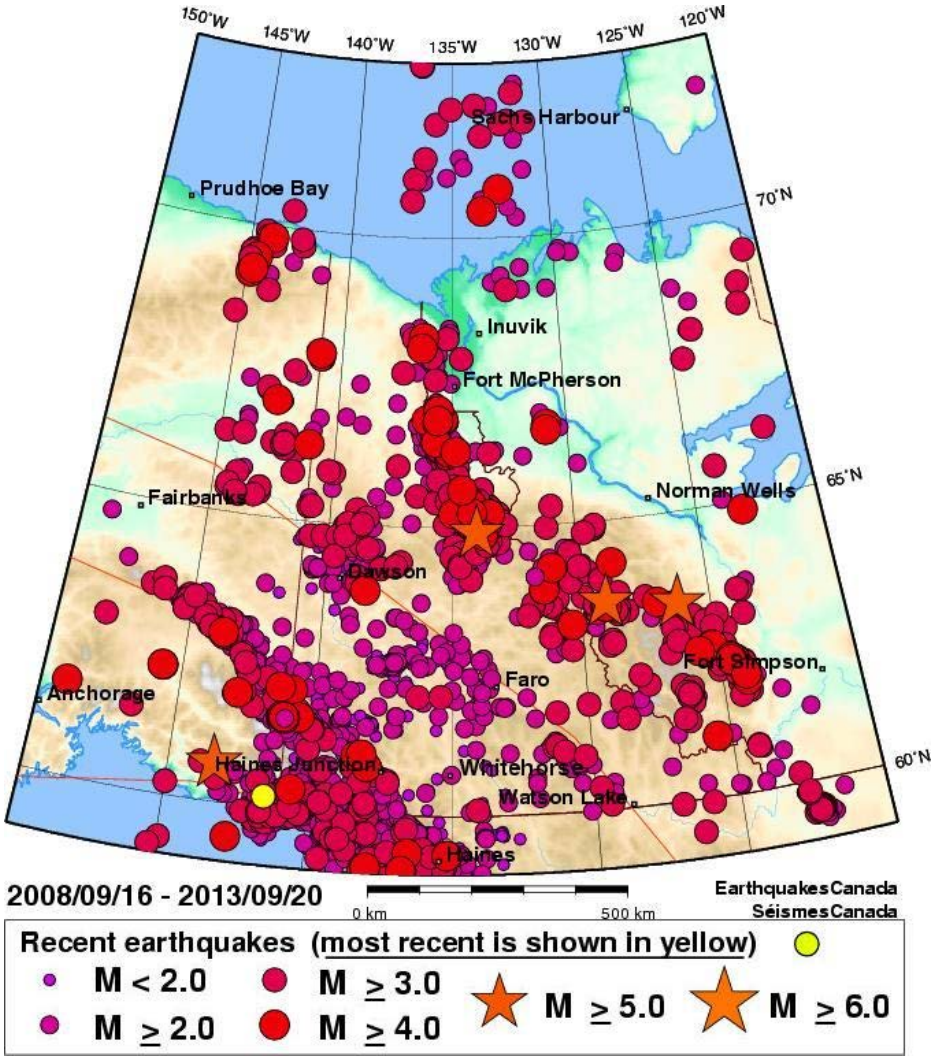


Figure 27: Earthquakes 2008-2013 (Source: Earthquakes Canada)

5.5.2 War and International Incident

Figure 28: Joint Task Force (North) Headquarters Yellowknife (Source: Wikipedia)

Definition	**Class**
An action or clash that results in a wider dispute between two or more nation-states.	Human-induced Hazard

NWT greatest impacts to date

N/A

Climate Change

Projected to increase in frequency

Cause/Explanation

War Emergency: a real or imminent war or other armed conflict that involves Canada or any of its allies that is of sufficient magnitude to be a national emergency.

Vulnerability	Description
People	The main effects of war on people are poverty due to destruction of properties and business, death and property destruction. War can also cause a dramatic impact on civilian health, because of the weapons which may be highly radioactive.
Infrastructure	The most commonly held thoughts on war's effect on infrastructure is the destruction of roadways, railways and bridges to hamper an enemy's ability to move freely and accumulate forces at a given point. In recent wars there have been specific examples of water and power plants being targeted in order to dramatically impact the ability of a populace to survive in a given area.
Communications	Communication facilities are likely the first to be targeted in any war or act of war or terrorism. Without communications authorities will be unable to respond to threats coherently and the loss of information can lead to a general state of panic amongst a population.

NWT Exposure/History

The number of military naval vessels traversing the Arctic Ocean is believed to be on the rise, given the strategic importance of the region.

Climate Change Impact

- Opening of artic sea waters and access to natural resources could lead to an international incident.
- Increased foreign military presence in Arctic.

Community Meeting Feedback

While there was no specific mention of this issue at the meetings, there was some discussion centering on the activities of the Canadian Military in the North. Most of this discussion revolved around the impact any exercises in the area may have on local wildlife and resources. There was specific mention of an incident near Yellowknife when a Canadian Armed Forces helicopter knocked out power to Yellowknife after striking a power line. However, there was no discussion regarding issues such as Canadian sovereignty in the far north.

Key Risk Analysis Considerations

- Potential to spontaneously cause multiple deaths and injuries;
- No historical experience in the NWT;
- High damage potential; and
- Low potential to affect any community in the NWT.

5.5.3 Food and Agricultural Emergency

Figure 29: Community Freezer Project Dehcho (Source: Arctic Energy Alliance)

Definition	**Class**
Any emergency which affects food security, food quality or food safety for many people	Natural Hazard

NWT greatest impacts to date

- Food recall

Climate Change

Projected to increase both frequency and consequence

Type	**Cause/Explanation**
animal disease	Three types: non-infectious, infectious and parasitic diseases with the potential to spread between animals and sometimes to humans.
food contamination	Food contamination refers to the presence in food of harmful chemicals and microorganisms which can cause consumer illness.
pest infestation (including rodents)	Large number of pests can cause damage, danger, discomfort or threat to food supply including foliage or root feeding insects that damage plants.
plant disease and infestation	Any plant makes an ideal habitat for insects and may lead to an infestation. A series of harmful physiological processes caused by irritation of the plant by some invading agent.
Vulnerability	**Description**
People	Humans are reliant on a well regulated safe supply of food and agricultural processes. Any emergency caused by a failure of this system can impact on the immediate and long term health of anyone affected.
Infrastructure	N/A
Communications	N/A

NWT Exposure/History

When	**Where**	**Impact**
Feb 12, 2012	All Co-op grocery Stores in the NWT	A brand of frozen hamburgers manufactured in Ontario was recalled as it may have been contaminated with E. coli. Consumption of food which contains this strain of virus can cause life-threatening illness.

Climate Change Impact

- Wildlife species migration is altered by climate change which could affect hunting.
- Changes in insect populations (number, type and seasonal peaks) could affect the food chain (Pryor and Cobb, 2007 p.18).
- Increased vulnerability to other hazards due to more dependence on transported food with a reduction of hunting and fishing.

Community Meeting Feedback

Stakeholders at the meetings raised little concern over agriculture as very little occurs in the NWT. Concerns were expressed during the meetings in the Dehcho, Sahtu and Beaufort Delta over the storage of food and spoilage. There was also discussion amongst residents of the South Slave over how climate change was affecting growing seasons.

Key Risk Analysis Considerations

- Some potential to spontaneously cause multiple deaths;
- Little historical experience in the NWT; and
- Potential to affect any community in the NWT.

5.5.4 Falling Debris

Figure 30: First piece of debris found from the crashed Cosmos-954 Soviet satellite, 1978. (Source: Wikipedia)

Definition	**Class**
Any object (such as a satellite) which survives its passage through the Earth's atmosphere and impacts Earth	Natural Hazard

NWT greatest impacts to date

Environmental

Climate Change

N/A

Type	**Cause/Explanation**
natural space object crash	Comets and asteroids have impacted the earth in the past and will continue to do so in the future. However, in general large impacts are rare. It is estimated that an object greater than 50 m in diameter impacts the earth's surface approximately every 100 years.
human made space object crash	An earth orbiting human-made object (such as a satellite) which survives atmospheric re-entry to impact earth.
Vulnerability	**Description**
People	Any object falling to earth from space will be of concern in terms of public safety and there will always be a worry of people being injured or killed by falling debris. Given the low population of the NWT and rare occurrence of these events there is a low likelihood of this happening.
Infrastructure	Damage to buildings, roads and other infrastructure would be a concern in the event of falling debris.
Communications	An object which falls from space may impact a communications satellite or microwave tower which could directly impact communications in a region.

NWT Exposure/History

When	**Where**	**Impact**
445 million yrs	Near Fort Smith	Pilot Crater is an impact crater 6 kilometers in diameter.
400 million yrs	Nicholson Crater lake	Nicholson Crater is a meteorite crater 12.5 kilometers in diameter.
130 million yrs	Victoria Island	Prince Albert Crater is an impact crater measuring 25 kilometers in diameter.
January 24, 1978	Near Great Slave Lake	A soviet satellite, Cosmos 954, crashed to earth scattering radioactive waste across 124,000 square kilometers of the NWT, Alberta and Saskatchewan. The clean-up operation continued into October 1978.

Climate Change Impact

None

Community Meeting Feedback

None

Key Risk Analysis Considerations

- Very low frequency;
- Potential to spontaneously cause multiple deaths and injuries;
- Current and historical experience in the NWT;
- Damage potential if near or in a community; and
- Potential to affect any community in the NWT.

6 Vulnerability Analysis

Vulnerability is shaped by physical, social, economic and environmental factors, which increase the sensitivity of a community to the impact of hazards. Resilience is determined by those factors or processes, which decrease the sensitivity of a community to the impact of hazards. This section of the HIRA outlines how well prepared and equipped the NWT is to minimize the impact of or cope with the hazards examined in Section 5.

6.1 Resilience

Community resilience is the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change (CARRI, 2013).

The people of the NWT possess a number of qualities that have proven advantages to overcoming the impacts of a disaster.

The isolation of many communities in the NWT fosters independence among people who are used to power disruptions, communication failures and formidable weather conditions.

Traditional knowledge of the land provides NWT communities with an awareness of the natural hazard signs in the environment that helps them to prepare for disasters that frequently impact their communities (Ford, 2004). The combination of a strong level of awareness among community members to the signs and conditions preceding a flood event, preparation in anticipation of flooding by ensuring an adequate supply of food and by broadcasting information within the community, the existence of evacuation procedures and strong social networks to help with the recovery after the event underlies the community's adaptability. The community is vulnerable only to flood events of great magnitude (Ford, 2004).

Key NWT Resiliency Factors

- Self-reliance
- Awareness of natural hazard signs in the environment
- The mixed economy
- Strong social and cultural capital
- Meaningful partnerships
- Creative and innovative solutions to a variety of challenges
- Preparation for hazard events by ensuring adequate food supplies and by broadcasting hazard information within the community

While not a factor in every NWT community, the mixed economy, based upon both wage employment and subsistence-based activities, such as hunting, fishing, and gathering, is indicative of cultural vitality and adaptive capacity (Fournier 2012). It reduces the impact of some hazards by giving communities other sources of food supply when hazards impact shipping routes.

Success in the north depends upon the connection of people with one another, with the environment, and with their heritage. These bonds have supported the region's communities for generations. Strong ties with family, friends, and the broader group is reflected in the sharing

and mutual self-help practices of many NWT communities (Fournier 2012). Table 6 demonstrates the strong sense of belonging among people of the NWT.

Table 6: Sense of belonging to local community, somewhat strong or very strong. Population ages 12 and older (Source: Statistics Canada, CANSIM table 105-0501 and Catalogue no. 82-221-X)

	2009	2010	2011	2012
Number of people who have a sense of belonging to their local community, somewhat strong or very strong in the NWT.	26,733	26,394	27,575	27,632

By building meaningful partnerships with the private sector, NWT communities increase their resources, knowledge, and expertise which help them limit impact of hazards, and bounce back more rapidly. Impact and Benefit Agreements (IBAs) can be used by NWT communities to benefit from economic development initiatives. An example is the Diavik Diamond Mine. Through community consultations and the development of a community plan, Diavik ensures that local businesses and residents benefit from the development of its mine. Diavik established hiring quotas for the local workforce; slated up to 70 per cent of its business for contract by regional companies; developed training and skills development programs; and established community-based partnerships between communities, local businesses, and regional governments. The outcome of these types of initiatives is greater local capacity and resilience through enhanced human, productive, and financial capital (Fournier 2012).

6.2 Vulnerability Factors

Some of the key vulnerability factors in the communities of the NWT include:

- Lack of adequate infrastructure;
- Remoteness;
- Issues associated with cultural duress and the legacies of Aboriginal policies;
- Underdeveloped private sector;
- Lack of local capacity; and
- Socio-economic impediments.

In the NWT, transportation, communication, waste management, and water treatment infrastructure can be insufficient or in need of repair. Some airports, key public facilities, railroads, and pipelines are in need of renovation. Certain infrastructure such as paved highways and railroads is virtually non-existent in most of the NWT (Fournier, 2012).

The remoteness of communities leads to self-reliance but can complicate emergency response when local resources are overwhelmed. The impact of some hazards can delay or limit external emergency response. For example, a pandemic could impact intercommunity medical response or smoke from a wildfire could limit air evacuation.

The health, vitality, and prosperity of Aboriginal communities are important for regional resilience in the NWT. However, government policy, relocation activities, residential schools, and economic and social issues have led to cultural duress. These factors have also worked to

undermine the self-reliance of Aboriginal communities and, by extension, their capacity to foster resilient societies (Fournier, 2012).

