# NORTHWEST TERRITORIES HAZARD IDENTIFICATION RISK ASSESSMENT


MARCH 2024

Government of
Northwest Territories

Acknowledgements:

This study was made possible by a contribution of funding through the Climate Change Preparedness in the North Program, Government of the Northwest Territories partnership.

Government of Canada Gouvernement du Canada

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# 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 the NWT emergency management program. Identified hazards, risk levels, impacts, strategies, climate change indicators and history are used to inform preparedness programs, mitigation strategies, emergency response plans, exercises, and training and awareness programs. It also serves as a historical reference of emergency events in the territories.

Governments have limited resources and planning for every possible hazard is not a realistic method for emergency management. However, an informed ranking of hazards provides a cost-effective approach to risk mitigation, emergency planning and response. The NWT Emergency Management Organization (EMO) has been using the HIRA since 2014 when the first comprehensive assessment for the territories was completed. This document builds upon the work completed in 2014 to assess the hazards and vulnerabilities of the NWT. It updates the background information and considers additional hazards and emergency events that have occurred since 2014. The result is an updated rating of twenty hazards that could affect the NWT, ranked in order of emergency planning priority.

NWT EMO contracted the services of Calian Ltd. to support the HIRA update project. Calian Ltd conducted jurisdictional scans, a literature review, compiled historical events, surveys with key stakeholders and the public, and engagement sessions with community governments, Indigenous governments, and the Government of the NWT (GNWT). They also assessed and analyzed collected data to develop hazard rankings and drafted report content.

The NWT Hazard Summary (inset) provides a list of the hazards ranked into five categories of risk. These rankings are supported by the NWT risk matrix (page 21) and the information outlined in the hazard narratives in Section 4. As the five NWT regions have many regional differences, analysis was conducted at the regional level and specific regional hazard summaries are provided at Annex B.

## NWT Hazard Summary

**Extreme**

1. Flood (Ice Jam/Freshet)

**High**

2. Wildfire/Interface Fire

**Medium**

3. Critical Services – Power/Fuel Interruption
4. Transportation Incident – Road/Ice Road Closure
5. Human Disease (Pandemic/Epidemic)
6. Severe Weather – Extreme Cold
7. Hazardous Materials – Spill
8. Severe Weather – Snowstorm/Windstorm
9. Structural Fire
10. Earth Movement - Erosion
11. Transportation Incident – Aircraft Incident
12. Snow Load Hazard

**Low**

13. Earth Movement - Permafrost Degradation
14. Critical Services – Water Services Interruption
15. Hazardous Materials – Explosion
16. Public Safety – Cyber Security
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

Hazard rankings were determined using best practices methodology combined with insight from emergency management officials across the territories. The NWT HIRA is considered a living document and while a comprehensive approach was taken in the development and update, some errors or omissions may be included/excluded.

Overall Flood (Ice Jam/Freshet) and Wildfire/Interface Fire were found to be the highest risk hazards throughout the NWT (In 2023 the NWT had its most significant wildfire season resulting in the evacuation of two thirds of the residents of the NWT, the implications of the 2023 wildfire season have not been fully assessed and incorporated in this HIRA update.). These hazards have frequently caused extensive damage to people, property, the environment (including air quality and ecosystem impacts), and the economy. Both hazards are also expected to increase in frequency and severity due to climate change, causing more extensive damage to communities in the future.

Several factors can compound the impacts of a disaster event, emergency response strategies and the recovery of individuals and their communities. Considerations include the setting – rural and remote, the population distribution – Yellowknife, regional centres and smaller communities, the economy – resource and administration based, the health of the population, and climate change impacts. In addition, there are several emerging and current issues that may increase or change some of the hazard ratings, including expected increased mining and oil and gas exploration and development, difficulty in predicting future weather and ice conditions, capacity to deal with major oils spills in the north, increased shipping through the Northwest Passage and the levels of poverty across the territories.

This report also recognizes vulnerability as one of the main components of disaster risk and the importance of reducing vulnerabilities and building community resilience. Community resilience is its ability to anticipate risk, limit impacts and bounce back quickly from disaster events. It also includes information on critical infrastructure to highlight the importance of including critical infrastructure protection as part of emergency plans and programs.

A good understanding of the risks in the NWT, planning priorities, factors that contribute to risk, vulnerabilities, resilience, and critical infrastructure will allow emergency management officials across the territories to better plan and prepare for future emergencies and ensure the safety and security of NWT residents.

# SOMMAIRE

La détermination des dangers et évaluation des risques (DDER) aux Territoires du Nord-Ouest (TNO) répertorie les dangers et examine les risques qui posent une menace pour la population, les biens, l'environnement et l'économie des TNO. La DDER constitue un volet essentiel du programme de gestion des urgences du gouvernement des Territoires du Nord-Ouest (GTNO). Les dangers, les niveaux de risque, les répercussions, les stratégies, les indicateurs du changement climatique et l'historique sont utilisés pour éclairer les programmes de préparation, les stratégies d'atténuation, les plans d'intervention d'urgence, les exercices et les programmes de formation et de sensibilisation. La DDER sert également de référence historique des situations d'urgence survenant aux TNO.

Les gouvernements disposent de ressources limitées et la planification de tous les dangers possibles n'est pas une méthode réaliste de gestion des urgences. Cependant, la hiérarchisation des dangers fournit une approche rentable de l'atténuation des risques, de la planification des urgences et de l'intervention d'urgence. L'Organisation de gestion des urgences des TNO (OGU) utilise la DDER depuis 2014, date à laquelle la première évaluation complète des TNO a été effectuée. Le présent document s'appuie sur les travaux réalisés en 2014 pour évaluer les dangers et les vulnérabilités des TNO. Il met à jour les renseignements généraux et tient compte des dangers supplémentaires identifiés et des situations d'urgence survenues depuis 2014. L'objectif est de présenter un classement mis à jour de vingt dangers qui peuvent peser sur les TNO et les classer en ordre de priorité aux fins de la planification des urgences.

L'OGU des TNO a retenu les services de Calian Ltd. pour appuyer le projet de mise à jour de la DDER. Calian Ltd. a procédé à des analyses par sphère administrative, à une analyse documentaire, à la compilation d'événements historiques, à des sondages auprès des principaux intervenants et du public, et à des séances d'échanges avec les administrations communautaires, les gouvernements autochtones et le gouvernement des TNO (GTNO). La société a

## Résumé des risques aux TNO

**Extrême**

1. Inondation (embâcle/crue nivale)

**Élevé**

2. Feu de forêt/feu en milieu périurbain

**Moyen**

3. Services essentiels – Interruption de l'alimentation en électricité ou de l'approvisionnement en carburant
4. Incident de transport – Fermeture de route ou de route de glace
5. Maladies humaines (pandémie/épidémie)
6. Conditions météorologiques extrêmes– Froid extrême
7. Matières dangereuses – Déversement
8. Conditions météorologiques extrêmes– Tempête de neige/vent
9. Incendie de structure
10. Mouvement de terrain - Érosion
11. Incident de transport – Incident d'aéronef
12. Risque de surcharge de neige

**Faible**

13. Mouvement de terrain - Dégradation du pergélisol
14. Services essentiels – Interruption de l'approvisionnement en eau
15. Matières dangereuses – Explosion
16. Sécurité publique – Cybersécurité
17. Maladies animales
18. Sécurité publique – Action sociale

**Négligeable**

19. Mouvement de terrain - Tremblement de terre
20. Débris spatiaux

également évalué et analysé les données recueillies pour établir la classification des dangers et rédiger le contenu du rapport.

Le sommaire (encadré) répertorie les risques aux TNO classés en cinq catégories de risque. Ces classements sont appuyés par la matrice des risques des TNO (page 21) et les renseignements présentés dans les descriptions des dangers à la section 4. Comme les cinq régions des TNO présentent de nombreuses différences régionales, une analyse a été effectuée à l'échelle régionale et des résumés des dangers propres à chaque région sont fournis à l'annexe B.

Les classements de dangers ont été déterminés à l'aide d'une méthodologie fondée sur les pratiques exemplaires ainsi qu'avec l'aide de responsables de la gestion des urgences aux TNO. La DDER des TNO est considérée comme un document évolutif et, bien qu'une approche exhaustive ait été adoptée pour l'élaboration et la mise à jour, certaines erreurs ou omissions peuvent être incluses ou exclues.

Dans l'ensemble, les risques d'inondation (embâcle ou crue nivale) et de feux de forêt ou feux en milieu périurbain constituent les risques les plus élevés aux TNO. En 2023, les Territoires du Nord-Ouest ont connu leur saison des feux de forêt la plus importante, ce qui a entraîné l'évacuation des deux tiers des résidents des Territoires du Nord-Ouest. Les répercussions de la saison des feux de forêt de 2023 n'ont pas été entièrement évaluées et intégrées dans cette mise à jour de la DDER. Ces dangers ont souvent entraîné de lourdes conséquences pour la population, les biens, l'environnement (y compris la qualité de l'air et les répercussions sur les écosystèmes) et l'économie. Ces deux dangers devraient également augmenter en fréquence et en gravité en raison du changement climatique, causant à l'avenir des dommages de plus en plus importants aux collectivités.

Plusieurs facteurs peuvent aggraver les répercussions d'une catastrophe, les stratégies d'intervention d'urgence et le rétablissement des personnes et de leurs collectivités. Les facteurs à prendre en compte comprennent le milieu (rural et éloigné, la répartition de la population); Yellowknife, les centres régionaux et les petites collectivités; l'économie (axée sur les ressources et l'administration); la santé de la population et les répercussions du changement climatique. En outre, plusieurs enjeux émergents et actuels peuvent augmenter ou modifier certains des indices de danger, y compris l'augmentation prévue de l'exploration et de l'exploitation minières, pétrolières et gazières, la difficulté de prévoir les conditions météorologiques et l'état de la glace dans le futur, la capacité de faire face aux importants déversements de pétrole dans le Nord, l'augmentation du transport maritime dans le passage du Nord-Ouest et les niveaux de pauvreté aux TNO.

Ce rapport souligne également la vulnérabilité comme l'une des principales composantes du risque de catastrophe et l'importance de réduire les vulnérabilités et de renforcer la résilience des collectivités. La résilience des collectivités est définie comme dans leur capacité à anticiper les risques, à limiter les impacts et à se relever rapidement après les catastrophes. Le rapport comprend également de l'information sur les infrastructures essentielles en vue de souligner l'importance d'inclure la protection des infrastructures essentielles dans les plans et les programmes d'urgence.

Une bonne compréhension des risques aux TNO, des priorités de planification, des facteurs qui contribuent aux risques, des vulnérabilités, de la résilience et des infrastructures essentielles permettra aux responsables de la gestion des urgences de l'ensemble des TNO de mieux planifier, de mieux se préparer aux urgences futures et de veiller à la sécurité des Ténois.

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# 1. BACKGROUND & INTRODUCTION

## 1.1 Overview of the Northwest Territories

### 1.1.1 Setting

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.

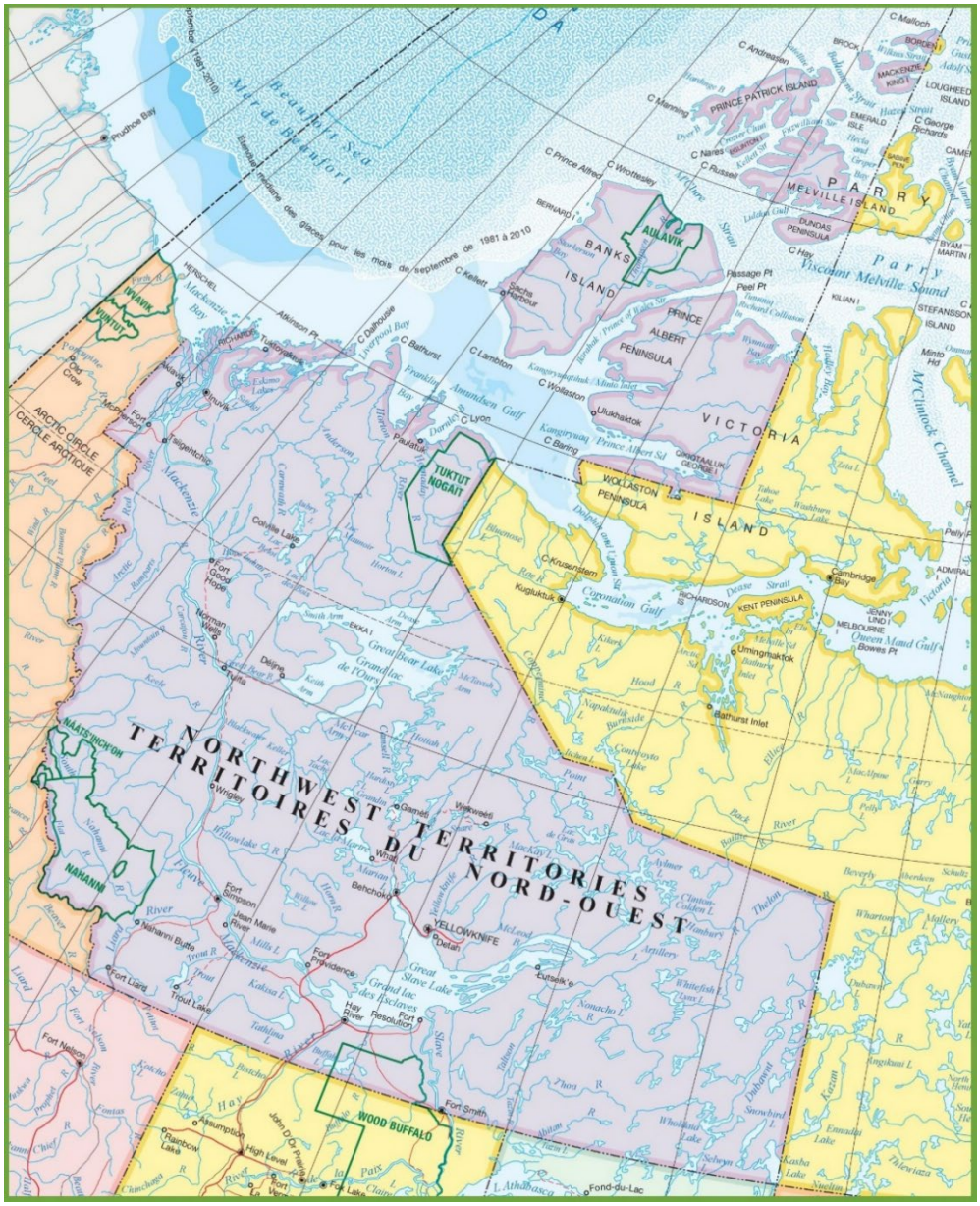



**Figure 1: Large detailed map of Northwest Territories with cities and towns (Ontheworldmap.com, 2012-2023, p. 7)**

With a land mass of 1,171,918 square kilometers, the NWT is the third-largest province or territory in Canada (Statistics Canada, 2016). The remote nature of the Territory presents challenges for emergency management officials as resources are distributed across large distances with limited transportation options, resulting in increased reliance on local resources and aging infrastructure.

Key geographical features within the Territory include (World Atlas, 2023):

- 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;
- Western approach and entrance to the Northwest Passage, known shipping route through Canada's arctic;
- 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.

### 1.1.2 Population

The NWT contains 33 communities across six regions. The NWT Bureau of Statistics estimates the population as of July 1, 2022, to be 45,605 (NWT Bureau of Statistics, 2022) with just under half (47.9%) living in Yellowknife (21,720). There are six communities with population counts ranging from approximately 1000 to 3000 (Inuvik (3,214), Tuktoyaktuk (1,058), Fort Smith (2,607), Hay River (3,796), Behchokǫ̀ (2,057) and Fort Simpson (1,230), 17 communities with population ranging from approximately 200-1000, and nine communities with less than 200 residents.

**Table 1: Community Population Estimates by Ethnicity, Northwest Territories, July 1, 2022**

| Place | Total | Indigenous | Non-Indigenous |
|---|---|---|---|
| | | | |
| **Northwest Territories** | **45,605** | **22,935** | **22,670** |
| | | | |
| **Beaufort Delta Region** | **6,888** | **5,493** | **1,395** |
| Aklavik | 708 | 654 | 54 |

| | | | |
|---|---|---|---|
| Fort McPherson | 759 | 683 | 76 |
| Inuvik | 3,214 | 2,135 | 1,079 |
| Paulatuk | 327 | 309 | 18 |
| Sachs Harbour | 118 | 99 | 19 |
| Tsiigehtchic | 205 | 166 | 39 |
| Tuktoyaktuk | 1,058 | 987 | 71 |
| Ulukhaktok | 499 | 460 | 39 |
| | | | |
| **Dehcho Region** | **3,316** | **2,784** | **532** |
| Fort Liard | 523 | 473 | 50 |
| Fort Providence | 711 | 617 | 94 |
| Fort Simpson | 1,230 | 889 | 341 |
| Hay River Dene Reserve | 341 | 333 | x |
| Jean Marie River | 92 | x | x |
| Kakisa | 36 | x | x |
| Nahanni Butte | 101 | 96 | x |
| Sambaa K'e (Trout Lake) | 97 | x | x |
| Wrigley | 126 | 118 | x |
| | | | |
| **Sahtu Region** | **2,669** | **2,037** | **632** |
| Colville Lake | 161 | 145 | 16 |
| Délı̨nę | 633 | 580 | 53 |
| Fort Good Hope | 628 | 576 | 52 |
| Norman Wells | 704 | 258 | 446 |
| Tulita | 543 | 478 | 65 |
| | | | |
| **South Slave Region** | **7,462** | **4,187** | **3,275** |
| Enterprise | 121 | 46 | 75 |
| Fort Resolution | 556 | 504 | 52 |
| Fort Smith | 2,607 | 1,560 | 1,047 |
| Hay River | 3,796 | 1,766 | 2,030 |
| Łutselk'e | 356 | 299 | 57 |
| | | | |
| **Tłı̨chǫ Region** | **3,027** | **2,812** | **215** |
| Behchokǫ̀ | 2,057 | 1,898 | 159 |
| Gamètì | 277 | 269 | x |
| Wekweètì | 140 | 130 | x |
| Whatì | 553 | 515 | 38 |
| | | | |
| **Yellowknife Region** | **22,243** | **5,622** | **16,621** |
| Dettah | 227 | 220 | x |

| | | | |
|---|---|---|---|
| Yellowknife | 21,720 | 5,303 | 16,417 |
| | | | |

The NWT Bureau of Statistics estimates that the Indigenous population of the NWT was approximately 50% as of February 22, 2023 at 22,935 residents (Dene 15,012; Métis 2,564; Inuit 5,359). The Indigenous population in the Yellowknife region (Yellowknife, Dettah, Ndilǫ) is estimated at 5,622 persons (approximately 25%) of that region's overall population (22,243).