The private sector contributes to community resilience when major business and employers, operating in and around the community, are locally owned. A private sector role may be nominal in in the NWT where government is the main employer. Promoting local business increases the resiliency of communities.

6.2.1 Social Vulnerability

This HIRA focuses on certain aspects of social vulnerability and their role in contributing to the risk from hazards. Generally, the term social vulnerabilities reflects "…the degree to which societies or socio-economic groups are affected by stresses and hazards, whether brought about by external forces or intrinsic factors—internal and external—that negatively impacts the social cohesion of a municipality" (United Nations Development Programme, 2000). For the purpose of this report, vulnerability is defined as the ability of an individual within a household to recover from a natural hazard impact.

Social vulnerability information is particularly relevant and should be considered a key element of any emergency plan. Numerous hazards such as floods, fires, and human health emergencies can have serious impacts on vulnerable populations (e.g. the very old and the very young); just as certain types of disasters can have a tremendous impact on the housing market and local economy.

Low-income groups inevitably have less money to spend on building or renting a house designed to avoid or limit damage in the event of a disaster. Low-income groups also have the least resources on which to call when some disaster damages or destroys their housing.

Table 7: Data presented is rounded to the nearest 100 persons, therefore categories may not sum to the totals. (Source: Statistics Canada, Labour Force Survey Prepared by: GNWT Bureau of Statistics)

Year	Population 15+	Labour Force	Employed	Unemployed	Unemployment Rate
2001	28,500	21,800	20,000	1,900	8.7
2002	29,200	22,300	21,000	1,300	5.8
2003	30,200	22,900	21,300	1,600	7.0
2004	31,000	23,700	22,200	1,500	6.3
2005	31,200	24,000	22,700	1,300	5.4
2006	31,300	24,400	23,100	1,300	5.3
2007	31,700	24,800	23,400	1,400	5.6
2008	32,100	24,100	22,700	1,400	5.8
2009	32,100	22,800	21,300	1,400	6.1
2010	32,300	23,200	21,500	1,700	7.3
2011	32,100	24,500	22,700	1,800	7.3
2012	32,100	24,700	22,700	2,000	8.1

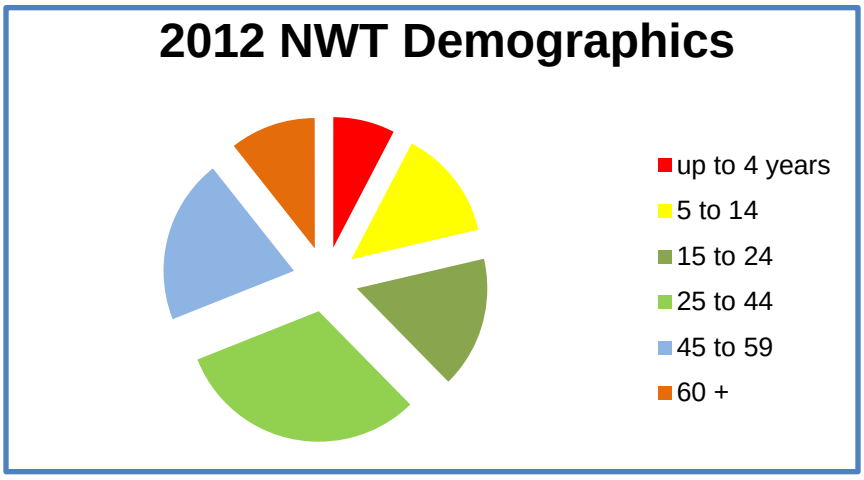
6.2.2 Language Groups

Effective emergency response depends upon efficient communications between responders and the community. Language disparities can be a barrier to accurate communication and leave a community more at risk.

Mother Tongue is the first language learned at home during childhood and still understood.

The NWT has 11 official languages. English is the predominant mother tongue. In 2011, 31,340 persons stated that English was their mother tongue, representing 77.5% of the population. With the exception of Tłı̨chǫ, the population with an aboriginal language as a mother tongue is highly concentrated in the older age categories. Half of those aged 45 years and over spoke an aboriginal language as their mother tongue compared to 21% for those less than 25 years of age. By community, Wekweètì had the highest proportion of persons with an aboriginal language as their mother tongue (71%), followed by Gamètì at 69% and Trout Lake at 68% (GWT Bureau of Statistics 2012). Both Wekweètì and Trout Lake showed increases from 2006 while Gamètì declined over the same period. Of those with French as their mother tongue, 75% (810 persons) reside in Yellowknife (GNWT, Bureau of Statistics, 2011).

6.2.3 Age Groups



Children have special needs and are always at high risk in disasters. In addition, they are also hard to service, since many of the guidelines for equipment, supplies and treatment protocols are designed for adults (Kollek, 2009). In 2011, the National census indicated that with 21.7% of the population 14 and under, the NWT had a higher percentage of children in the population than Canada as a whole (16.7% 14 and under) (GNWT, Bureau of Statistics, 2011).

6.2.4 Disability

A disaster resilient community means everyone must be part of the solution. Emergency response decisions, policies and plans should reflect the needs of persons living with disabilities. Investment in hazard mitigation should provide for the needs of persons living with disabilities. Table 8 displays the severity of disability of individuals with disabilities in the NWT. Severely and very severely disabled individuals should be taken into consideration in emergency response plans as their capacity to respond to emergency circumstance is unique.

Table 8: Severity of disability for adults and children with disabilities, (Source: NWT Bureau of Statistics; Statistics Canada, Participation and Activity Limitation Survey, 2006)

	Total	Mild	Moderate	Severe	Very Severe
Total - Aged 15 years and over	3,220	1,270	820	760	360

6.3 Critical Facilities

Within this HIRA, critical facilities are defined as facilities that are essential in order for the NWT to carry out emergency response activities.

The primary critical facility for coordination of any large-scale disasters or emergencies is the Emergency Operations Centre (EOC). Before or during a hazard event, the EOC is essential for site support, including the coordination of special resources, information, multiple departments and external agencies. In the NWT according to their emergency response plans, each community has a designated EOC most often located in the municipal government building. Each Region in the NWT has designated an EOC within the Regional Emergency Response Plan.

Region	Emergency Operations Centre (EOC) location
Dehcho Region	Milton Building on 97th Avenue in Fort Simpson
Beaufort Delta Region	2 Firth or 43 Distributor Street Inuvik
North Slave Region	Yellowknife Airport EOC or MACA HQ
Sahtu Region	#6 Canol Road in Norman Wells or #3 Mackenzie Drive
South Slave Region	174 McDougal Road or Sweetgrass Building, 177 McDougal Road

The Territorial EOC (TEOC) will coordinate overall territorial response, ensure communication with appropriate EOCs, provide regular information reports to the Minister, Emergency Measures Officer and participating agencies. The EMO's office suite becomes the facility housing GNWT emergency staff and other critical employees/officers of territorial departments, federal agencies and non-government organizations.

In addition to the EOC, emergency first response facilities are of critical importance to carrying out emergency response activities. These include police, fire, ambulance, and health facilities, along with emergency shelters.

Most communities in the NWT have small capacity shelters in case the evacuation of residents to a safe area is required. Inuvik, Norman Wells, Yellowknife, Fort Simpson, Hay River and Fort Smith (the larger communities) have designated shelters using recreation centres, schools and other facilities, and plans in place to host between 200 and 400 evacuees during an emergency or disaster.

6.4 Critical Infrastructure

Critical infrastructure consists of those physical and information technology facilities, networks, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of the NWT communities.

Critical infrastructure in NWT can be particularly vulnerable due to:

- high construction and operating costs due to distance, isolation and extreme cold;
- infrastructure that deteriorates rapidly in extreme environments;
- the high cost of reopening infrastructure, even after a brief interruption in operation;
- an existing infrastructure deficit;
- the lack of options and "backups" in infrastructure services; and
- capacity constraints in the form of finances and human resources (National Round Table on the Environment and the Economy, True North, p.47).

Critical infrastructure spans ten sectors:

	Sector	**Description**
1	Energy and Utilities	e.g. electrical power, natural gas, oil production and transmission systems
2	Communications and Information Technology	e.g. telecommunications, broadcasting systems, software, hardware and networks including the Internet
3	Finance	e.g. banking, securities and investment
4	Health Care	e.g. hospitals, health care and blood supply facilities, laboratories and pharmaceuticals
5	Food	e.g. safety, distribution, agriculture and food industry
6	Water	e.g. drinking water and wastewater management
7	Transportation	e.g. air, rail, marine and surface
8	Safety	e.g. chemical, biological, radiological and nuclear safety, hazardous materials, search and rescue, emergency services, and dams
9	Government	e.g. services, facilities, information networks, assets and key national sites and monuments
10	Manufacturing and Industry	e.g. defence industrial base, chemical industry

(Source: Public Safety Canada, 2010)

6.4.1 Energy and Utilities

In the NWT, there are three main energy sources used to generate electricity: natural gas, diesel fuel and hydro resources. Hydroelectric generation is used in eight communities in the Great Slave Lake area, while natural gas-fired power plants provide electricity to the community of Norman Wells. The remaining 24 communities have electricity provided by diesel-fired power plants. Alternative Energy Programs are being put in place such as a waste-heat recovery system in Ulukhaktok, wind turbines in Sachs Harbour and a Solar Wall in Fort Smith. Fuel must be shipped into the communities by pipeline, barge, ice road or air. The destruction of a bulk fuel storage facility would lead to the loss of the prime energy supply for an entire community including local transportation. Ultimately this has the potential to affect every public service available to local residents including communications.

NWT Power Corporation (NTPC) is a provider of essential services in many communities and should be incorporated into detailed local preparedness and response, particularly those at risk to severe storms or potential evacuation. Northlands Utilities Limited may play a similar role where it is the power distributor.

With a population of about 43,000 people spread across nearly 1.2 million square kilometres, operating on a grid system is not feasible. Wherever possible, NWT Power Corporation provides hydroelectricity. However, each community has its own standalone power plant and facilities to ensure there is a reliable source of electricity, regardless of conditions (NWT Power Corporation website).

Hydro Operations (NWT Power Corporation website)

Yellowknife (Jackfish Lake)

The Yellowknife diesel generation facility is located on the shores of Stock Lake (Jackfish Lake).

It supplies power to the City of Yellowknife and communities of Dettah and Behchokǫ̀. The standby power plant is used to augment and/or supply prime power as backup to the Snare and Bluefish hydro systems.

The facility includes control equipment, the central control room, fuel storage, stores for the Hydro Region, and the regional office. It also has 8 generators:

- Two 5.18 MW diesel generators;
- Two 2.50 MW diesel generators;
- Two 2.85 MW diesel generators; and
- Two 3.30 MW diesel generators.

Snare Hydro System

The Snare Hydro System is located on the Snare River about 140 km northwest of Yellowknife. It is made up of four separate hydro plants: Snare Rapids, Snare Falls, Snare Cascades, and Snare Forks. Snare Falls can be used as a secondary source of power by the other three power plants. This system provides power to Yellowknife and the communities of Behchokǫ̀ and Dettah.

The system contains:

- A main turbine with an 8.0 MW generator at Snare Rapids;

- A smaller turbine with a 500 kW generator at Snare Rapids;
- A variable pitch turbine with a 7.4 MW generator at Snare Falls;
- A variable pitch turbine with a 4.3 MW generator at Snare Cascades; and
- Two 5.0 MW generators and a 150 kW standby generator at Snare Forks.

Bluefish Hydro Facility

NTPC purchased the Bluefish Hydro Electric facility, located outside Yellowknife, from Miramar Con Mine in 2003. It is located at Bluefish Lake, the headwaters of the Yellowknife River. In conjunction with the Snare Hydro System, Bluefish provides power to the City of Yellowknife and communities of Behchokǫ̀ and Dettah.

The facility consists of the two dams, headgate, penstock, and operations office. It also has the following hydro units:

- A 3.5 MW hydro unit; and
- A 4.0 MW hydro unit.

Taltson Hydro

The Taltson Hydro plant is located approximately 64 kilometers north of Fort Smith on the Taltson River. It provides power to Fort Smith, Hay River, Hay River Reserve, Fort Resolution and Enterprise.

The hydro plant consists of:

- An 18 MW hydro unit; and
- A 300 kW emergency standby diesel generator.

Table 9: Power Sources by NWT Community (Source: NWT Power Corporation website)

Region	Community	Power Source (NWT Power Corporation website)
Inuvik	Aklavik	Plant currently has a 1.28 MW capacity, consisting of four 320 kW diesel engines.
	Fort McPherson	Total installed capacity of the plant is 1.83 MW. The plant also provides residual heat to various buildings using the Aadrii heating system.
	Inuvik	Thermal Operations regional office complex is located in Inuvik. Two power plants consist of: • three natural gas fuelled generators rated at 2.8 MW, 2.8 MW, and 2.1 MW; • two 2.5 MW diesel generators; • one 720 kW diesel generator; and • one 300 kW diesel generator.