### 1.1.3 Economy

The Economy of the NWT is heavily reliant on diamond mining, public administration (government), real estate and rental and leasing, and Health care and social assistance industries (NWT Bureau of Statistics, 2022). These industries contribute to over 60% of the NWT economy with diamond mining being the largest contributor at approximately 28%.

Three diamond mines are operational in the NWT (Diavik, Gahcho Kué and Ekati). The Diavik mine is expected to remain in production until 2025, the Gahcho Kué mine is expected to run until 2030 and Ekati until 2029, unless new resources are developed. Declining production at the diamond mines is a challenge to overall economic growth in the NWT however new metal mines (some of which will produce critical minerals such as copper, nickel, cobalt, and rare earth elements) will help to offset some of the economic loss (Conference Board of Canada, 2023).

**Table 2: Gross Domestic Product at Basic Prices by Selected Industries, 2021 to 2022 Northwest Territories, Millions of chained (2012) dollars**

| | 2021 | 2022 | Percent Change (%) |
|---|---|---|---|
| All industries | 4,333.5 | 4,396.6 | 1.5 |
| **Goods Producing Industries** | | | |
| Agriculture, forestry, fishing and hunting | 7.9 | 8.5 | 7.6 |
| Mining, quarrying, and oil and gas extraction | 1,377.5 | 1,295.9 | -5.9 |
| Oil and gas extraction | 125.4 | 125.8 | 0.3 |
| Diamond mining | 1,299.7 | 1,201.0 | -7.6 |
| Support activities for mining, oil and gas | 59.3 | 58.5 | -1.3 |
| Utilities | 63.0 | 63.3 | 0.5 |
| Construction | 271.7 | 328.0 | 20.7 |
| Manufacturing | 13.9 | 12.6 | -9.4 |
| **Service Producing Industries** | | | |
| Wholesale trade | 43.9 | 41.9 | -4.6 |
| Retail trade | 175.2 | 162.5 | -7.2 |
| Transportation and warehousing | 120.9 | 160.4 | 32.7 |
| Information and cultural industries | 105.8 | 107.2 | 1.3 |
| Finance and insurance | 129.0 | 133.1 | 3.2 |
| Real estate and rental and leasing | 414.1 | 417.4 | 0.8 |
| Professional, scientific and technical services | 93.5 | 93.5 | 0.0 |
| Management of companies and enterprises | 3.3 | 2.3 | -30.3 |
| Administrative & support, waste man. | 53.8 | 52.0 | -3.3 |
| Educational services | 215.1 | 216.0 | 0.4 |
| Health care and social assistance | 345.6 | 359.1 | 3.9 |
| Arts, entertainment and recreation | 3.2 | 3.2 | 0.0 |
| Accommodation and food services | 62.9 | 70.3 | 11.8 |
| Other services (except public administration) | 59.5 | 62.3 | 4.7 |
| Public administration | 804.6 | 799.6 | -0.6 |
| Federal government | 161.2 | 160.7 | -0.3 |
| Provincial and territorial | 498.0 | 482.5 | -3.1 |
| Local, municipal and regional | 94.6 | 94.6 | 0.0 |
| Aboriginal | 56.9 | 64.8 | 13.9 |

The NWT has not defined the tourism sector separately in their economic data collection. The tourism sector was highlighted in the 2021-2022 Economic Review as an opportunity to broaden the economy of the NWT and provide increased employment opportunities beyond Yellowknife (Government of the Northwest Territories, 2022). Trapping and commercial fishing were identified as important components of the renewable resource sector for their contributions to incomes in smaller communities and for economic diversification (eg. Trapping and commercial fishing).

Beyond the economic value, the NWT Bureau of Statistics reported on average more than 40% of the population over the age of 15 outside of the Yellowknife area participated in traditional activities such as producing arts and crafts, hunting and fishing, trapping, or gathering berries.

### 1.1.4 Health

There are several important socioeconomic factors that influence the health status of the NWT population including education, unemployment, poverty, housing, crime and violence:

- NWT education levels have been improving over the last 30 years with the proportion of the population with a high school diploma or higher increasing from 51.6% to 72.6% but remain lower than the national average;
- The NWT's unemployment rate has historically been close to the national average;
- Generally, Yellowknife has the highest average family income (over $75,000) while smaller communities have the lowest average family income (less than $30,000). Families in smaller communities earn less (almost 50%) and spend more (approximately 25%) on living expenses compared to Yellowknife residents. The number of NWT residents on income assistance has dropped since the 1990s but has increased somewhat in recent years;
- The proportion of NWT households considered to be in the core need for housing has remained steady since the 1990s with smaller communities having the highest need; and
- The NWT has an overall crime rate, and a violent crime rate, over seven times the national average (Government of the Northwest Territories, 2019).

Self-rated health is considered a good measure of the overall health of a population. The NWT has a lower proportion of the population who rate their general health as being excellent or very good compared to the Canadian average. The life expectancy in the NWT is age 77, almost five years lower than the national average of 82 years.

Top reasons for hospitalizations in the NWT are mental health issues (14.8%), injuries and poisonings (14.3%), circulatory diseases (13.0%), respiratory diseases (12.2%) and digestive system diseases (10.3%), very similar to reasons and rates for Western Canada (Government of the Northwest Territories, 2019). Other diseases and rates include:

- Cancer rates have remained relatively flat in the NWT over the last 15 years and are similar to the national average;
- Rates of Chronic Obstructive Pulmonary Disease (COPD) is higher than the Canadian average, growing slightly over the past 15 years;
- Rates of diabetes is higher in the NWT than the Canadian average, growing by over 50% during the past 15 years;
- The rate of heart attack is higher in the NWT compared to the national average, growing by over 80% in the past 15 years;
- The rate of stroke is higher in the NWT compared to rates in Canada, growing by over 40% in the last 15 years.

The NWT has the second highest health care expenditures per capita, after Nunavut, in Canada. The lack of population density makes it difficult to achieve the economies of scale that southern jurisdictions do, where populations are larger and more concentrated. Specialized services and hospital care in the NWT often requires patient travel, further adding to overall health care costs.

### 1.1.5 Climate Change Context

"*Climate change represents serious environmental, economic and social challenges for the Northwest Territories"* (Government of the Northwest Territories). Climate change is defined as a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators. Climate change can involve both changes in average conditions and changes in variability, including, for example, extreme events (Government of the Northwest Territories).

According to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report released in 2021, a number of regional changes from climate change are forecasted that are likely to impact on the NWT (Intergovernmental Panel on Climate Change, 2021):

- High confidence that the annual mean surface air temperature (temperature in daily weather reports) will continue to increase during the rest of this century;
- High confidence that annual mean precipitation and the intensity of that precipitation will increase within the Arctic region, projected to be dominated by rainfall;
- Likely that the Arctic has warmed at more than twice the global rate over the past 50 years, and it is virtually certain that surface warming in the Arctic will continue to be more pronounced than the global average warming over the 21st century;
- Extreme heat events have increased around the Arctic since 1979 including as recent as 2023 ( (Thoman, 2023); and
- Good confidence that weather changes will lengthen the fire season and high confidence that fires will become part of the tundra regions.

The Canada's Changing Climate Report (2019) provides additional climate change information for the North forecasted to happen in the following decades:

- The annual mean temperature is estimated to increase by approximately 1.8°C for a low emission scenario (RCP2.6) to 2.7°C for a high emission scenario (RCP8.5) for 2031–2050, and by 2.1°C (RCP2.6) to 7.8°C (RCP8.5) for 2081–2100.
- Changes in winter snow cover and in the amount of snow are projected to be minimal across northern Canada because increased snowfall at high latitudes is expected to be offset by increasing temperatures that will shorten the snow-accumulation season.
- Glaciers and ice caps will continue to shrink. There is a greater than 50% probability that, by 2050 under a high emission scenario, extensive regions in the Canadian Arctic will be free of sea ice in September, with additional ice-free months possible in some regions.
- Annual mean precipitation for the North is projected to increase, by 8.2% for a low emission scenario (RCP2.6) to 11.3% for a high emission scenario (RCP8.5) for 2031–2050, and by 9.4% (RCP2.6) to 33.3% (RCP8.5) for 2081–2100.

Rapid changes in northern regions are clear and unequivocal, indicating the urgency of action needed to avoid substantial future impacts and reduce risks to northern populations and ecosystems (Intergovernmental Planel on Climate Change, 2022). In addition, the impacts of climate change are bringing new hazards that the NWT needs to be aware of; past experiences on the land don't necessarily apply when things are changing so fast (Canadian Broadcasting Corporation, 2021).