Region	Community	Power Source (NWT Power Corporation website)
	Paulatuk	Power plant has a total installed capacity of 840 kW.
	Sachs Harbour	Three diesel generators with a total installed capacity of 795 kW.
	Tsiigehtchic	Three small generating units with a total capacity of 500 kW.
	Tuktoyaktuk	Three diesel generators have a total installed capacity 2.21 MW.
	Ulukhaktok	Three diesel generators that have a combined capacity of 1.16 MW. The plant also has a small heat recovery system that heats three buildings in the community.
Sahtu	Colville Lake	Three small generating units ranging from 75-90 kW.
	Déljne	Total installed capacity of the plant is 1.19 MW, generated one 550 kW and two 320 kW diesel generators.
	Fort Good Hope	Three diesel generators with a total installed capacity of 1.23 MW.
	Norman Wells	Power plant is a standby plant with two generating units. NTPC currently purchases the electrical energy from ESSO and resells it to the community. Total installed capacity of Norman Wells standby plant is 2.12 MW.
	Tulita	Three diesel engines with a total installed capacity of 1.1 MW.
North Slave	Behchokǫ̀	Primarily supplied with electricity generated from the Snare Hydro system. The standby plant consists of: • An 850 kW diesel generator, and • A 350 kW diesel generator.
	Dettah	Bluefish Hydro Facility.
	Gamètì	Diesel plant has three generators rated at 100, 212 and 300 kW.
	Łutselk'e	Diesel plant consists of three diesel generators rated at 180, 320 and 320 kW.
	Wekweètì	Diesel Generator.
	Whatì	The main diesel plant contains two generators, rated at 175 kW and 480 kW each. In addition, a separate module also contains a 320 kW generator. NTPC uses excess heat from diesel generation to provide heating to the local school through the Waste Heat Recovery System.
	Yellowknife	Bluefish Hydro Facility.
South Slave	Enterprise	Taltson Hydro plant.
	Fort Providence	Diesel generator plant for electricity.

Region	Community	Power Source (NWT Power Corporation website)
	Fort Resolution	Taltson Hydro plant, plus diesel plant has one diesel generator with a capacity of 600 kW. There is also a standby 100 kW diesel generator located at Buffalo Junction which is approximately 77 km west from Fort Resolution on Highway 5 to Hay River.
	Fort Smith	Hydro electricity from the Taltson Hydro Facility. A standby diesel plant consists of three diesel generators with a total connected generating capacity of 6 MW.
	Hay River	Taltson Hydro plant.
	Hay River Reserve	Taltson Hydro plant.
	Kakisa	Diesel power to generate electricity.
Dehcho	Fort Liard	Three diesel generators with a total output of 1.32 MW.
	Fort Simpson	Four diesel generators with a total output capacity of 3.2 MW. Fort Simpson also has a 60 kW solar array.
	Jean Marie River	Three small diesel generators with a total capacity of 230 kW.
	Nahanni Butte	Three small diesel generators with a total output capacity of 245 kW.
	Trout Lake	Diesel generator for electricity.
	Wrigley	Three generating units with a total output of 781 kW.

Additional On-site Facilities

All plants also have fuel storage, substations, office and staffing facilities, and inventory storage.

Backup Reliability

In case of emergency, NTPC has several generators that are available on demand. These emergency generators would be transported by land or air, should the need arise.

6.4.2 Communications and Information Technology

The NWT communications system is a mixture of land-based services and satellite served communities. The NWT has two major service providers, NorthwesTel and SSi Micro (ACIA Report, 2011).

NorthwesTel

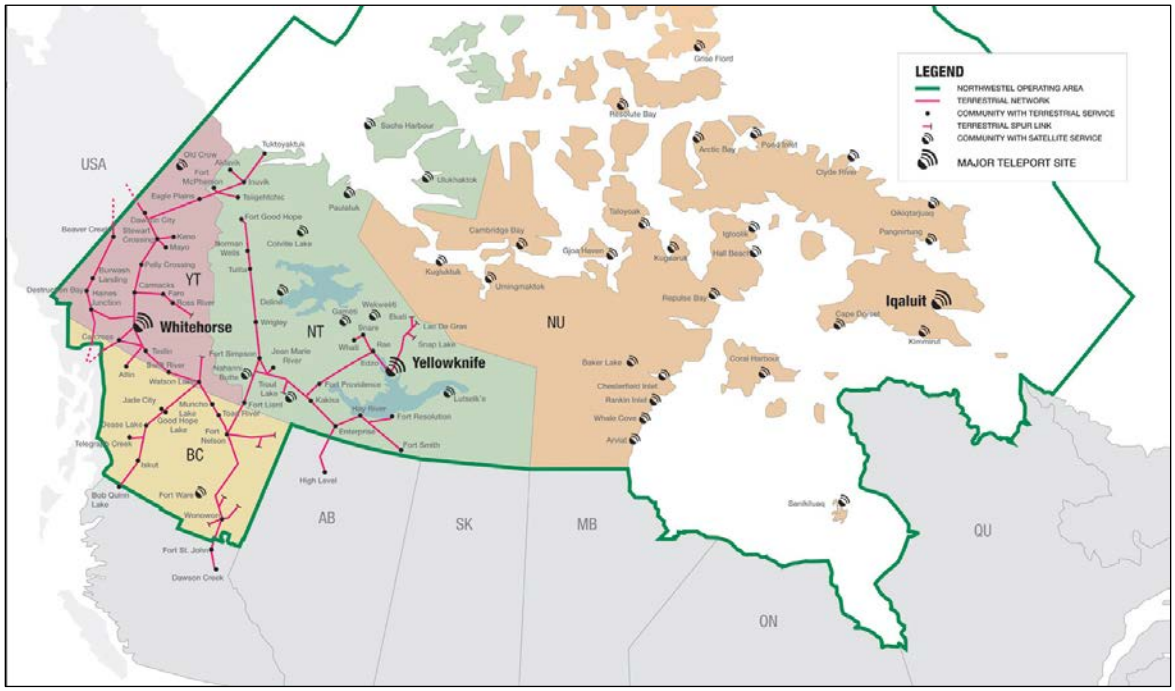
Headquartered in Whitehorse, NorthwesTel delivers a broad range of telecommunications solutions and television services to a population of 120,000 northern Canadians in 96 communities scattered throughout the Yukon, NWT, Nunavut, northern British Columbia and Alberta.

NorthwesTel's operations include local telephone services; long distance communications by microwave radio, fiber optic cable and satellite; cable television, and advanced data communications, including High Speed Internet in many parts of its operating area (ACIA Report, 2011).

NorthwesTel also provides wireless services for northern customers through cellular, broadband wireless, wireless Local Area Networks, wireless Metropolitan Area Networks and trunked radio services (ACIA Report, 2011).

Website: http://www.nwtel.ca/

Table 10: NorthwesTel Operating Area (Source: NorthwesTel website)



SSi Micro

Headquartered in Yellowknife, SSi Micro is the largest Internet Service Provider in Northern Canada, serving more than 60 Northern communities within Nunavut and the NWT (ACIA Report, 2011).

Website: http://www.ssimicro.com/

Since 1996, government investors (both as users and investors for public access), service providers and community organizations have struggled to finance, upgrade and build the networks needed to use 21st century communication tools (ACIA Report, 2011).

Communication infrastructure in the Arctic is fragile, creating a high level of vulnerability that can jeopardize the safety and security of Canadian citizens. Information is key for responders to be prepared. Early identification of requirements for emergency services is important to avoid 11th hour problems accessing services.

There is no cell phone coverage along the vast majority of roads in the NWT. There are dead spots in satellite phone reception. It is very difficult to send photos or large amounts of data from the field during an emergency, and challenging to keep workers safe if communications fail (ACIA Report, 2011).

6.4.3 Finance

There are five major banks in Yellowknife that offer a full range of personal and business banking, investment and financial services. All branches have automated banking machines.

There are also a number of independently-owned ATM machines throughout the city. Some mid-sized communities have banks such as CIBC in Hay River, Inuvik, Fort Simpson and Norman Wells, RBC in Hay River, and the Bank of Montreal in Fort Smith.

6.4.4 Health Care

All healthcare facilities are deemed critical infrastructure and are outlined in the table below.

Table 11: Health Care Facilities within Each NWT Community

Region	Community	Health Care Facilities
Inuvik	Aklavik	Health and Social Services Centre
	Fort McPherson	Health Centre
	Inuvik	Inuvik Regional Hospital (includes the Long Term Care Centre)
	Paulatuk	Health and Social Services Centre
	Sachs Harbour	Health Centre
	Tsiigehtchic	Health Centre (Out of Inuvik)
	Tuktoyaktuk	Health Centre
	Ulukhaktok	Health and Social Services Centre
Sahtu	Colville Lake	Health Station
	Déljne	Health Centre
	Fort Good Hope	Health Centre
	Norman Wells	Health Centre
	Tulita	Health Centre
North Slave	Behchokǫ̀	Health Centre
		Jimmy Erasmus Seniors Home
	Dettah	Health Station
	Gamètì	Health Centre
	Łutselk'e	Health Centre
	Wekweètì	Health Centre
	Whatì	Health Centre
	Yellowknife	Stanton Territorial Hospital - manages the provision of all medevac and patient transfer services in NWT
		Stanton Medical Clinic
		Stanton Medical Centre
		Stanton Ophthalmology Clinic
		Healthy Family Program Centre (47th Street)
		Home and Community Care, Public Health (1st floor, Jan Stirling Building)
		Centre for Northern Families
		Frame Lake Community Health Clinic

Region	Community	Health Care Facilities
		Yellowknife Primary Care Centre
		Aven Cottages - Territorial Dementia Facility - AVENS – A Community for Seniors
		Aven Manor – A Community for Seniors
South Slave	Enterprise	Patients drive to Hay River for their medical needs
	Fort Providence	Health Centre
	Fort Resolution	Health Centre
		Fort Resolution “Our Great Elders” Facility- Homecare and Administration
	Fort Smith	Northern Lights Special Care Home
		Health and Social Services Centre
		Polar Crescent Group Home – Child welfare
		Trailcross Treatment Centre – Child welfare
	Hay River	H.H. Williams Memorial Hospital
		Woodland Manor Long Term Care Residence
		South Slave Medical Clinic
	Hay River Reserve	Patients drive to Hay River for their medical needs
	Kakisa	Patients drive to Fort Providence or Hay River for their medical needs
Dehcho	Fort Liard	Health Centre
	Fort Simpson	Health and Social Services Centre
		Elders Care Home
	Jean Marie River	Health Station
	Nahanni Butte	Health Cabin
	Trout Lake	Health Station
	Wrigley	Health Center

Health and Social Services has initiatives that rely on good connectivity, and are actively implementing new technology that aims to improve service delivery to patients throughout the NWT at lower costs. Efforts include increased telehealth for specialist connections, electronic record management, and increased computing radiography rolled out in 18 communities. Any of these services can be disrupted by hazards which effect communications.

6.4.5 Food

The isolation of many parts of the NWT, and the cost of transporting food to remote communities, contribute to high food insecurity. Hazards that impact transportation can lead to food scarcity. The NWT has little conventional agriculture. Much of the local food economy is based on traditional harvesting. There are significant hunting, trapping, and fishing industries in the territory. Community freezers may be considered critical facilities. The GNWT has several programs that assist the development of hunting and trapping in the territory and support the teaching of this knowledge to the next generation.

6.4.6 Water

NWT communities rely on surface water, and in some cases groundwater, as sources for their public water supply. The management of drinking water is the shared responsibility of all levels of government. Community governments are responsible for operating and maintaining Water Treatment Plants (WTPs) and systems. The GNWT is responsible for the regulation of water supply systems providing certification training and support to WTP operators and for working collaboratively with stakeholders to implement the NWT Water Stewardship Strategy.

Table 12: Public Water Source by NWT community (Source: 2010 GNWT Report on Drinking Water)

Region	Community	Public Water Source	Water treatment system classification
Inuvik	Aklavik	Mackenzie River	Class II
	Fort McPherson	Deep Water Lake	Class II
	Inuvik	Mackenzie River and 3 Mile Lake	Class I
	Paulatuk	New Water Lake	Small System
	Sachs Harbour	DOT Lake	Small System
	Tsiigehtchic	Tso Lake	Class I
	Tuktoyaktuk	Kudlak Lake	Class I
	Ulukhaktok	RCAF Lake	Small System
Sahtu	Colville Lake	Colville Lake	Small System
	Déljne	Great Bear Lake	Small System
	Fort Good Hope	Mackenzie River	Small System
	Norman Wells	Mackenzie River	Class II
	Tulita	Great Bear Lake	Class I
North Slave	Behchokǫ̀ (Edzo)	West Channel	Class II
	Behchokǫ̀ (Rae)	Marian Lake	Class II
	Dettah	see Yellowknife	N/A
	Gamètì	Rae Lake	Small System
	Łutselk'e	Great Slave Lake	Small System
	Wekweètì	Snare Lake	Small System
	Whatì	Ground Water	Class I
	Yellowknife	Yellowknife River	Class I
South Slave	Enterprise	see Hay River	N/A
	Fort Providence	Mackenzie River	Class II
	Fort Resolution	Great Slave Lake	Class II
	Fort Smith	Slave Lake	Class III
	Hay River	Great Slave Lake	Class II
	Hay River Reserve	see Hay River	Small System

Region	Community	Public Water Source	Water treatment system classification
	Kakisa	see Hay River	N/A
Dehcho	Fort Liard	Ground Water	Class I
	Fort Simpson	Mackenzie River	Class II
	Jean Marie River	Mackenzie River	Small System
	Nahanni Butte	Ground Water	Class I
	Trout Lake	Trout Lake	Small System
	Wrigley	Ground Water	Small System

6.4.7 Transportation

NWT transportation infrastructure includes a network of roads, ports and airports, including a rail connection to Hay River. Overall, the NWT has 2,200 kilometers of all-weather roads, complemented by 2,100 kilometers of ice roads. Over 570 km of the ice roads are private for oil and gas development and mine resupply. There is also a well-developed marine freight route along the Mackenzie River to the Arctic Ocean. Sachs Harbour, Ulukhaktok, Paulatuk, and Łutselk'e are fly-in only, with no access to roads at any time of the year. A further 11 communities only have winter roads. There are 27 community-based airports plus several privately-operated air strips.

Figure 31: Ferry (Source: NWT Highway, Ferry and Ice Crossing Information Brochure, Department of Transportation)

Table 13: Community Transportation Types (Source: GNWT Ministry of Transportation website)

Region	Community	Air	Road	Water/Rail
Inuvik	Aklavik	No airport.	Winter ice road connects to the Dempster Highway through Inuvik.	Bulk supplies and food are barged in during the summer months.
	Fort McPherson	Located 3.2 km south of the hamlet, the airport was built in 1972 and has a gravel runway (3500' x 100') and an air terminal building. There is limited, seasonal service.	Dempster Highway from Dawson City, Whitehorse and Inuvik year round. There are minor disruptions to road access with during break-up and freeze-up.	"Abraham Francis" Ferry service Km 74 – Peel River. This crossing is subject to extreme high and low water level fluctuations which may cause delays at any time.

Region	Community	Air	Road	Water/Rail
	Inuvik	Twelve kilometres east of the community, the full-service airport was built in 1956/58. It has an asphalt runway (6000' x 150') and an air terminal building. Flights operate daily. Inuvik Mike Zubko Airport is deemed a port of entry into Canada and is staffed by the Canada Border Services Agency.	Dempster Highway from Dawson City, Whitehorse. It is an unpaved, gravel road. There are two ferry crossings that make the road impassable for periods during break-up and freeze-up. In the winter drivers cross the rivers by ice bridge.	
	Paulatuk	Adjacent to the hamlet and built in 1994, the airport has a gravel runway (4000' x 100') and an air terminal building. Flights three times a week.		
	Sachs Harbour	The airport is adjacent to the hamlet and was built in 1955/56. It has a gravel runway (4000' x 100') and an air terminal building. Flights twice weekly.		
	Tsiigehtchic		Dempster Highway either from the Yukon or from Inuvik. The highway from Inuvik crosses the river using a ferry service in summer (from 0900-0100, late May-late October) and ice road in winter.	"Louis Cardinal" Ferry services are provided at Mackenzie River Hwy 8.
	Tuktoyaktuk	The airport was built in 1955 and lies 3.2 km SE of the hamlet.	In the winter an ice road is built along the waterways of the	

Region	Community	Air	Road	Water/Rail
		It has a gravel runway (5000' x 150') and an air terminal building. Flights to Inuvik daily. Tuktoyaktuk James Gruben Airport is deemed a port of entry into Canada.	Beaufort Delta between Inuvik and Tuktoyaktuk.	
	Ulukhaktok	Built in 1978, the airport lies 3 km north of the hamlet and has a gravel runway (4300' x 100') and an air terminal building. Flights two days a week.		
Sahtu	Colville Lake	Adjacent to the community, the airport was built in 1975. It has a gravel runway (2400' x 100'). Flights four days a week.	An ice road opens up in winter connecting the community to Fort Good Hope.	
	Déljne	One of the NWT's newer airports, it was built in 1998, 2.3 km NW of the community. It has a gravel runway (3925' x 100') and an air terminal building. Flights Monday to Saturday.	Accessible in the winter by an ice road links that links Déljne to Tulita and the Mackenzie River winter road.	
	Fort Good Hope	The airport lies 2.4 km from the community and was built in 1994. It has a gravel runway (3000' x 100') and an air terminal building. Flights daily, Monday to Saturday.		Shipping along the Mackenzie River in the summer.
	Norman Wells	Built in 1942, the airport is adjacent to	A winter road alongside the	

Region	Community	Air	Road	Water/Rail
		the community. It has an asphalt runway (6000' x 150') and an air terminal building. Flights daily to various destinations within the NWT.	Mackenzie River is built from the Dehcho region up through the Sahtu.	
	Tulita	The airport was built in 1982, 2 km NE of the hamlet. It has a gravel runway (3000' x 100') and an air terminal building. Flights daily, Monday to Saturday.	A winter road links Tulita to Wrigley and ultimately to the Mackenzie Highway. It usually is open from mid to late winter.	The community is accessible by river in the summer months. Barges deliver supplies up the Mackenzie River.
North Slave	Behchokǫ̀	No airport.	Accessible year-road by the Mackenzie Highway. An ice road opens in the winter giving the community access to Whatì. Year-round bus service from Yellowknife with regular stops in Behchokǫ̀, to Hay River.	
	Dettah	No airport.	Via ice road in the winter or during summer using the Ingraham Trail.	Accessible by a six and half kilometer boat ride.
	Gamètì	Built in 1991, 3 km NE of the community, the airport has a gravel runway (3000' x 100') and an air terminal building. Flights daily except Saturdays.	A winter road off Highway 3 provides winter access to the community.	In the summer people can travel to and from Behchokǫ̀ by boat.
	Łutselk'e	Located 1.8 km NE of the community, the airport was built in 1994 and has a gravel runway (3000'	There is no road access to Łutselk'e.	Łutselk'e to Yellowknife by snowmobile, across Great Slave Lake,

Region	Community	Air	Road	Water/Rail
		x 100') and an air terminal building. Flights throughout the week.		after the ice freezes.
	Wekweètì	Three kilometers east of the community, the airport was built in 1994. It has one gravel runway (3000' x 75') and an air terminal building. Flights four days a week.	Ice road covering both land and frozen water from January through March.	
	Whatì	Built in 1991, the airport lies 1.6 km east of the community. It has a gravel runway (3000' x 100') and an air terminal building. Flights every day except on Saturdays.	A winter road off Highway 3 provides winter access to the community.	
	Yellowknife	Four kilometers from the city centre, the full-service airport was built in 1946/47 and has two asphalt runways (7500' x 150' and 5000' x 150'). It has an air terminal building and aviation fuel is available. Sixty scheduled flights depart daily to destinations across Canada. Yellowknife Airport is deemed a port of entry into Canada and is staffed by the Canada Border Services Agency.	Accessible by the Mackenzie Highway and Highway 3 year-round.	
South	Enterprise	No airport.	Hwy 2 – Hay River Highway (Great	

Region	Community	Air	Road	Water/Rail
Slave			Slave Route) This highway, the NWT's shortest, connects the town of Hay River to Highway 1 at the community of Enterprise. The highway runs through Hay River, terminating on the southern shore of Great Slave Lake. Its total length is 48.6 kilometres, all of which are paved.	
	Fort Providence	The airport lies 3 km east of the community and was built in 1972. It has a gravel runway (3000' x 100'). No scheduled air service.	Fort Providence is accessible by road year-round. Dehcho Toll Bridge spans the Mackenzie River at km 24 on Highway #3.	
	Fort Resolution	The airport has a gravel runway (4000' x 100') and an air terminal building. No scheduled air service.	NWT Highway 6 ends at Fort Resolution.	Accessible by boat along the Slave River and via Great Bear Lake.
	Fort Smith	Located 4 km NW of the community, the airport was built in 1938/39. There are two runways, one asphalt (6000' x 200') and one asphalt/gravel (1800' x 100', summer only), and an air terminal building. Flights daily.	Accessible by the Mackenzie Highway year-round. A winter road connects the community to Fort Chipewyan and Fort McMurray.	
	Hay River	Full-service airport lies 4 km NE of Hay River was built in 1942/43. It has two runways, one asphalt (6000' x 150') and one	Accessible by the Mackenzie Highway year-round.	The north end of the CN Northern Railway Line from Edmonton. Large barge terminal (some 70 acres) for

Region	Community	Air	Road	Water/Rail
		asphalt/gravel (4000' x 150'). It also has an air terminal building. Flights daily.		receiving, loading and offloading barges.
	Hay River Reserve		Hay River Reserve is accessed on a side road from Highway 5 in summer. In winter there is an ice crossing between the town and reserve.	
	Kakisa		Connected to the Mackenzie highway by a 13 kilometre all-weather road less than 200 kilometres west of the Alberta/NWT border.	Floatplane or boat in the summer and snowmobile in the winter.
Dehcho	Fort Liard	Built in 1982, adjacent to the community, the airport has a gravel runway (2956' x 100') and an air terminal building. No scheduled air service.	Accessible year-round by road from Fort Nelson, B.C. and Grimshaw, Alta.	
	Fort Simpson	Built in 1944, the airport lies 16 km south of the community. It has an asphalt runway (6000' x 150') and an air terminal building. Scheduled flights operate daily.	Liard or Mackenzie Highways.	"Lafferty" Ferry services are provided at Liard River Hwy 1. People also use the river system to travel between communities in the region and the territory by boat in the summer months.

Region	Community	Air	Road	Water/Rail
	Jean Marie River	The airport was constructed in 1988 adjacent to the community. It has a gravel runway (2500' x 60'). No scheduled air service.	A narrow all-weather access road is located along the stretch of Mackenzie Highway between Fort Providence and Fort Simpson.	Boat from Great Slave Lake up the Mackenzie River.
	Nahanni Butte	Built in 1962, the airport lies adjacent to the community. It has a gravel/earth runway (2500' x 60'). There is no scheduled air service.	No road access during the summer months. Ferried across the Liard River by river taxi. In the winter an ice road connects the community to the Liard Highway.	
	Trout Lake	Adjacent to the community, the airport was built in 1987. It has a gravel runway (2500' x 60'). No scheduled air service.	Winter road connects the community with the Mackenzie Highway.	The community is also accessible by boat and snowmobile.
	Wrigley	The airport was built in 1965, 2.7 km from the community. It has a gravel runway (3500' x 100') and an air terminal building. No scheduled air service.	Mackenzie Highway.	"Johnny Berens" Ferry.

6.4.8 Safety

All facilities housing the fire stations, RCMP and Ranger Patrols in each community are considered critical facilities. See section 8.4.2 Police for further information.

6.4.9 Government

All facilities housing government operations in each community are considered critical facilities. Some examples in Yellowknife include the Legislative Assembly, City Hall, and Yellowknife Correctional Centre.

6.4.10 Industry

Critical infrastructure in some NWT communities must include industries that support the local economy such as mines or oil and gas extraction.

Table 14: Yellowknife Major Employers (Source: Yellowknife Community Profile http://www.yellowknife.ca/)

Major Employers	Full Time Employees
Government of the NWT (1)	2,320
Government of Canada (2)	766
Diavik Diamond Mines Incorporated	368
BHP Billiton Diamonds	280
RTL Robinson Trucking	260
Yellowknife Education District No. 1	230
First Air	226
NorthwesTel	174
Yellowknife Catholic Schools	164
City of Yellowknife	176
Air Tindi	170

Amounts based on actual number of Full Time Employees as of September 1, 2008
(1) Per GNWT Main Estimates
(2) Includes all federal Crown Corporations and the RCMP

7 Risk Mitigation

Governments have limited resources and planning for every possible hazard is not a realistic approach. However, an informed ranking of hazards provides a cost-effective approach to hazard mitigation, emergency planning and response. Community emergency committees can use the following table to help identify the most cost effective strategies to mitigate their risk and improve preparedness.

Table 15: Control and Treatment Options

	Hazard	Mitigation Strategies
	Fire/Explosion	Forest Management Division has adopted FireSmart principals to identify and mitigate wildfire risks. Consider implementing FireSmart programs for all communities and include the response capabilities for urban/rural/wildland fires. Create fire education training and awareness sessions for first responders and the public. Enforce fire prevention practices.
	Flood	Outline a water management and community development policy. Develop and exercise plans/programs for: • watershed management; • river/lake/ocean modeling/prediction and monitoring; • erosion control; and • flood response. In the face of rapid snowmelt and intense rains in spring and summer, communities susceptible to flash flooding should review and improve their drainage facilities and protect vulnerable buildings and facilities (Black, R et al. 2010).
	Weather - Winter Storm	Develop and enforce snow load standards. Ensure that plans are in place for severe winter storms. Develop/distribute and facilitate a public awareness program around how to prepare for and what to do in a severe winter storm. Identify and communicate available “safe areas” for community members.
	Transportation Accidents	Enforce safety and prevention programs. Ensure Dangerous Goods practices/regulations are followed. Implement transportation route monitoring programs. Confirm that emergency response plans in place for all areas to allow for prompt response to transportation accidents.
	Critical Infrastructure Failure - Energy Crisis	Understand the potential risks associated with critical infrastructure failure – energy crisis. Build partnerships between stakeholders. Ensure back up/alternate systems in place for life safety. Ensure emergency response plans in place.

	Hazard	Mitigation Strategies
	Critical Infrastructure Failure – Other	Understand the potential risks associated with critical infrastructure failure. Build partnerships between stakeholders. Ensure back up/alternate systems in place for life safety. Ensure emergency response plans are in place.
	Critical Infrastructure Failure - Water Contamination	Understand the potential risks associated with water contamination. Plan for identification and reduction of contaminants into ground and surface water. Ensure water sampling and monitoring program in place. Ensure emergency response plans are in place.
	Weather - Other Extreme	Develop and enforce building standards for identified extreme weather hazards. Develop/distribute and facilitate public awareness programs. Ensure that emergency plans in place. Ensure “safe areas” are available and known to community members.
	Industrial Emergency	Identify the industries in each community and rank according to risk. Ensure back-ups are in place for the industries ranked as critical. Ensure appropriate safety and emergency plans are in place.
	Weather - Wind Storm	Develop and enforce building standards for severe winds. Develop/distribute and facilitate public awareness programs. Ensure emergency plans include response to wind storms. Ensure “safe areas” are available and known to community members.
	Human Disease	Ensure disease monitoring plans are in place between all levels of government and private sector. Ensure preparedness plans are in place. Ensure response plans are in place and are exercised, including containment and quarantine procedures. Human vaccination against anthrax is available for personnel likely to be involved in investigating or responding to anthrax outbreaks.
	Ice Hazard	Develop and enforce building standards for ice accumulations. Develop/distribute and facilitate public awareness programs. Confirm that ice storm emergency plans in place. Ensure “safe areas” are available and known to community members. The Canadian Ice Service (CIS) provides the most accurate and timely information about ice in Canada's navigable waters.
	Snow Load Hazard	Include snow load hazards in community response plans. Clear snow from public building rooftops. Perform a Roof Risk Assessment on key community structures such as schools and community centers.
	Earth Movement - Permafrost Degradation	Develop and enforce building standards for building slumping and/or collapse. Develop/distribute and facilitate public awareness programs. Include permafrost degradation risk actions in emergency plans.