Climate change impacts are a major cause for concern in the NWT with several communities raising concerns about the changes occurring and potential future impacts. Climate change is expected to contribute to several key risk areas for the NWT including:

- Wildfires are a natural part of Arctic ecosystems. But as the Arctic warms, the nature of wildland fires in the region is changing. The fire season is longer with more frequent and intense fires (Environment and Climate Change Canada, 2019).
- There is some confidence that projected higher temperatures will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events. However, it is uncertain how projected higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of future snowmelt-related flooding (Environment and Climate Change Canada, 2019).
- Canada's Changing Climate Report from 2019 indicates very high confidence that the permafrost temperature has increased over the past 30 to 40 years. The economic impact of permafrost thaw is causing approximately $51 million worth of damage to existing infrastructure annually (Crown-Indigenous Relations and Northern Affairs Canada, 2019). The NWT Association of Communities have identified that communities within the NWT are seeing significant impacts as the permafrost degrades, including:

    - Numerous changes on the land, including damage to pingos and lakes, ground slumping and river and coastal erosion (ex. in Tuktoyaktuk and Aklavik, rising sea levels and winter storms are causing coastal erosion and affecting community infrastructure);
    - Direct impacts to infrastructure such as roads, building foundations, marine docks and airport runways;
    - Changes on the land that make travel and harvesting more difficult and dangerous; and
    - Communities are spending more money fixing problems related to permafrost thawing (NWT Association of Communities, 2018).

### 1.1.6 Emerging and Current Issues

Several emerging issues could also impact the Northwest Territories' exposure and vulnerability to the hazards. These include:

- One of the mandates of the GNWT is to increase resource exploration and development to restore levels of investment, partnership, employment and growth in the NWT's economy after the COVID-19 pandemic (Government of the Northwest Territories, 2019-2023). Specific changes in the oil and gas and mineral sectors can have direct impacts on the NWT environment creating associated hazards (Environment and Climate Change, 2022).

- Natural Resources Canada projected exploration spending in the NWT in 2021 would raise to $41.5 million, a 47% increase from 2020. The Tlicho all-season road opened in November 2021, providing year-round access to Whati and improved access to several exploration projects in the area. Mining operations continue at the Ekati, Diavik, and Gacho Kue diamond mines while Vital Metals Limited commenced a demonstration production at Nechalacho, the first rare earths producer in Canada (Northwest Territories Geological Survey, 2022). 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 resource related hazards.

- 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., 2007-2009). The remoteness of Arctic and Northern communities also poses a challenge with regard to critical infrastructure and emergency management considerations, which are likely to be exacerbated due to climate change (Crown-Indigenous Relations and Northern Affairs Canada, 2019)This could lead to an increased vulnerability to ice hazards and an increased in search and rescue requirements.

- Concern that increased drilling in Beaufort Sea will increase the risk of oil or other spills within an already vulnerable environment. This concern was temporarily relieved when the Government of Canada announced an Order Prohibiting Certain Activities in Arctic Offshore Waters in July of 2019. The order prohibited oil and gas activities in Canada's Arctic waters while the 2016 Arctic offshore oil and gas indefinite moratorium is maintained. This was set to expire on December 31, 2021, but was further extended in March 2022 (Crown-Indigenous Relations and Northern Affairs Canada, 2022). If drilling resumes the concern and risk may increase due to the vulnerability of the northern/Arctic environment which is compounded by access and response capacity limitations and the complexity of oil spills in Arctic waters (Arctic Council, 2020).

- Concern over the capacity and level of preparedness and response for oil spills in the north. The NWT has vast undeveloped oil and gas reserves. It is estimated that the NWT could hold as much as 37 percent of Canada's marketable light crude oil resources and 35 percent of its marketable natural gas resources (Government of the Northwest Territories, n.d.). To enhance preparedness, the Canadian Coast Guard (CCG) has community packs of spill equipment in the NWT, in Ulukhaktok and Tuktoyaktuk, with additional oil spill resources available from the CCG base in Hay River (World Wildlife Fund- Canada, 2017). As new drilling programs are approved, increased spill response capacity will be required.

- Concern that increased vessel (boat) traffic through the Northwest Passage may also increase the risk of spills, potential for search and rescue incidents and depletion of community resources. A study by the Arctic Council showed that there was an increase in the number of "unique"[1] ships entering/traversing the Northwest Passage by 44% between 2013 and 2019 (Arctic Council, 2021). For example, when the cruise ship *Akademik Ioffe* ran aground in the northwest passage in 2018[2] the passengers (162) were disembarked into the community of Kugaaruk[3] Nunavut (pop. 933). The influx of that many people on a small remote NWT community could easily overwhelm the community resources and capacity.

[1] Unique as defined by the Arctic Council report is an individual ship that is counted once whether or not is enters the passage multiple times

[2] https://www.highnorthnews.com/en/arctic-cruise-ship-runs-aground-canadas-northwest-passage

[3] https://nunatsiaq.com/stories/article/65674breaking_cruise_ship_akademic_ioffe_runs_aground_in_nunavut_waters/


**Figure 2: Northwest Passage Trade Route (Encyclopaedia Britannica Inc., 2022)**

- Current issues such as poverty may impact the Northwest Territories' exposure and vulnerability to hazards. Poverty is one of the defining factors for vulnerability to the impacts from disasters. A report by Alternatives North indicated several areas of concern regarding poverty levels in the NWT such as (Alternatives North, 2020):

    - The lack of economic diversity contributes to "have and have not" families and communities;
    - The reality that as of November 2020, 25% of all NWT children and half of children in lone parent families in smaller communities live in poverty;
    - The cost of food in small communities is a cause for concern in 25% of the households in those communities; and
    - One in five households in the NWT have insufficient financial resources for a basic living standard.

    These factors can compound the effects of a disaster event affecting individuals or their community.

## 1.2 Document Purpose and Scope

The purpose of the NWT HIRA is to identify hazards that exist in the territory, including natural, technological, and human-induced; 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. It is intended to provide a research-based foundation for risk to aid territorial and municipal governments in developing appropriate mitigation, preparedness, response and recovery plans and programs. In addition, given the anticipated impacts of climate change, the HIRA serves as a mechanism for the GNWT to evaluate and better understand how

climate change can affect hazards within the context of community governments and emergency managment, mitigation strategies, the types of preparedness activities that are necessary, the type of response operations required, and the implementation of long-term recovery strategies.

This document builds upon the work completed in 2014 to identify hazards and vulnerabilities of the NWT. It updates the 2014 HIRA background information and considers additional hazards and emergency events that have occurred since then.

# 2. HIRA METHODOLOGY

## 2.1 Overview

The NWT HIRA is an all-hazards approach and includes the identification of hazards and the analysis of risks. At the core of the risk analysis is the equation Risk = Frequency X Impact (Emergency Management Ontario, 2012). The HIRA process follows the steps of Hazard Identification, Risk Assessment, Risk Analysis and Monitor and Review.

**Figure 3: HIRA Process**


The NWT HIRA was first completed in April 2014 and provided an examination of the risks that pose the greatest threat to the people, property, environment, and economy of the NWT. The HIRA is a critical part of the NWT emergency management program and requires updating every five years. This is done through the final stage in the HIRA process, Monitor and Review. Risks are monitored and evaluated for consideration in periodically reviewing HIRA findings to ensure that the HIRA stays current and valid for its intended purpose.

MACA EMO contracted the services of Calian Ltd. to support the 2023 HIRA update project. Contractor support included conducting jurisdictional scans, literature reviews, compiling historical events in the NWT, surveys and engagement sessions with the public, community governments, Indigenous governments, and the GNWT, assessing and analyzing collected data, and drafting report content.

Key activities undertaken as part of the 2023 HIRA update include:

- A literature review;
- Stakeholder Engagement;
  - Web-based survey (public facing & stakeholder facing),
  - Engagement sessions (virtual meetings), and
- Data Analysis.

## 2.2 Literature Review

A literature review was completed to develop an inventory of academic studies and best practices both nationally and internationally. The literature review aimed to identify any studies, reports, or other papers that have been published since 2014 regarding the hazard landscape within the NWT. Specific sources of documentation varied, but generally included the following:

- Existing NWT emergency management related documentation;
- Government of the Northwest Territories' documentation and databases;
- Academic Research Libraries;
- Government of Canada Academic Databases (e.g., Environment and Climate Change Canada);
- Open-source literature (e.g., web-searches); and
- Others as available.

A full list of documentation consulted and cited can be found in the Bibliography in Section 8.

## 2.3 Stakeholder Engagement

### 2.3.1 Web-based Survey

Preliminary data collection was done through the administration of two web-based surveys: one for government stakeholders (at all levels) and one for the public. Eight members of the public responded to the survey and there were 41 respondents from across governments at all levels. The intent of these surveys was to collect data specific to hazards across the Territory. This included information on historical hazards, current hazards, and expected future hazards that could be a concern for residents.

A series of objectives were developed for each survey to guide the development of survey questions. These objectives were as follows:

**Stakeholder Survey:**

1. Develop an updated comprehensive understanding of the historical, current, and anticipated hazard landscape in each of the NWT's five regions;
2. Establish an updated inventory of the impact(s) that various hazards have had, have, or may have on various regions in the territory;
3. Identify updated mitigation measures, including all historical, current, and anticipated, available to support with addressing key hazards; and
4. Establish an updated understanding of how the operating environment contributes to the increased risk posed by various hazards.