	Hazard	Mitigation Strategies
		Ensure “safe areas” are available and known to community members.
	Civil Unrest	Have intelligence and monitoring plans in place with law enforcement and stakeholders. Coordinate integrated response plans with stakeholders.
	Earth Movement – Other	Develop and enforce building standards. Develop/distribute and facilitate public awareness programs. Ensure emergency plans in place. Ensure “safe areas” are available and known to community members.
	Earth Movement - Earthquake/ Tsunami	Develop or adopt and enforce building standards for earthquakes. Develop/distribute and facilitate public awareness programs for what to do in the case of an earthquake or tsunami. Ensure emergency plans in place. Develop tsunami inundation mapping and hazard zones for at risk communities. Plan and communicate “safe areas” for community members to go to in the event of an earthquake or tsunami.
	War/ International Incident	Ensure notification and information/communication protocols are in place with Federal Government Departments. Ensure appropriate emergency plans are in place based on the perceived or real risk of war and potential casualty threats.
	Food and Agricultural Emergency	Ensure disease and recall monitoring plans are in place between all levels of government and private sector. Ensure public awareness information and programs are available from the Federal Government and industry associations. Ensure that response plans include containment and quarantine procedures.
	Falling Debris	Have monitoring and notification protocols in place with appropriate agencies (i.e. CSA, NASA, NavCan). Ensure emergency plans are in place for potential risks associated with falling debris.

8 Appendices

8.1 Summaries of Stakeholder Meetings

As part of the process in collecting data for the HIRA, regional meetings were held during June and July of 2013. These meetings were held in Fort Simpson, Fort Smith, Norman Wells, Inuvik and Yellowknife.

The intent of these meetings was mainly to listen to what stakeholders, within the various regions, saw as the main risks with which they dealt with on a consistent basis. The workshops were looking for regional and local perspectives on what the data collection had shown in order to get a better understanding of what exactly was taking place in communities and regions around the NWT. Another valuable aspect of these meetings was the gathering of local/traditional knowledge from those who lived on and off the land and within the remote communities of the NWT.

The majority of these meetings yielded much of the information which had been gathered remotely through the investigation phase of the project. Many respondents identified areas of concern which were well-known and documented such as floods, forest fires and lack of resources to deal with many issues.

There were also specific regional issues identified which had not been seen in the data collection phase. Some examples of this type of information included the storage of radioactive waste in the South Slave Region, the identification of warming waters within the Sahtu which was leading to issues with fish in the region, and the isolation felt in the Beaufort Delta Region when the telecommunications were lost for several days and residents were unable to access money from local banks and stores.

Attendance at these meetings was good with few exceptions and the feedback from the attendees was well received and very informative. A summary of each of the meetings is contained within each respective Regional HIRA.

8.2 Glossary and Terminology

Critical infrastructure – essential underlying systems and facilities upon which our standard of life relies.

Disaster – essentially a social phenomenon that results when a hazard intersects with a vulnerable community in a way that exceeds or overwhelms the community's ability to cope and may cause serious harm to the safety, health, welfare, property or environment of people; may be triggered by a naturally occurring phenomenon which has its origins within the geophysical or biological environment or by human action or error, whether malicious or unintentional, including technological failures, accidents and terrorist acts.

Emergency – a present or imminent event that requires prompt coordination of actions concerning persons or property to protect the health, safety or welfare of people, or to limit damage to property or the environment.

Emergency management – the management of emergencies concerning all-hazards, including all activities and risk management measures related to prevention and mitigation, preparedness, response and recovery.

Hazard – a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Local Authority – means the council of a municipal corporation as defined in the *Cities Towns and Villages Act*; *Hamlets Act*; *Charter Communities Act*; the council of a settlement corporation as defined in the *Settlements Act*; or an organization which has entered into an agreement with the Minister, pursuant to Sec. 6(1) of the *Act*, to develop and implement a community emergency plan when a local governing municipal corporation does not exist.

Mitigation – sustained actions taken to eliminate or reduce risks and impacts posed by hazards well before an emergency or disaster occurs; mitigation activities may be included as part of prevention.

Resilience – the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.

Risk – the combination of the likelihood and the consequence of a specified hazard being realized; refers to the vulnerability, proximity or exposure to hazards, which affects the likelihood of adverse impact.

Risk-based – the concept that judicious emergency management decision-making will be based on an understanding and evaluation of hazards, risks and vulnerabilities.

Risk management – the use of policies, practices and resources to analyze, assess and control risks to health, safety, environment and the economy.

Sustainable – a sustainable approach is one that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Threat – the presence of a hazard and an exposure pathway; threats may be natural or human-induced, either accidental or intentional.

Volunteer firefighter: a local resident who freely offers his/her services to the community to assist in firefighting duties because the community does not warrant a fulltime fire brigade. These individuals play an essential role in protecting residents and are a very integral part of ensuring the public safety of their communities.

Vulnerability – the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. It is a measure of how well prepared and equipped a community is to minimize the impact of or cope with hazards.

8.3 Specific Climate Change Report

Researchers do not yet know everything there is to know about climate change including its full potential impact over the next five to ten years. While it is difficult to attribute any single weather event to climate change, world climate scientists agree that climate change makes extreme weather events both more likely to occur and more catastrophic in scope. Even under the best-case climate scenarios, we are likely to experience more extreme weather, more droughts, more destructive storms and floods.

What will changes in temperature and precipitation mean for the NWT? How will higher sea levels affect coastal communities? What might permafrost degradation and stronger and more frequent storms mean for the infrastructure of the NWT?

Emergency planners need to assess the risks and consider how hazard patterns could alter due to climate change. The following table outlines the key climate change effects on both the frequency and consequences for each hazard identified in this document.

Hazard	Key Effects of Climate Change on Frequency	Key Effects of CC on Consequences	↑Increase (frequency)
Civil Unrest	The effect of climate change on activities such as aboriginal livelihoods or increased access to resources and compensation could lead to protests/civil unrest.	The impacts could be larger protests in the NWT and Ottawa or at meetings such as the Artic Council.	↑Increase frequency
Critical Infrastructure Failure - Energy Crisis	Structural elements of energy infrastructure in place could be affected, more frequently. Transport of fuel could be affected with ice road degradation/shorter season.	Costs to adjust infrastructure for degradation in permafrost. May require larger fuel storage tanks to adjust for shorter ice road season.	→Neutral or limited impact
Critical Infrastructure Failure – Other	Infrastructure will be affected more frequently by structural effects of permafrost melting (effect on roads, airports, etc.).	Isolated populations with loss of road or airport or telephone service.	↑Increase frequency/ consequence
Earth Movement - Earthquake/ Tsunami	Earth movements are expected to increase. There is some antidotal evidence that earthquakes can increase with climate change in permafrost regions (normally earthquakes are not/minimally affected by climate change).	With less sea ice, waves (created from ice dropping) could have a larger impact. Sea level rise can also increase the damage to property and people at shorelines. Impact of earthquake on less stable permafrost soil,	→Neutral or limited impact

Hazard	Key Effects of Climate Change on Frequency	Key Effects of CC on Consequences	↑Increase (frequency)
		due to warming associated with climate change.	
Earth Movement – Permafrost Degradation	Thawing of permafrost expected with climate change, top two to three meters will have thawed by 16-20% by 2100. Increase in earth movements, including coastal landslides, subsidence, sink holes, as well as avalanches.	Infrastructure vulnerability related to permafrost thawing, and necessity for building code updates to deal with this trend. Positive feedback loop, as permafrost thawing releases GHGs, thus creating more climate change.	↑Increase frequency/ consequence
Earthquake Movement – Other	Increased landslides are expected, with thawing of permafrost, reducing soil strength. Increased avalanches associated with increases in temperature and precipitation. Excess water draining as permafrost thaws can also lead to subsidence, and excess water creating ponds or draining away. Additional outcomes include the potential for glacial lake outburst floods.	Damage to buildings, roads and other infrastructure has and is being caused by these earth movements including erosion, riverbank collapse and sinkholes. Also increase in maintenance costs associated with landslides and avalanches, even where no infrastructure damage occurs.	↑Increase frequency/ consequence
Falling Debris	None	Research is being conducted on the impact of climate change on falling debris; early evidence suggests more debris may penetrate the atmosphere.	→Neutral or limited impact
Fire/ Explosion	The length of the fire season in the Territories is expected to increase by up to 50 days this century. Lightning sparks some 80% of forest fires, which are correlated with increase temperatures of climate	Decrease in moisture conditions could lead to larger forest fires. Shorter ice road season availabilities could mean more fuel stored in communities.	↑Increase frequency/ consequence

Hazard	Key Effects of Climate Change on Frequency	Key Effects of CC on Consequences	↑Increase (frequency)
	change. The melting of permafrost and more droughts suggests peat fires will be more common. Warmer temperatures, changes in precipitation, atmospheric moisture, wind, and cloudiness could increase the number and size of wildfires.		
Flood	Projected increase in precipitation (North) by 2050. Medium confidence level (globally) of increases in flooding with increased precipitation. Increased frequency of flash flooding with a combination of snowmelt and intense rain in the spring.	Projections of increase in rain (10-20%) and snowfall (40%) in this by 2050. Precipitation and snow will be concentrated in the Fall and Winter each year. Flooding mostly in April and May with snow melt. In 2050, rainfall increases that were once in 50 years will now by once in 35 years.	↑Increase frequency/ consequence
Food and Agriculture	Increase in temperature increases the number of invasive species. Increase in temperatures may lead to more need for controlled temperature storage for food.	Impact of changing temperatures on climate sensitive livelihoods (fishing, hunting, farming). Effects on roads and ice roadways will affect transportation of food to communities in the NWT. Climate change impacts on surface water will affect agriculture, an industry that is growing.	↑Increase frequency/ consequence
Human Disease	One of the least predicable factors related to climate change is stated to be the effect on infection diseases.	More diseases are likely to survive in warmer temperatures predicted with climate change.	↑Increase frequency/ consequence

Hazard	Key Effects of Climate Change on Frequency	Key Effects of CC on Consequences	↑Increase (frequency)
Ice Hazard	Melting of sea ice. More rescues.	Predictions indicate approx. 10% coverage per decade. There may be no ice cover in the summer by the middle of the century. Increase in sea level of 1 m within a century.	↑Increase frequency/ consequence
Industrial Emergency	None.	There is expected to be an impact of climate change on infrastructure associated with industry. Treatment associated industrial usage, such as tailing ponds and for example ice encapsulated arsenic are expected to be affected by climate change.	↑Increase frequency/ consequence
Snow load Hazard	Increased number of days of snow.	1/5th of municipal buildings are under snow load risk (a portioned repaired, a portion under watch). Greater snow removal. Demands on roadways. Increased snow during events. Wetter snow, leads to higher snow loads. Variation in community's observations from higher snow loads to wetter snow, to less snow – aligns with variability associated with climate change.	↑Increase frequency/ consequence
Transportation Accidents	A shift in the type of travel is possible, for instance climate change's effect on ice roads could lead to more air travel.	Need to shift to all weather roads over time, as climate change has an effect on ice roads and shortens the season of viability. Infrastructure is also affected, which includes	↑Increase frequency/ consequence

Hazard	Key Effects of Climate Change on Frequency	Key Effects of CC on Consequences	↑Increase (frequency)
		airports and their runways. Concern about the risk associated with degradation of roadways, and the transportation of dangerous goods.	
Water Contamination	Increased siltation and water volumes associated with precipitation. Climate change is expected to lead to the greater bioaccumulation of mercury and POPs.	Increases siltation, and water volume leading to greater demands on systems. Degradation of infrastructure is expected with the climate change effect on permafrost.	↑Increase frequency/ consequence
Weather – Windstorm	Increase in strong winds.	Tornado activity is moving north. Cyclone activity is increasing.	↑Increase frequency/ consequence
Weather – Winter Storm	More intense and frequent winter storms, and more unpredictability.	Increases snowpack, earlier melting, and rain on snow are prevalent with climate change. Increased snow load (both snow and precipitation) on buildings. 1/5th of municipal buildings are under snow load watch in NWT.	↑Increase frequency/ consequence
Weather - Other	Increase in rain and snow events. Increase in lightning with heat.	Increase in hotter days will lead to degradation in the permafrost. Snow loading can affect infrastructure.	↑Increase frequency/ consequence
War/ International Incident	Increased attention to the region, associated with increased navigability and access to natural resources, brought on by warming temperatures of climate change.	None.	↑Increase frequency

The following narratives provide added detail concerning the potential effects of climate change relative to territorial hazards identified in table 8.3.

Civil Unrest: Civil unrest could be indirectly affected by climate change. Protests related to first nation's treaty rights show that other issues, such as the impact of climate change on livelihoods could draw similar attention. Academic research shows increased likelihood of violence with climate change in warmer environments, and may have some limited applicability to the NWT.