**Public Survey:**

1. Update information on past, current, and future hazards that affect each region.
2. Update information on past, current, and future impacts of these hazards on each region.

3. Update information on past, current, and future mitigation measures and supports used to address these hazards.

Each of the surveys were available in spring 2022 for a period of approximately eight weeks. Links to the stakeholder survey were provided to each participant who had been pre-identified by the NWT EMO as key emergency management partners. A follow-up reminder email was sent to all individuals targeted for the stakeholder survey part-way through the survey window. This distribution email was accompanied by a request to attend an engagement session with the HIRA project team to further elaborate on data provided within the survey. The public-facing survey was promoted to residents through print and social-media-based distribution.

Results of both surveys were collected and included as part of the data analysis process. Data collected was subjected to both qualitative and quantitative analysis to identify key trends to form the basis for discussions during stakeholder engagement sessions.

### 2.3.2 Stakeholder Engagement Sessions

Stakeholder engagement sessions were conducted virtually for each of the five regions. Participants included members of the NWT EMO, representatives from community governments, and emergency management partners from across the territorial government and other organizations within the NWT.

During these sessions, facilitation professionals led participants through a series of questions that explored likely hazards which could impact participants, communities or organizations and the associated and potential impacts of those hazards. Discussions aimed to identify both historical data and traditional knowledge to inform the HIRA update process, and explored how the current hazard landscape may change with the increasing impacts of climate change. Discussions also identified how community governments and other organizations prepare for these incidents through plans, programs, and mitigation measures (i.e., supply stores, moving buildings, etc.).

## 2.4 Data Analysis

Data analysis involved a review of the feedback provided by stakeholders and the public to the surveys (quantitative data) with further insight and details offered during the stakeholder engagement sessions (qualitative data). While the number of public survey responses was low, this was compensated for by the higher number of responses from emergency management officials at the territorial and local levels, and information gained during the stakeholder engagement sessions. Initial analysis identified key hazards impacting the NWT and provided a basis to update the results to the 2014 HIRA findings.

Feedback and data analysis was used to update the hazard definitions in the HIRA. This process was completed as a preliminary step in the review process. The process for ranking individual hazards was as follows:

**Step 1 - Likelihood Scale:**

The likelihood was assessed based on historical observations and current conditions (see Table 3 below for the likelihood rating scale). This rating level key aimed to ensure that the qualitative interpretation of likelihood was maintained.

**Table 3: NWT HIRA Likelihood Rating Scale**

| Likelihood Rating Scale | Description | Probability (%) | Description |
|---|---|---|---|
| **1** | Improbable / Rare | < 10% | It is expected that the risk will probably occur only once in 100 years or greater. |
| **2** | Unlikely | 10%-29% | It is expected that the risk will occur at least once in 25 years but not expected to occur in a 3-year period. |
| **3** | Possible | 30% - 59% | It is expected that the risk will occur at least once in 3 years but not expected to occur each year. |
| **4** | Likely | 60% - 89% | It is expected that the risk will occur at least once a year but not expected to occur each month. |
| **5** | Almost Certain | 90% - 100% | It is expected that the risk will occur many times a month or the risk already is happening. |

Likelihood ratings were assigned to each of the hazards based on input from key stakeholders, and where possible from NWT EMO members from various GNWT departments with in-depth knowledge in that hazard area. Additionally, survey data and engagement session information provided insight regarding the frequency of various hazards and was used in the development of final scores.

**Step 2 - Consequence Scale:**

The second component of the risk assessment process was assigning a consequence score for each of the identified hazards. The consequence score of a hazard incident/potential incident is a metric ranging from a score of one (limited consequences) through to five (catastrophic consequences). Hazards were rated for impacts to Infrastructure and Services, Human and Social, and Physical and Environmental impacts which were totaled to determine the consequence score. The descriptor for each score was based on the overall impacts faced should the hazard be realized. A detailed breakdown of the consequence scale can be found in Annex A.

**Step 3 - Risk Calculation:**

Finally, the risk rating was calculated by using the formula below which considers the likelihood of a hazard occurring and the potential consequences of that hazard. This provided a numerical risk ranking for each hazard that can be used to compare against other hazards. Risk ranking provides valuable information regarding which hazards pose higher risks and can help prioritize planning and mitigation activities by emergency management partners.

**Risk = Likelihood x (sum of consequence scores divided by 14)**

The following table was used to rank the hazards identified as part of the HIRA update process. As outlined below, any hazard with a ranking of over 14 falls into the "extreme" category, whereas hazards with a ranking of 4 or below fall into the "Low" or "Negligible" categories. In cases where risk rating scores were tied, overall ranking was determined in consultation with territorial emergency management officials.

**Table 4: Risk Categories**

| Risk Categories |
|---|
| Extreme (=>14) |
| High (10-14) |
| Medium (5-9) |
| Low (2-4) |
| Negligible (1) |

# 3. HIRA FINDINGS

## 3.1 Hazard Identification

The following table presents the overall list of identified hazards, risk scores and ranking for the NWT. It contains risk ranking values for hazards identified and evaluated throughout the data collection and evaluation process.

**Table 5: Northwest Territories Top Hazards**

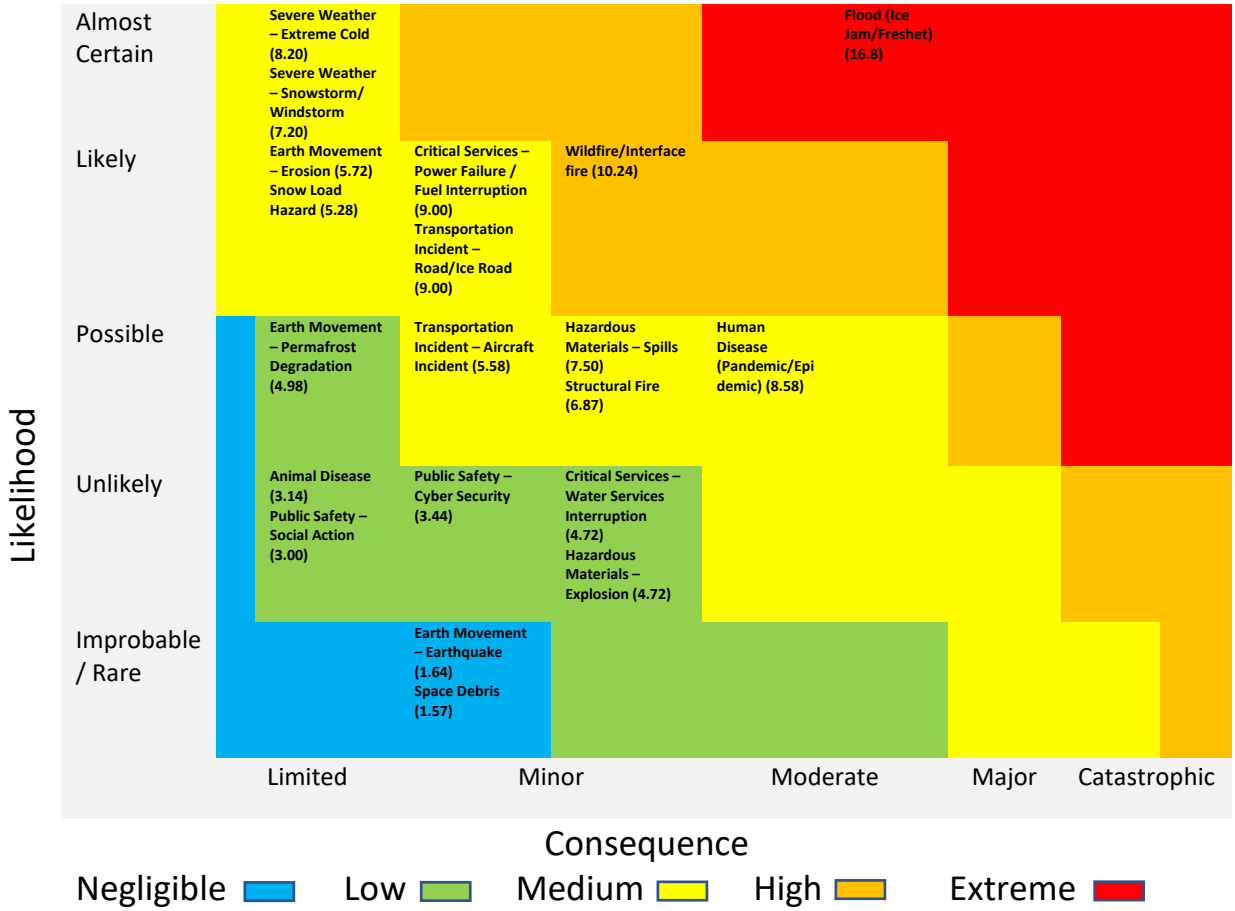
| Ranking | Hazard | Risk Score |
|---|---|---|
| **1.** | Flood (Ice Jam/Freshet) | 16.80 |
| **2.** | Wildfire/Interface Fire | 10.24 |
| **3.** | Critical Services – Power/Fuel Interruption | 9.00 |
| **4.** | Transportation Incident – Road/Ice Road Closure | 9.00 |
| **5.** | Human Disease – Pandemic/Epidemic | 8.58 |
| **6.** | Severe Weather – Extreme Cold | 8.20 |
| **7.** | Hazardous Materials - Spill | 7.50 |
| **8.** | Severe Weather – Snowstorm/Windstorm | 7.20 |
| **9.** | Structural Fire | 6.87 |
| **10.** | Earth Movement - Erosion | 5.72 |
| **11.** | Transportation Incident – Aircraft Incident | 5.58 |
| **12.** | Snow Load Hazard | 5.28 |
| **13.** | Earth Movement – Permafrost Degradation | 4.98 |
| **14.** | Critical Services – Water Services Interruption | 4.72 |
| **15.** | Hazardous Materials - Explosion | 4.72 |
| **16.** | Public Safety – Cyber Security | 3.44 |
| **17.** | Animal Disease | 3.14 |

| Ranking | Hazard | Risk Score |
|---|---|---|
| **18.** | Public Safety – Social Action | 3.00 |
| **19.** | Earth Movement - Earthquake | 1.64 |
| **20.** | Space Debris | 1.57 |

Note: Where risk ranking scores are tied, ranking was determined in consultation with territorial emergency management officials.

Figure 4 below is a graphic representation of the hazard landscape in the NWT. It shows the risk score plotted on the Likelihood versus Consequence scale with Risk level color coding.

**Figure 4: Risk Rating Matrix**




## 3.2 Mitigation Strategies

Hazard or disaster risk mitigation is defined as the measures taken before an emergency occurs to adapt to, eliminate or reduce the risks of disasters to protect lives, property, the environment, and reduce economic disruption (Public Safety Canada, 2017). These measures include both structural mitigative

measures (e.g., construction of floodways and dykes) and non-structural mitigative measures (e.g., building codes, land-use planning, and insurance incentives) (Public Safety Canada, 2017).

Table 6 below provides an overview of the types of risk mitigation strategies that were considered for each hazard.

**Table 6: Risk Mitigation Strategy Types**

| Mitigation Strategy | Description / Example | Suitable for… |
|---|---|---|
| **Avoid/Prevent** | The risk is avoided by changing the threat in a way to mitigate the risk. | Some political, technical, operational, or infrastructure risks. This may include legal or regulatory issues, maintenance issues, and technical upgrades. |
| **Transfer** | Some or all the risk is transferred to another party. This could be to insurance, different level of government, industry, etc. | Items that will impact on the community but are in the jurisdiction of another agency. This may include some natural disasters, flooding, or insurable business risks. |
| **Reduce** | Action is taken to reduce the likelihood or consequence of a hazard. | Most common response to a risk. Whenever possible/practical an identified risk should be reduced. Actions are taken in accordance with some plan to minimize the risk and/or limit consequences. |
| **Accept** | The risk is accepted due to low probability of consequence. Contingency plans may be prepared. | Some risks may need to be accepted by the community due to impractical options for mitigation of risk. A contingency or response plan may be put in place. This may be suitable to social action, and unpredictable events such as meteor impacts. |
| **Contingency** | A plan is developed to respond if the risk is realized. | This includes a wide range of risks and may be done in parallel with another risk response. In most cases an identified risk of significant likelihood or consequence should have a plan in place. |

The types of mitigation strategies were included for discussion in the stakeholder engagement sessions and interviews which resulted in the identification of several specific mitigation strategies currently being used or suggested as viable for use in the NWT. Many of these strategies are relevant to the individual, community government or the GNWT. Existing and recommended mitigation strategies may aid in reducing the risk(s) associated with specific hazards.

Table 7 below identifies different mitigation strategies either currently in place or considered viable through discussions with NWT stakeholders during the HIRA data collection and assessment process.

**Table 7: Specific Hazard Mitigation Strategies**

| Hazard | Mitigation Strategies |
|---|---|
| Flood (Ice Jam/Freshet) | • Elevate or relocate property out of the flood risk area<br>• Elevate structures and other infrastructure<br>• Use of water-resistant building materials<br>• Use of physical barriers such as berms/dikes<br>• Install secondary flood prevention devices in buildings (e.g., sump pumps and one-way valves)<br>• Use of artificial breakup techniques when ice jams form<br>• Develop building and zoning bylaws in line with identified flood risk areas and best practice |
| Wildfire/Interface Fire | • Implement community wide fire education and prevention campaign<br>• Establish clean air shelters<br>• Establish and maintain community fire departments<br>• Implement community fire bans when wildfire risk is high<br>• Implement FireSmart principles by all (e.g., fireguards, trimming brush, safe storage of fuel)<br>• Implement activities identified in the Community Wildfire Protection Plans |
| Critical Services - Power Failure / Fuel Interruption | • Install redundant/backup power generation or alternate forms of heat/power<br>• Establish essential facilities with backup power as shelters, warming/cooling centers, community telecommunications hubs, or other emergency management facilities<br>• Update or conduct a supply chain analysis for fuel supply including identifying territorial and community storage capacity<br>• Develop community fuel storage capacity where required |
| Transportation Incident Road / Ice Road | • Promote safe driving practices<br>• Monitor for weather impacts on road safety<br>• Implement road safety and education programs<br>• Develop and maintain emergency response plans to allow for prompt response to transportation accidents<br>• Monitor ice road conditions<br>• Adhere to ice-road travel policies and procedures |
| Human Disease (Pandemic/Epidemic) | • Monitor and follow public health recommendations<br>• Develop business continuity and essential services continuity plans |
| Severe Weather - Extreme Cold | • Monitor weather conditions for extreme cold conditions<br>• Implement public awareness programs for extreme cold<br>• Consider mitigation activities identified under “Critical Services - Power Failure / Fuel Interruption” |

| Hazard | Mitigation Strategies |
|---|---|
| Hazardous Materials - Spill | • Ensure proper storage and containment of hazardous materials<br>• Maintain emergency spill plans<br>• Ensure adequate training for those involved<br>• Ensure adequate spill containment/clean up equipment is maintained at or near hazardous material storage sites<br>• Relocate hazardous materials outside of hazard risk zones where possible (e.g., flood risk zone) |
| Severe Weather – Snowstorm / Windstorm | • Implement public awareness programs for snowstorms/blizzards<br>• Develop redundancy for interruptions/delays to essential services during snowstorms/blizzards (e.g., delays in supply chain or emergency transportation services)<br>• Develop contingency plans for weather monitoring and snow removal<br>• Consider mitigation activities identified under “Critical Services - Power Failure / Fuel Interruption” |
| Structural Fire | • Implement community wide fire prevention education campaign (e.g., promoting the need for smoke alarms and carbon monoxide alarms)<br>• Maintain fire alarm and sprinkler testing schedules<br>• Consider establishing/improving community fire departments<br>• Ongoing engagement with the Office of the Fire Marshal programs (e.g., Plan Review and inspections) |
| Earth Movement - Erosion | • Develop erosion hazard maps<br>• Limit development in areas with potential for significant erosion (e.g., by bylaw or resolution)<br>• Reinforce or relocate infrastructure in areas with potential for significant erosion |
| Transportation Incident - Aircraft Incident | • Promote aviation travel safety, education and prevention programs<br>• Develop emergency response plans to allow for prompt response to aircraft accidents<br>• Participate in Airport Live Exercises led by the Department of Infrastructure |
| Snow Load Hazard | • Assess critical infrastructure against current snow load building parameters and projected snow load risk<br>• Develop snow removal thresholds and plans<br>• Ensure future building designs incorporate climate change projected snow accumulation factors |
| Earth Movement - Permafrost Degradation | • Implement maintenance programs to improve the life of infrastructure (e.g. snow maintenance program to insulate permafrost around buildings in spring)<br>• Increase monitoring of permafrost and hydrological conditions near critical infrastructure<br>• Increase emergency preparedness in high-risk areas<br>• Adapt zoning and land-use to limit or restrict development in high-risk areas.<br>• Develop permafrost risk maps |

| Hazard | Mitigation Strategies |
|---|---|
| Critical Services - Water Services Interruption | • Develop and maintain essential services continuity plans<br>• Adhere to all testing and maintenance schedules for water treatment plan and related infrastructure<br>• Ensure alternative water source/supply available in case of interruption (e.g., bottled water supply)<br>• Ensure adequate sewage removal/treatment capacity |
| Hazardous Materials - Explosion | • Adhere to safety and storage requirements for all explosive products<br>• Ensure land-use planning identifies appropriate low-risk locations for property with an increased risk of explosions<br>• Ensure emergency response agencies are trained and equipped for potential explosion incidents |
| Public Safety - Cyber Security | • Implement cyber security awareness training programs<br>• Ensure all computer systems have updated software, anti-virus software and data backup<br>• Develop policies and guidelines for use of computers and mobile devices<br>• Consider government and other Cyber Security protocols/advice |
| Animal Disease | • Promote awareness of animal diseases in the NWT and how to protect yourself<br>• Report all suspected serious disease (Tuberculosis, Anthrax, Brucellosis, Chronic Wasting Disease, Erysipelas, and Rabies) animals to the local Renewable Resource Officer |
| Public Safety - Social Action | • Maintain awareness of Social Action activities<br>• Work cooperatively with social groups to ensure safety-oriented planning for social demonstrations<br>• Consider business continuity plans for potential work interruptions |
| Earthquake | • Ensure building/engineering standards with earthquake parameters are in place for earthquake prone areas<br>• Consider using ShakeOut (https://www.shakeout.org/) resources for developing safety and awareness programs<br>• Plan and communicate “safe areas” for community members to go to in the event of an earthquake or tsunami. |
| Space Debris | • Have monitoring and notification protocols in place with appropriate agencies |

# 4. HAZARD NARATIVES

This section provides an updated analysis of individual hazards identified through the risk assessment process. Hazard tables are intended to provide emergency management officials a basic understanding of the hazard, risk level, vulnerabilities, mitigation measures, climate change indicators and historical perspectives.