Critical Infrastructure Failure – Energy Crisis: The instability of infrastructure, such as fuel tanks and piping, with permafrost degradation could lead to an outage in services. The communities' concerns are single failure, such as an electrical outage, fuel shortages or a pipe failure, having a significant affect due to the remote nature of most communities. Fuel shortages have already occurred in a few communities. The CSA guidelines for infrastructure are being reviewed in the NWT and implementation is taking place on a risk-based approach for new infrastructure. Yellowknife has yearlong access by roadway but other communities rely on ice roads for the shipment of fuel. Alternative energy programs and community energy planning provide a good buffer for risks. Ice coverage of water areas, such as the Northwest Passage, is melting with climate change and there will also be increases in access to energy sources in the future, with the potential for disputes about ownership.

Critical Infrastructure Failure – Other: Infrastructure (airports, sewage piping, telephone systems, structures, ice roads, bridges etc.) is subject to the potential damage from soil instability due to permafrost melting, and the implementation of the CSA standard remains important. Climate change is not only expected to shorten ice road seasons, but also increase variability of weather, which could easily shutdown roadways.

Freeze and thaw cycles become more frequent with climate change and can degrade roadways and bridges, and especially ice roads. Community concerns are associated with degraded road conditions, and reliance on ice roadways. An incident that shuts down an airport can have pronounced effects on the movement of the population. The isolation of the population can prove problematic in terms of keeping stocked with supplies and in touch with other communities. The opening of the Northwest Passage, predicted with climate change, may give an alternate means of shipments reaching the NWT.

Earth Movement - Earthquake/ Tsunami: Climate change has indirect impacts, which include: sea ice breakage causing waves, increases in sea level and potential damage during a tsunami, or the increased impact of an earthquake on warmer permafrost soil. A tsunami type wave can start from ice breakage and its impacts can be greater with less ice covered water and sea level rise, both attributable to climate change.

Earth Movement – Permafrost Degradation: Frozen soil loses its strength as it thaws and makes infrastructure vulnerable to degradation. Thawing may be from both natural causes or causes such as forest fires, vegetation removal and climate change.

Places like Inuvik are the most vulnerable to this degradation with 45-70% of their buildings at risk from permafrost degradation.

Earthquake Movement – Other: Increased landslides are expected with the thawing of permafrost reducing soil strength. Increased avalanches are associated with increases in temperature and precipitation. Excess water draining as permafrost thaws can also lead to

subsidence and excess water creating ponds or draining away. Additional outcomes include the potential for glacial lake outburst floods. Isolated populations in the NWT are vulnerable with the loss of road, airport or telephone service.

Falling Debris: Early studies indicate there may be a negative impact of increased carbon dioxide accumulation on debris entering the atmosphere, specifically less of this debris will burn up and thus could increase this risk.

Fire and Explosion: The largest amount of fuel in the NWT is associated with forests, dry peat and fuel storage. Forest fires are a regular occurrence, and are projected to occur more with increased lightning strikes, which will be more prevalent with warmer temperatures. The length of the fire season is expected to increase by 50 days this century. The melting of permafrost makes peat more dry and susceptible to catching on fire. Large fuel reserves are kept in communities to ensure that quantities are sufficient when access to the community may be limited (i.e. ice road is not open). The burden on emergency firefighting services will increase over time due to the frequency of fires and the length of the fire season. Emergency response will likely need to cope with more of these events in the future. This will require increased capacity and funding, at a time when this service is already strained.

Food and Agriculture: Climate change will result in the increase and variability of temperatures, which will have an impact on climate sensitive livelihoods. Temperature also affects invasive species. It should be noted that the NWT has a small agriculture industry, but in recent years has been growing. The effects on roadway infrastructure, including ice roads, will also have an effect on transportation of food to the region.

Flood: In the NWT, flooding has been linked to both precipitation increases and early spring run-off conditions. There are projections of increase precipitation and snowfall in the North by 2050, thus expectation of increased flooding in the region. In fact, those one in 50 year occurrences will increase to one in 35 year occurrences in the North. More flooding will continue to occur in the spring, during times of rapid snowmelt and precipitation. The overall susceptibility of buildings and communities is based on the design of drainage systems and the location of the buildings, which require consideration for any design or new construction.

Human Diseases: The effect of climate change on diseases is stated to be unpredictable, although it stands to reason that with rising temperatures more diseases that would have been killed off in the cold will survive and the impact will be greater transmission.

Ice Hazard: It is predicted that about 10% of ice coverage per decade will be lost due to the increased temperatures associated with climate change. This could manifest as predicated with no ice cover in the summer by the middle of the century. Expect more rescues to be required as ice conditions will become more unpredictable with time. An indirect consequence of loss of sea ice is sea level rise, which is expected to be one metre within a century.

Industrial: Given the inability to forecast every effect of climate change on industrial operations, the NWT government can promote emergency preparedness as a means of dealing with emergencies, expected to be more pronounced with climate change. Permafrost degradation will affect the stability of infrastructure. Literature highlights the impact expected from treatment facilities such as mining tailing ponds, which rely on permafrost for structural integrity.

Snow load: There has been a 25-35% increase in snow since the 1950s. The number of days (frequency) and amount of snowfall has increased. The snow that falls is wetter due to a combination of rain and snowfall, resulting in higher snow loads. There is recognition of the increased risk of snow loads, and thus some municipal buildings are under watch. More snow removal is necessary on roadways to allow for passage and transportation of goods. There has

been an observation in communities of more snow falling, increased wet snow, and less snowfall. This tends to match with the variability associated with climate change.

Transportation Accidents: There is a need to consider shifting to all weather roads over time, as climate change has a dramatic effect on ice roads and shortens their season of usage. The GNWT estimates that one million dollars per year is required for maintenance of roadways due to climate change. Based on information presented its likely this figure will continue to increase. An elevated risk exists with degraded roadways and the transportation of dangerous goods. Search and rescue will need to contend with the changes in climate affecting roadways and the possibility of involvement of dangerous goods. Airport infrastructure can be affected with degradation of permafrost associated with climate change. Although aircraft accidents are not frequent, any increase associated with infrastructure degradation could have a devastating effect in terms of the impact to people and property, as well as the isolation affect with airline operations being halted. With climate change there is a general increase in snowstorms affecting shipments by road or air.

War and International Incident: There is increased attention in the Arctic region, with melting sea ice. Clearing of sea ice leads to easier navigation and access to natural resources. It seems possible that a clash could occur in the region. There is a security environment developing, but equally an environment of cooperation through the Artic Council.

Water Contamination: With climate change there is expected to be greater water volumes to treat due to increased precipitation. There is an additional load on the water treatment systems, with increased siltation and turbidity. In addition, the structure of water treatment systems and piping rely on permafrost that will degrade with climate change. Thus reference to the CSA standards for opportunities to upgrade systems through maintenance and replacement should be considered.

Weather – Windstorm: There is expected to be an increase in windstorms in the NWT, and this has already been observed. Tornados will be more frequent in the North with increased temperatures. Also, cyclones are expected to be more frequent with more temperature fluctuations.

Weather – Winter Storm: There are more intense and frequent winter storms, and generally more unpredictability. There are increases in snowpack, earlier melting, and a combination of rain and snow that leads to wetter and heavier snow.

Weather - Other Extreme: With climate change there will be an increase in rain and snow events, an increase in lightning with heat, degradation of permafrost with heat. Increased snow loads will affect structures.

8.4 Existing GNWT Response Capabilities

This section provides a summary of the NWT's response capabilities which were considered when assessing the territories' overall risk to the hazards discussed in Section 5.

In the NWT, emergency responders of all types have historically been difficult to recruit and retain. This has led to issues with inexperienced responders facing the challenging environmental conditions throughout the NWT. Efforts to train local or volunteer resources can be limited by financial concerns.

8.4.1 Fire

The Fire Chief/Local Assistant is responsible for directing the activities of the Fire Department to ensure that loss of life, property or injury, as a result of fire, is prevented and/or minimized within each community. The Fire Chief/Local Assistant is the sole authority and command at the scene of a fire.

MACA delivers training to community government fire departments through its School of Community Government.

The Office of the Fire Marshal (OFM) protects the public from loss of life and property as a result of fire. The OFM has direct contact with fire departments and the public across the NWT. The OFM plays a regulatory role by enforcing the *Fire Prevention Act* and its associated regulations, namely, the *Fire Prevention Regulations*, *Fireworks Regulations* and the *Propane Cylinder Storage Regulations*. NWT has adopted Firesmart principles to identify and mitigate hazards (Office of the Fire Marshal Public Safety Division, 2013).

Fire departments in the NWT are largely composed of volunteers, with only Yellowknife employing full-time fire fighters. Only Yellowknife, Hay River and Inuvik employ a full-time fire chief. It is estimated that approximately 340 volunteer firefighters support the NWT's community fire service which is an average of 10.3 per community, well below the national average of 28. In contrast, approximately 85,000 volunteer firefighters comprise 3000 volunteer fire departments across Canada (Office of the Fire Marshal Public Safety Division, 2013).

Many communities in the NWT experience difficulty in the recruitment of volunteers. Although reasons vary, a significant factor is the training which requires individuals to take time away from home and work for even the basic level.

Wildfire

The Department of Environment and Natural Resources directs the GNWT Forest Fire protection and suppression initiatives to provide:

- Assistance in the provision of and support to mobile/portable radio systems;
- Assistance in the procurement of radio communications equipment;
- Monitoring weather, forest and fire conditions, forecasting fire behaviour and conditions to guide preparedness arrangements, and managing NWT forest fire suppression operations;
- Advising Emergency Management Office and communities on forest fire conditions and behaviour, and recommending appropriate courses of action (seasonal); and

- Requisition of special firefighting and safety equipment, and other specialized materials and supplies which are available (seasonal).

Environment and Natural Resources is working with communities in the NWT to develop and implement Community Wildfire Protection Plans (CWPP). These plans are designed to identify and reduce wildland fire risk in communities. CWPP's are becoming a national standard for agencies and communities responsible for wildland fire management. The process is recognized as a crucial first step in better preparing homeowners and communities to reduce the risk of loss.

8.4.2 Police

Police servicing in the NWT is designated as G Division and is split into a North and South District. The capital city of Yellowknife is its own entity and does not fall under either district command. There are currently 23 RCMP Detachments in the NWT:

- Aklavik Detachment;
- Behchokǫ̀ Detachment;
- Déljne Detachment;
- Fort Good Hope Detachment – also services Colville Lake;
- Fort Liard Detachment;
- Fort McPherson Detachment – also services the community of Tsiigehtchic;
- Fort Providence Detachment – also services the community of Kakisa;
- Fort Resolution Detachment;
- Fort Simpson Detachment;
- Fort Smith Detachment;
- Gamètì Detachment;
- Hay River Detachment - also services the community of Enterprise and the Hay River Reserve;
- Inuvik Detachment;

Community Wildfire Protection Plans (CWPP)

Dehcho
Fort Liard CWPP 2011
Fort Simpson CWPP 2011
Jean Marie River CWPP 2010
Nahanni Butte CWPP 2011
Trout Lake CWPP 2011
Wrigley CWPP 2011

Inuvik
Aklavik CWPP 2012
Fort McPherson CWPP 2012
Inuvik CWPP 2012
Tsiigehtchic CWPP 2010

North Slave
Behchokǫ̀ CWPP 2012
Dettah CWPP 2012
Gamètì CWPP 2012
Łutselk'e CWPP 2012
Wekweètì CWPP 2012
Whatì CWPP 2012
Yellowknife CWPP 2012

Sahtu
Colville Lake CWPP 2012
Déljne CWPP 2012
Fort Good Hope CWPP 2010
Norman Wells CWPP 2010
Tulita CWPP 2011

South Slave
Enterprise CWPP 2010
Fort Providence CWPP 2010
Fort Resolution CWPP 2011
Fort Smith CWPP 2010
Hay River CWPP 2011
Kakisa CWPP 2010

- Łutselk'e Detachment;
- Norman Wells Detachment;
- Paulatuk Detachment;
- Sachs Harbour Detachment;
- Tuktoyaktuk Detachment;
- Tulita Detachment;
- Ulukhaktok Detachment;
- Whatì Detachment;
- Wrigley Detachment; and
- Yellowknife Detachment – also services N'dilo, and Dettah.

Neither Wrigley nor Gamètì Detachments have existing infrastructure in place to allow for RCMP members to reside and work in these communities full-time. RCMP members are designated as part of these detachments and travel to them on a regular basis.