## 4.1 Extreme Risk Category

### 4.1.1 Flood (Ice Jam/Freshet)

**Hazard:** Flood (Ice Jam/Freshet)

**Class:** Natural Hazard

**Definition:** An overflow or surge of water which threatens public safety and can cause property and environmental damage.

**Climate Change Indicator:** Projected to increase both in frequency and consequence.

**Figure 5: Fort Simpson**[4]

**Mitigation Strategies:**

- Relocate property out of the flood risk area
- Elevate structures and other infrastructure
- Use of water-resistant building materials
- Use of physical barriers such as berms/dikes
- Install secondary flood prevention devices in buildings (e.g., sump pumps and one-way valves)
- Use of artificial breakup techniques when ice jams form
- Develop building and zoning bylaws in line with identified flood risk areas and best practice

| Type | Cause/Explanation |
|---|---|
| Local Flooding | 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. |

[4] https://cabinradio.ca/62602/news/environment/fort-simpson-residents-move-to-higher-ground-about-700-displaced/

| | |
|---|---|
| Rainstorm | A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. |
| Snowmelt | River floods caused by snowmelts (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 including ice jam flooding, is common. Fatalities in the NWT due to flooding of all types are rare. Essential services can be impacted having an effect on people. |
| Infrastructure | Personal property damage can be extensive. Contamination by floodwaters, structural damage, and mold can destroy buildings. Roads can be damaged or washed away. Flooding can also negatively affect utilities and essential services and cause damage critical infrastructure and other property. |
| Communications | Communication towers and equipment may be damaged by flooding events. |
| Environment | Flooding may cause wastewater, petroleum products or other hazardous materials to contaminate the environment. |
| | |

| **NWT Exposure/History**[5] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Hay River, Kátł'odeeche First Nation | May 2022 | Hay River and Kátł'odeeche First Nation evacuated (whole communities) due to flooding from ice jams and backup on the Hay River. Damage to private and public property was extensive.<br>Evacuated: over 3000<br>Estimated Total Cost: $170,900,000 |
| Multiple communities: Hay River, Jean Marie River, Fort Simpson, Fort Good Hope, Aklavik, and the Little Buffalo River area of Fort Resolution | May 2021 | Significant spring breakup flooding impacted multiple communities across the NWT. Hundreds were forced to evacuate from their communities for an extended period. Damage to private and public property was extensive.<br>Evacuated: approximately 600<br>Estimated Total Cost: $38,000,000 |

[5] Information on past events taken from NWT EMO files.

| | | |
|---|---|---|
| Hay River | May 2020 | An evacuation was ordered for Vale Island and the West Channel portion of the community in response to high water levels, ice, and the increased risk of flooding.<br>Evacuated: approximately 362<br>Estimated Total Cost: unknown |
| Jean Marie River | May 2018 | Localized flooding believed to be caused by an ice jam on the Mackenzie River resulted in the evacuation of a few at risk homes.<br>Evacuated: approximately 5<br>Estimated Total Cost: unknown |
| Aklavik | June 2013 | The community government declared a state of local emergency because of localized flooding. An ice jam on the Peel Channel pushed the river levels up by more than five meters flooding Bickish Road, airport road, filling the drainage system and cutting access to the sewage lagoon and solid waste site.<br>Evacuated: none<br>Estimated Total Cost: unknown |
| Nahanni Butte | June 2012 | Seasonal snow melt and excessive precipitation caused water levels in the Liard River to reach flood levels resulting in the evacuation of Nahanni Butte residents to Fort Simpson and extensive damage to several buildings within the community. The flooding impacted over 60 percent of the land area of the community.<br>Evacuated: more than 57<br>Estimated Total Cost: approximately $1,916,000 |
| Fort Liard | April 2010 | An ice jam on the Liard River caused water to back up on the Liard and Petitot Rivers resulting in localized flooding. Low-lying areas of the community were flooded, access to 50 homes and the water treatment plant was cut off, and three homes flooded.<br>Evacuated: unknown<br>Estimated Total Cost: unknown |
| Hay River | May 2008 | Flooding due to snow melt and ice jams on the Hay River resulted in damage to public and private property. The Town declared a State of Local Emergency and residents of the West Channel area were required to evacuate. In Old Town the water covered several streets, Lakeshore Drive, and the Hay River beach area.<br>Evacuated: approximately 600<br>Estimated Total Cost: $460,000 |
| Nahanni Butte | June 2006 | The community experienced localized flooding due to snow melting when the Liard River overflowed its banks along four areas, cutting off access to the airport and closing the only road into the community. |

| | | |
|---|---|---|
| | | Evacuated: unknown<br>Estimated Total Cost: unknown |
| Aklavik | May 2006 | The Mackenzie River overflowed its banks at Aklavik during the spring break-up inundating most of the community with floodwater. Infrastructure was damaged after the Peel River Channel overflowed its banks swamping the town under several feet of water.<br>Evacuated: 300<br>Estimated Total Cost: $3,500,000 |
| Fort Good Hope | May 2005 | Ice blockages at the mouth of Jackfish Creek and Rabbitskin River caused localized flooding resulting in the community declaring a State of Local Emergency, infrastructure damage and the evacuation of 50 residents.<br>Evacuated: 50<br>Estimated Total Cost: $920,000 |
| Hay River, Kátł'odeeche First Nation | May 2003 | 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 Kátł'odeeche First Nation. Several residences in both communities had to be evacuated due to the floodwaters.<br>Evacuated: unknown<br>Estimated Total Cost: $100,000 |
| | | |

**NWT Exposure – Flooding**

Damaging floods regularly occur during spring break up in the NWT because of high water and ice jams on the Mackenzie, Liard, Peel and Hay River systems. Spring break up starts in April in the southern region of the NWT, works its way northward, and is completed in about ten weeks. Ten NWT communities are considered at increased risk of annual flooding, while others may still be at some risk.

**NWT communities at increased risk of annual flooding include:**

- **Hay River;**
- **Kátł'odeeche First Nation;**
- **Fort Simpson;**
- **Jean Marie River;**
- **Fort Liard;**
- **Nahanni Butte;**
- **Tulita;**
- **Fort Good Hope;**
- **Fort McPherson; and**
- **Aklavik**

**It is important to note that risk of flooding may exist for all communities with nearby waterways.**

The development of flood forecasting systems in the North has been restricted by a lack of basic data on floods, and the cost and complexity of forecasting (Environment and Climate Change Canada, 2014). While the NWT does not have flood forecast systems, the Department of Environment and Climate Change produces NWT Water Monitoring Bulletins that are provided to territorial and regional emergency managers to help understand the status of waterways near communities at risk of flooding during spring break up and other high flood risk periods. They also conduct snow surveys and produce annual spring bulletins which are distributed to government agencies and industry to inform of anticipated freshet conditions (Environment and Climate Change, 2023).

**Climate Change Impacts**

Canada's Changing Climate Report from 2019 suggests there is some confidence that projected higher temperatures will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events. However, it is uncertain how projected higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of future snowmelt-related flooding (Environment and Climate Change Canada, 2019). A recent Arctic Monitoring and Assessment Program report, Arctic Climate Change Update 2021: Key Trends and Impacts, indicates inland and coastal flooding, and extreme temperature and precipitation events already have major socioeconomic impacts in the Arctic and are expected to become more frequent and/or severe in the years ahead (Arctic Monitoring & Assessment Program, 2021):

- There will be a transition from snow to rain being the dominant annual precipitation by mid to late century which could change the type of flooding to expect;
- Average annual snowfall will decrease; however, the snow is projected to hold more moisture;
- Heavy snowfalls are likely to decrease with the exception of the far North, coastal areas and around large waterbodies;
- Rainfall may occur in the winter months triggering rain-on-snow events;
- There is consensus that water level rise events that meet the 100-year return period threshold could happen more frequently;
- Thinner ice and warmer overall temperatures could lead to a reduction in ice-jam flood risk; and
- Less sea-ice and storm surges has increased the risk and vulnerability to coastal flooding and erosion with projections for increased frequency for occurrence.