8.4.3 Medical and Health Authorities

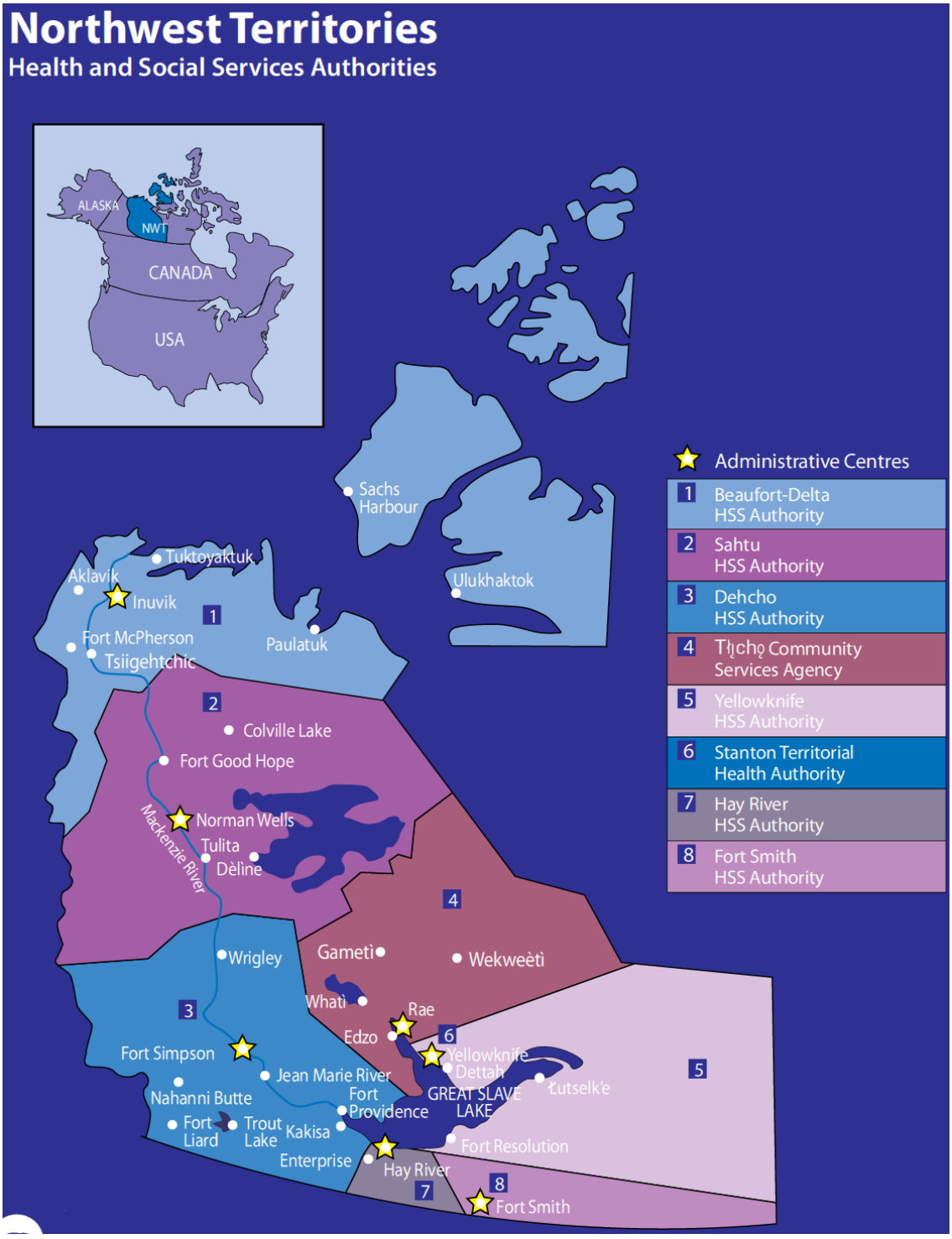


Figure 32: NWT Health and Social Services Authority Map 2008 (Source: GNWT Health and Social Services http://www.hss.gov.nt.ca/sites/default/files/nwt_hss_authority_map.pdf)

Beaufort-Delta Health and Social Services Authority (BDHSSA)

The BDHSSA operates the Inuvik Regional Hospital (51-bed hospital), 8 health centres and community based health and social services programs throughout the Inuvik Region. It includes:

- Nine practicing physicians;
- Seven remote health centers;
- Seven remote social services locations;
- Three group homes; and
- Two seniors care facilities.

Dehcho Health and Social Services

Community	Health Care	Health Resources
Fort Liard	Health Centre	1 Nurse in Charge, 1 Nurse Practitioner, 2 Community Health Nurses, 1 Community Health Worker, 2 Home Support Workers, physician from Fort Simpson makes monthly visits to the community, for 3-5 days
Fort Providence	Health Centre	Nurse in Charge, Community Health Nurses, Nurse Practitioner, Community Health Worker, Home Support Worker, physician from Fort Simpson makes monthly visits to the community, for 3-5 days
Fort Simpson	Health and Social Services Centre	5 Community Health Nurses and 1 Nurse Administrator, laboratory, x-ray, autoclave, OBS, pharmacy room, 2 emergency rooms and 5 clinic rooms, 2.88 physicians per year, which is currently covered by locum physicians
Hay River Reserve	Patients drive to Hay River for their medical needs	
Jean Marie River	Health Cabin	1 Community Health Worker, Fort Simpson Health and Social Services team have regular scheduled visits to Jean Marie River
Kakisa	Patients drive to Fort Providence or Hay River for their medical needs	
Nahanni Butte	Health Cabin	1 Community Health Worker (CHW), Fort Simpson Health and Social Services team have regular scheduled visits

Community	Health Care	Health Resources
Trout Lake	Health Cabin	1 Community Health Worker (CHW), Fort Simpson Health and Social Services team have regular scheduled visits
Wrigley	Health Center	1 Community Health Worker (CHW) and 1 Community Health Representative (CHR) along with the Home Support Worker (HSW). Fort Simpson Health and Social Services team have regular scheduled visits

Fort Smith Health and Social Services Authority

Community	Health Care	Health Resources
Fort Smith	Health and Social Services Centre	Acute care beds, offices and clinic examination rooms - nurse practitioner is on staff while a compliment of 4 physicians and two practicing midwives

Hay River Health and Social Services Authority

Community	Health Care	Health Resources
Hay River	H.H. Williams Memorial Hospital	The H.H. Williams Memorial Hospital a 29 bed accredited Hospital; a 15 bed long term care facility; a supportive living program consisting of three residential homes and a day program building; a medical clinic (including Specialists) and a variety of social, mental health, community and home care services.

Sahtu Health and Social Services Authority

Community	Health Care	Health Resources
Colville Lake	Receives health and social services from the Fort Good Hope Health Centre	Physician visits once a month
Déljne	Health Centre	3 Nurses, 3 Prevention and Health Promotion Workers, 2 Home Support Workers, Physician visits 5 days a month
Fort Good Hope	Health Centre	3 Nurses, 3 Prevention and Health Promotion Workers, 2 Home Support Workers, Physician visits 5 days a

Community	Health Care	Health Resources
		month
Norman Wells	Health Centre	4 Nurses, 1 Prevention and Health Promotion Worker, 1 Home Support Worker
Tulita	Health Centre	3 Nurses, 2 Prevention and Health Promotion Workers, 1 Home Support Worker

Stanton Territorial Health Authority

Yellowknife - Stanton Territorial Hospital, with 80 beds available for inpatient care and 30 beds dedicated to ambulatory care (i.e. Medical Day Care Unit, Surgical Day Care Unit), Stanton Medical Clinic, Stanton Medical Centre, and Stanton Ophthalmology Clinic.

Tłı̨chǫ Community Services Agency

Community	Health Care	Health Resources
Behchokǫ̀	Jimmy Erasmus Seniors Home	
	Health Centre	7 Nurses, 2 Social Workers, Addiction Counselor
Gamètì	Health Centre	1 Nurse
Wekweètì	Health Station	Nurse
Whatì	Health Centre	2 Nurses

Yellowknife Health and Social Services Authority

Yellowknife Health and Social Services Authority (YHSSA) provides community-based health and social services programs to 20,000+ residents of Dettah, Fort Resolution, Łutselk'e, N'Dilo and Yellowknife.

Community	Health Care	Health Resources
Fort Resolution	Health Centre	1 nurse practitioner, 1 community health nurse, a Community Health Representative, Bi-weekly physician visits
	"Our Great Elders" Facility-Homecare and Administration	Home nursing care services
Łutselk'e	Health Centre	2 community health nurses, a community health representative,

Community	Health Care	Health Resources
		Physician visits
Yellowknife	Home and Community Care (1st floor, Jan Stirling Building)	
	Public Health (1st floor, Jan Stirling Building)	
	Healthy Family Program Centre (47th Street)	
	Integrated Services	
	Centre for Northern Families	Walk-in clinic, a nurse practitioner and a doctor
	Frame Lake Community Health Clinic	11 Physicians, 2 Nurse Practitioners,
	Yellowknife Primary Care Centre	15 Physicians, 4 Nurse Practitioners,

Medical Travel

Medical travel is a GNWT health care benefit provided to all NWT residents who do not have access to medical travel benefits through an employer. The Medical Travel staff arrange emergency medical evacuations, schedule air travel bookings, special charter bookings and ground transportation between communities for residents living in the NWT's 33 communities.

Ground Ambulance and Highway Rescue Services

The communities of Yellowknife, Hay River, Behchokǫ̀, Inuvik, Fort Simpson and Fort Smith operate a community-based ground ambulance service which is operated predominantly by volunteers. In light of the necessary resources, capacity, equipment and training, Health and Social Services Authorities generally do not provide support for ground ambulance services within communities or on NWT highways. Communities with ambulance services also provide both highway ambulance and rescue services within a prescribed distance of their municipal boundaries.

The GNWT utilizes a Highway Emergency Alerting Protocol (HEAP) to assist the RCMP and community Fire Departments in responding to vehicular accidents on territorial highways and winter roads. The Protocol describes a uniform plan for emergency response to highway accidents in various zones designated across the NWT. It guides the following activity:

- Establishing command authority;
- Dispatching resources;
- Accident reporting;
- Emergency landing procedures; and
- Clarifying medevac coverage areas.

The Stanton Territory Health Authority coordinates inter-facility and medevac services for the territory.

Ambulance Service Providers (2004)	
Yellowknife	City of Yellowknife
Hay River	Town of Hay River
Fort Smith	Town of Fort Smith
Behchokǫ̀	Tłı̨chǫ Community Services Board
Inuvik	Blue Ice EMS Ltd
Fort Simpson	Village of Fort Simpson

8.4.4 Search and Rescue (SAR)

SAR response to	Primary	Secondary
Aircraft incidents	Canadian Forces	RCMP Civil Air Search and Rescue Association (CASARA) Search and Rescue Volunteer Association of Canada (SARVAC) Any multi-tasked Federal aircraft or vessel
Marine incidents in tidal and international waters	Canadian Coast Guard	Canadian Forces Canadian Coast Guard Auxiliary (CCGA) Search and Rescue Volunteer Association of Canada (SARVAC) Any multi-tasked Federal aircraft or vessel Police force of jurisdiction Vessel of opportunity

SAR response to	Primary	Secondary
Ground and inland water incidents	Parks Canada within National Parks, Crown owned land – military bases and training areas Territorial responsibility delegated to RCMP	Canadian Forces Canadian Coast Guard Any multi-tasked Federal aircraft or vessel Civil Air Search and Rescue Association (CASARA) Canadian Coast Guard Auxiliary (CCGA) Search and Rescue Volunteer Association of Canada (SARVAC)

Organization	SAR Responsibility
Royal Canadian Mounted Police	Coordination of public ground search and rescue (including inland waters).
Canadian Forces	Humanitarian assistance including air and marine search and rescue.
Fisheries and Oceans (Coast Guard)	Marine emergency alerting including ship spills and marine search and rescue under coordination of the National Search and Rescue Program and support of marine search and rescue volunteer training under the coordination of the National Search and Rescue Program.
Transportation Canada	Air search and rescue alerting and support of air search and rescue volunteer training under the coordination of the National Search and Rescue Program.
Park Canada Agency	Available to provide professional advice and support on search and rescue.

With the signing of the Agreement on Cooperation of Aeronautical and Maritime Search and Rescue in the Arctic, Canada can look to its circumpolar neighbours for assistance in the face of an Arctic crisis. Currently, the Joint Rescue Co-ordination Centre at CFB Trenton in Ontario commands air search and rescue for the NWT. The lack of northern ports was identified as a problem in the Quadrennial SAR Forum, July 15, 2013 (National Search and Rescue Secretariat, 2013).

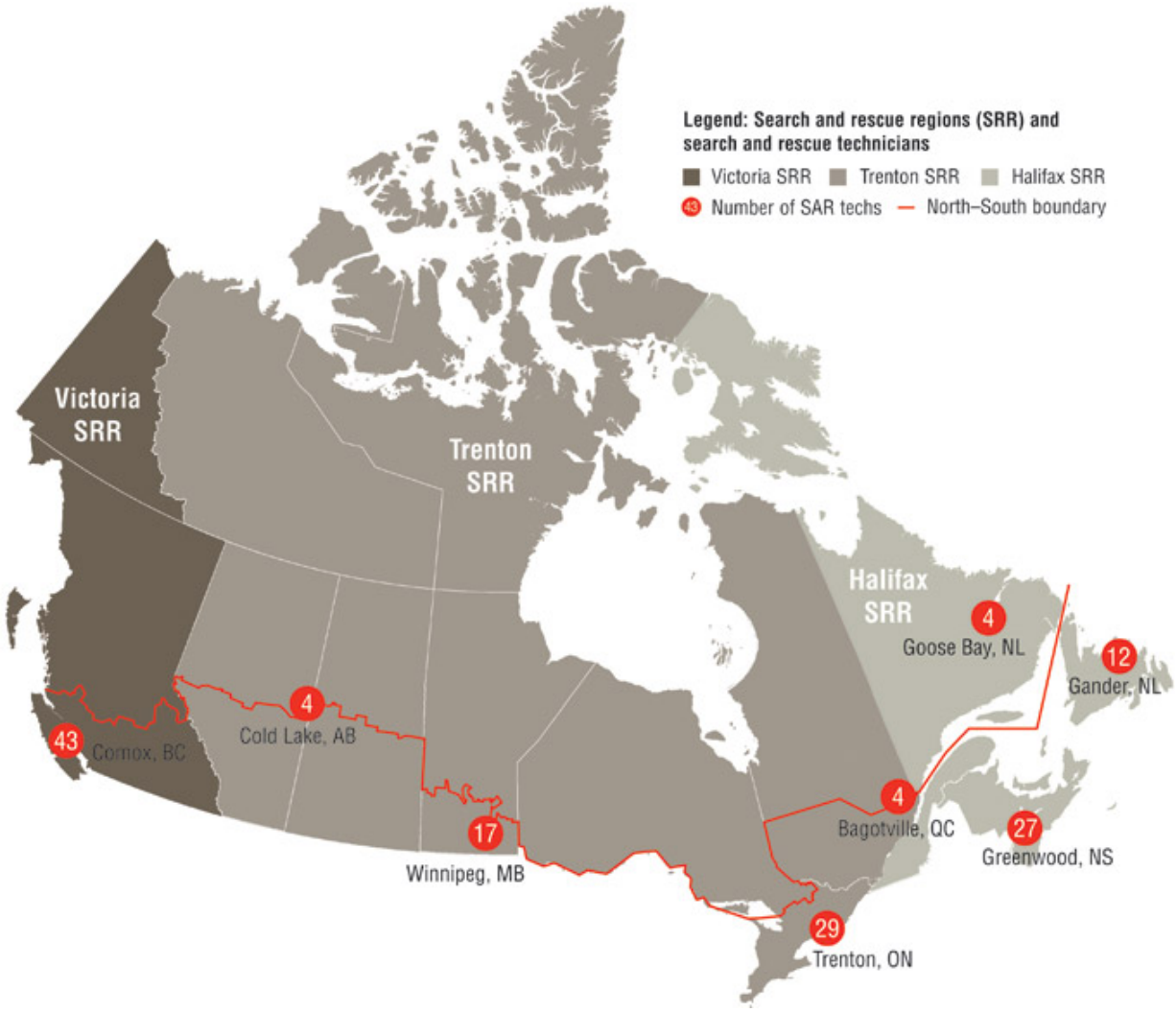


Figure 33: Search and Rescue Regions (Source: CBC News/Conference Board of Canada)

8.4.5 Emergency Response and Preparedness Organizations

The response to most emergencies is managed by the Local Authority, as the community government of the affected community. The Regional Emergency Response Committee is established as the body responsible for the planning and coordination of the area response to emergencies within each region. The Regional Emergency Response Committee provides support and assistance in specific areas as requested by the Local Authority. Should the emergency exceed the capabilities of the Local Authority to respond, or should its jurisdiction be surpassed, the GNWT may assume control of emergency operations in an effort to return conditions to normal under the authority of the Emergency Measures Officer, as the senior territorial emergency official appointed by the Minister Responsible for Civil Emergency Measures.

8.4.6 Public Works and Utilities

During an emergency, GNWT Public works and Services department is responsible for:

- Provision of specialized equipment and personnel;
- Professional assistance in undertaking reconstruction;
- Damage assessment in the public sector;
- Assistance in the acquisition of special emergency accommodation for GNWT emergency workers;
- Technical advice regarding electrical installations, pressure vessels and other materials and installations which may affect the response to an emergency; and
- Provision of emergency postal/courier services.

The following private utilities can also provide support:

- NorthwesTel might undertake to coordinate existing telecommunications service providers to ensure a proper level of emergency preparedness is maintained at territorial and regional level in providing voice and data service during emergencies;
- NWT Power Corporation is a provider of essential services in many communities and should be incorporated into detailed local preparedness and response, particularly those at risk to severe storms or potential evacuation;
- Northlands Utilities Limited may play a similar role where it is the power distributor;
- Air Transport companies should be listed in the community resource register – and informed that they could become part of local response should conditions dictate; and
- Construction firms may also have unique equipment that may be valuable to community response and they should be identified in community resource data.

8.4.7 Emergency Social Services

The Health and Social Services department assists local authorities in meeting the needs of disaster victims by providing, issuing or arranging for the following services:

- Personal counseling services;
- Acute care and mental health contingency planning and services; and
- Critical incident stress debriefing for victims and emergency response personnel.

The Canadian Red Cross is also available in collaboration with local authorities to provide emergency social services delivered by volunteers and staff, trained to national standards.

8.4.8 Amateur Radio

Yellowknife Amateur Radio Society (YARS) is a society incorporated and registered with the GNWT Registrar of Societies to provide assistance and support to civil authorities in times of emergency. YARS is affiliated with the Radio Amateurs of Canada.They currently operate two permanently linked VHF repeaters, one in Yellowknife and the second in Bechokǫ̀. A third repeater, to be located in Hay River, is under evaluation.

8.4.9 HAZMAT

Yellowknife Fire department maintains NFPA 472 Haz-Mat Operations level for 24 career fire staff. Dangerous Goods supplier/transporters may have to undertake the provision of chemical identities and documentation, emergency medical information, immediate response advice, representatives at the EOC/Site, strategy for controlling releases, monitoring and restoration.

In the NWT from 2003 to 2007 only 3 first responders received CBRN Training at any level (Public Safety Canada, 2008).

An initial oil spill response capacity is required on site of a land-based oil handling facility under the *Canada Shipping Act*, 2001 during loading or offloading operations which support community resupply operations. In Inuvik, CCG has placed community packs of spill equipment in communities however there have not been enough spills to keep people trained. There is no organization or company to maintain paid full time or part-time spill response employees. If a spill occurred during a key harvesting time it was suggested there might be a shortage of individuals to respond to an oil spill as many would be on the land.

8.4.10 Canadian Forces

Headquartered in Yellowknife, NWT, Joint Task Force (North) is responsible for Canadian Joint Operations Command's single largest region. Joint Task Force (North)'s area of responsibility encompasses approximately four million square kilometres, or 40 per cent of Canada's land mass, and 75 per cent of its coastal regions.

Created as part of a broader transformation of the Canadian Forces in 2006, Joint Task Force (North) is one of 6 regional Joint Task Forces across Canada, and reports directly to Canadian Joint Operations Command, located in Ottawa, Ontario.

In addition to its headquarters located in Yellowknife, NWT, Joint Task Force (North) maintains detachments in Whitehorse, Yukon, and Iqaluit, Nunavut.

Joint Task Force (North) is responsible for the command of the Canadian Rangers in the North through the 1st Canadian Ranger Patrol Group and for support to the Cadet program and the Junior Canadian Rangers program in the three territories.

In total, there is approximately 250 Regular Force, Reserve Force and civilian personnel who are working north of the 60th parallel within one of the following units:

- Joint Task Force (North) Headquarters and its two detachments in Iqaluit and Whitehorse;
- Area Support Unit (North);
- 1st Canadian Ranger Patrol Group;
- 440 (Transport) Squadron;
- 1 Field Ambulance Detachment; and
- C Company of the Loyal Edmonton Regiment.

NWT Communities with a Ranger Patrol

Aklavik

Behchokǫ̀

Déljne

Fort Good Hope

Fort McPherson

Fort Providence

Fort Resolution

Fort Simpson

Fort Smith

Gamètì

Hay River

Inuvik

Łutselk'e

Paulatuk

Sachs Harbour

Trout Lake

Tsiigehtchic

Tuktoyaktuk

Tulita

Ulukhaktok

Wekweètì

Whatì

Yellowknife

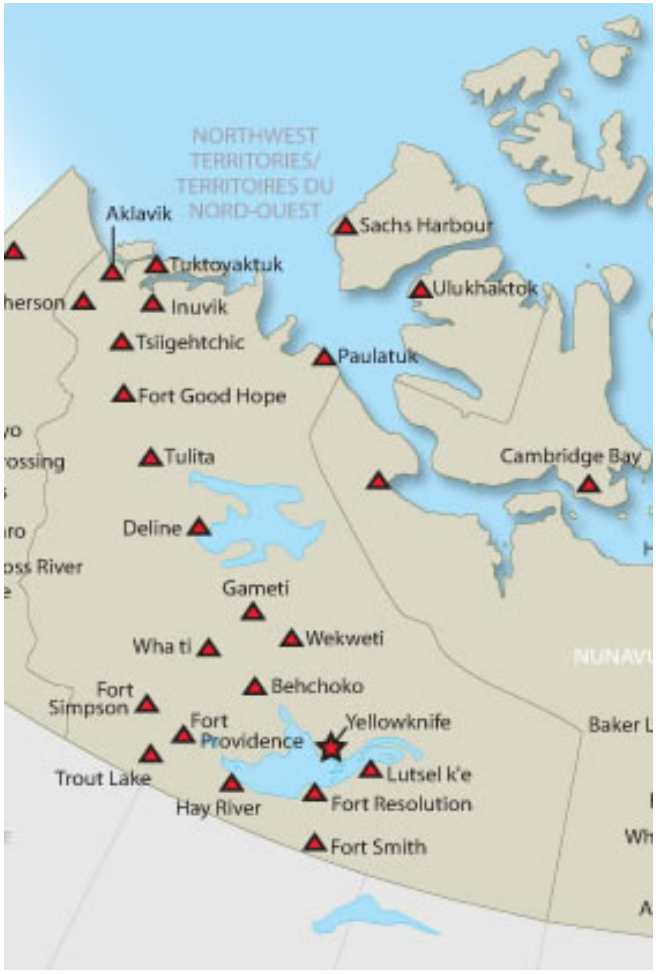


Figure 34: 1st Canadian Ranger Patrol Group in NWT (Source: Government of Canada, Canadian Army website)

8.5 Online Survey Result Summary

SCOPE OF THE SURVEY

As part of the NWT Hazard Risk Identification Assessment, Vanguard EMC Inc. launched two online publically available surveys on May 27th 2013 which ran for three months. They closed Aug 30, 2013.

NWT Hazard Community Survey

This survey was to be completed by any resident of the NWT, about their community or the community which they represent.

NWT Territory-wide Hazard Survey

This survey was to be completed by any resident of the NWT, who was interested in commenting on hazards territory-wide.

Each survey consisted of six questions as well as the definition of each hazard and contact information for regional superintendents. Each survey should have taken about three minutes to complete.

OBJECTIVES

- Validate the list of hazards that exist in the territory, both natural (i.e. geological, meteorological, and biological), and technological and human-induced (i.e. accidental or intentional) created by Vanguard EMC Inc., based upon HIRA project research.
- Gain a broader understanding of how frequently hazards occur and how severe their impact may be on communities, critical infrastructure, property, and the environment, in the past, and which hazards pose the greatest threat to communities.
- Identify any hazards that had been overlooked during the scan of relevant studies, plans and other research methods.

SURVEY PROMOTION

The GNWT MACA website homepage invited all residents of the NWT to participate in both surveys.

E-mail invitations were sent directly to key individuals across the Territory asking them to participate in the survey.

During the HIRA workshops, participants were invited to complete the online survey and given the opportunity to complete a paper survey provided by Vanguard EMC Inc.

STATISTICS

Completion rate	92%
Complete responses	14 online
Estimated completion time	3:30 minutes
Oldest response	June 11, 2013

Newest response Aug. 20, 2013

SUMMARY

The top five hazards that participants felt would cause the greatest damage to the people, property and environment in the NWT:

1. Critical Infrastructure Failure - Energy Crisis would prove to cause the greatest damage;
2. Fire/Explosion;
3. Human Disease;
4. Flood; and
5. Weather - Winter Storm.

The top five hazards based upon how likely they are to cause damage to the NWT over the next ten years:

1. Fire/Explosion;
2. Flood;
3. Critical Infrastructure Failure - Energy Crisis;
4. Weather - Winter Storm; and
5. Earth Movement – Permafrost Degradation.

Additional Comments and Hazards Proposed:

- Carrington Event (solar flare);
- Forest pests and diseases;
- Telecommunications/Data network will be a source of damage in the future. The reliance on this type of communication to provide core services such as medical services and the aging infrastructure provided by vendors such as NWTel will increase the risk to the GNWT of failures;
- Recommendation that transportation accidents could be divided into air, road, rail and marine as many communities have risk to one or two but not all and a response is fundamentally different for each; and
- More attention has been focused on the need for effective emergency preparation and response in recent years due to the increase in natural disasters as a result of climate change.

FURTHER DETAILS

No one ranked the following hazards as one of the top five hazards that they feel would cause the greatest damage to the people, property and environment in the NWT:

- Earth Movement – Other;
- Falling Debris;
- Ice Hazard;
- Snow Load Hazard; and
- Weather - Wind Storm.

No one ranked the following hazards as one of the top five hazards based upon how likely they are to cause damage to the NWT over the next ten years:

- Civil Unrest;
- Earth Movement - Earthquake/ Tsunami;
- Earth Movement – Other;
- Falling Debris;
- Food and Agricultural Emergency; and
- Ice Hazard.

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Other Documents Reviewed for this HIRA

Maps with topographic details of the NWT

A copy of the current plans for communities in the NWT including:

- Municipal/Village Emergency Response and Recovery Plans/Emergency Management Plans;
- Evacuation plans;
- Wildland urban interface fire plans;
- GNWT Pandemic plan; and
- Mosquito control program / West Nile virus plan.

Official Community Plans (OCPs) with appendices and attachments:

- OCPs; and
- Area Plans.

A copy of the Emergency Program Bylaws

Fire response capability

Capabilities of the local ESS (include Reception Center locations), First Responder, Search and Rescue and Highway Rescue groups

Gas, electric, fuel and propane service providers

Telecommunication, radio broadcast and amateur radio service providers

Major financial institutions in the NWT

Local hospitals, labs and health centers

Waste disposal and recycling programs/centers

Agricultural production, type and quantity

Critical government facilities in the NWT

Leading manufacturers in the NWT

Municipal/village local water sources and type of sewage treatment

A list of heavy industries and their locations, especially those that utilized hazardous materials (dangerous goods)

Local building codes and compliancy

Known derailments, and common motor vehicle accident sites including ice roads

8.7 Regional Hazard Identification Risk Assessments

8.7.1 Annex A South Slave Region Hazard Identification Risk Assessment

8.7.2 Annex B North Slave Region Hazard Identification Risk Assessment

8.7.3 Annex C Dehcho Region Hazard Identification Risk Assessment

8.7.4 Annex D Sahtu Region Hazard Identification Risk Assessment

8.7.5 Annex E Inuvik Region Hazard Identification Risk Assessment