## 4.2 High-Risk Category

### 4.2.1 Wildfire/Interface Fire

| | |
|---|---|
| **Hazard:** Wildfire/Interface Fire |  |
| **Class:** Natural / Human Caused | |
| **Definition:** A wildfire (or wildland fire) is an unplanned fire that happens in a natural area, like a forest or grassland. An Interface Fire is when wildfires spread to and through the Wildland Urban Interface (WUI), an area where houses and other human developments meet or are mixed with wildland vegetation. | **Figure 6: NWT Wildfire**[6] |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | |

**Mitigation Strategies:**

- Implement community wide fire education and prevention campaign
- Establish clean air shelters
- Establish and maintain community fire departments
- Implement community fire bans when wildfire risk is high
- Implement FireSmart principles by all (e.g., fireguards, trimming brush, safe storage of fuel)
- Implement activities identified in Community Wildfire Protection Plans

| Type | Cause/Explanation |
|---|---|
| Forest, grass, bush, and brush fire | Uncontrolled burning in relatively unpopulated grassland, brush or woodlands. |
| Wildland/urban interface fire | Fires that encroach on developed and populated areas. |
| Peat fire | Wildfire in bogs or fens (muskeg) (can smolder beneath ground for long periods of time and create smoke hazards to surrounding populations). |
| **Vulnerability** | **Description** |
| People | High injury and fatality potential from the immediate threat of the fire as well as an increase in respiratory symptoms due to smoke/air quality. Smoke can impede evacuation of remote communities. |
| Infrastructure | Total loss or damage to personal property and critical infrastructure can occur including public buildings, roadways, rail-lines, power facilities and water treatment plants. |
| Communications | Any existing power and communications infrastructure can be damaged and destroyed causing significant impacts to communications. |

[6] https://www.cbc.ca/news/canada/north/wildfires-and-boreal-forest-1.5419726

| | |
|---|---|
| Environmental | While fires are a natural component of the ecosystem, increased fires in permafrost areas can lead to further permafrost degradation. Wildfire can also increase the risk of mud/landslides in burnt areas. |
| | |

| NWT Exposure/History[7] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Across the NWT | Summer 2023 | Throughout summer 2023, wildfires threatened a number of NWT communities, primarily in the North and South Slave regions. This resulted in evacuations of approximately 70% of NWT residents, territorial park closures, health effects due to smoke, shortages of goods, and highway closures interrupting public travel. EMO response actions extended from May to October. Over that period, territorial and regional emergency response committees supported 12 community evacuations (two of which required evacuation on two separate occasions).<br>Estimated Total Cost: under review<br>Evacuated: ~31,234 |
| Wrigley | July 2022 | A wildfire 20km southwest of Wrigley was active from June to August, increasing the risk to the community and the Mackenzie Valley fiber line. The community remained prepared to evacuate on short notice and heavy smoke was experienced for most of that time. |
| Wekweètì | July 2019 | A wildfire 11km northeast of the community and extreme wildfire risk ratings increased the risk to Wekweètì. Smoky conditions were experienced. |
| Behchokǫ̀ | July 2019 | A wildfire (~136 hectares) 11km north/northeast of the community and extreme wildfire risk ratings increased the risk to Behchokǫ̀. Smoky conditions were experienced. |
| Behchokǫ̀ | June 2019 | A wildfire (~15 hectares) 9km east of the community and extreme wildfire risk ratings increased the risk to Behchokǫ̀. Firefighting efforts and favorable weather conditions brought the wildfire quickly under control. |
| Fort Liard | June 2018 | A wildfire (~300 hectares) 20km southeast of the community and extreme weather conditions increased the risk to Fort Liard and directly threatened the community landfill. It also increased the risk to the fibre line along highway 7 and smoky conditions reduced visibility on the highway. |

[7] Information on past events taken from NWT EMO files.

| | | |
|---|---|---|
| Fort Good Hope | July 2017 | Fort Good Hope declared a State of Local Emergency due to a wildfire 18-20km from the community. The wildfire grew to approximately 14,000 hectares in size and caused smoke impacts to the community. Evacuation preparedness and planning took place, but no evacuation was required. |
| Nahanni Butte | September 2017 | A wildfire approximately 8000 hectares in size located approximately 5km south/southwest of Nahanni Butte resulted in heavy smoke and ash in the community and prompting a staged evacuation to Fort Liard (7-9 September).<br>Evacuated: ~80 |
| Fort Smith | July 2016 | A wildfire approximately 4 hectares in size was located approximately 5 km south of Fort Smith putting area residents and infrastructure at increased risk. Smoky conditions were experienced, and evacuation planning and preparedness activities were conducted but no evacuation resulted. |
| Reid Lake Area | July 2016 | A wildfire located approximately 40km from Yellowknife, near Reid Lake Territorial Park resulted in the evacuation of the park and area cabins, and the closure of highway 4. The wildfire grew to over 6,000 hectares in size and one cabin and a lodge were lost to the fire. |
| Hay River | June 2015 | A wildfire located approximately 6-8 km south of Hay River lead to the evacuation of Paradise Gardens and Patterson Road subdivisions and the planning and preparation for the general evacuation of Hay River and surrounding areas. The wildfire grew to approximately 20,000 hectares in size and damaged some power distribution lines and poles. |
| Across the NWT (Kakisa, Hay River, Gametì, Whatì, Wekweètì, Fort Providence, Jean Marie River, Yellowknife, Fort Resolution, Enterprise and Behchokǫ̀) | Summer 2014 | Throughout summer 2014, wildfires threatened a number of NWT communities, primarily in the North and South Slave regions. This resulted in evacuations, territorial park closures, health effects due to smoke, shortages of goods, and highway closures interrupting public travel. EMO response actions extended from May to the end of August. Over that period, territorial and regional emergency response committees supported eleven communities experiencing increased wildfire risk; managed the evacuation of two communities; and conducted four evacuations of remote areas. GNWT departments also collaborated on two territorial park evacuations, traffic interruptions on highways 1, 3, 4 and 5, the protection of critical communications and power distribution infrastructure, and communicated the risks associated with wildfire smoke to residents.<br>Estimated Total Cost: $28,000,000<br>Evacuated: ~850 |

| | | |
|---|---|---|
| Jean Marie River | July 2013 | A wildfire approximately 10km from the community resulted in planning and preparedness activities for evacuation. A number of vulnerable residents self-evacuated as a precaution. |
| Wrigley | July 2013 | A wildfire approximately 23km southeast of Wrigley resulted in the evacuation of 40 residents to Fort Simpson. The wildfire also threatened an Enbridge Pump Station and pipeline, coming within 5 km of it.<br>Evacuated: ~40 |
| Inuvik | July 2012 | A wildfire approximately 12km from Inuvik and 5km from the town water source grew to about 4,000 hectares in size increasing the risk to the community and area infrastructure. |
| Délı̨nę | July 2011 | A wildfire approximately 11km north of Délı̨nę prompted the evacuation of 108 residents to Yellowknife due to the increased fire risk and smoke impacts.<br>Evacuated: ~108 |
| Behchokǫ̀ | September 2011 | A wildfire near Edzo resulted in a forest fire danger in the Behchokǫ̀ area due to strong north-westerly winds. The fire presented an immediate risk to the community of Edzo, (within 100 metres of houses and structures) and spotted across Highway 3 to the southeast, threatening a government (Highways) camp in that area. Residents of Edzo were evacuated immediately in anticipation of the fire entering the community. The evacuation was lifted by nightfall, as the fire behaviour conditions abated and action on the fire had successfully reduced the threat to the community. The fire was thought to have been started by an ATV.<br>Evacuated: unknown |
| Norman Wells | July 2003 | A wildfire located approximately 17km northwest of Norman Wells grew to around 1850 hectares and resulted in a declared State of Local Emergency and the evacuation of vulnerable residents to Inuvik.<br>Evacuated: ~96<br>Estimated Total Cost: 120,000 |
| | | |

**NWT Wildfires**

Wildfire is a natural occurrence that is necessary for a healthy environment. Wildfires manage fuel loads that can cause more extreme fires and threaten communities, cycle nutrients back into the soil, and promote regrowth and regeneration (Environment and Natural Resources, 2021).

Most wildfires in the NWT are the result of lightning. From 2015 to 2021 there was a total of 1109 wildfires of which 96 were listed as human caused. The area burned for the same time period was 2,230,920 hectares (National Forestry Database, 2021).

**Peat Fire**

The NWT has nearly one-fifth of Canada's peat deposits at about 230,000 square kilometers of peatland. This peatland is storing approximately 24 billion tons of carbon (Canadian Broadcasting Corporation, 2021).

**Climate Change Impacts**

Climate warming is associated with an increase in boreal forest and tundra wildfires. Between 1948 and 2018, air temperature has risen on average by 2.3 °C in northern Canada (Environment and Climate Change, 2022). These changes are projected to have an impact on wildfire occurrences in the North. Projected warmer and drier conditions are expected to increase fire season length, annual area burned and the number of large fires (Natural Resources Canada, 2020). The Arctic Climate Change Update 2021: Key Trends and Impacts (2021) also indicates:

- Wildfires are expected to become more frequent and/or severe in the years ahead;
- Increased fires in the North in turn increases the carbon release to the atmosphere;
- Earlier spring snowmelt could lead to dryer ground conditions making fire ignitions (human or lightning) more frequent;
- Increase fire activity in permafrost areas will lead to further permafrost degradation; and
- An increase of 29-35% of burn areas for lightning caused fires (Arctic Monitoring & Assessment Program, 2021).

## 4.3 Medium Risk Category

### 4.3.1 Critical Services – Power/Fuel Interruption

| | |
|---|---|
| **Hazard:** Critical Services – Power / Fuel Interruption |  |
| **Class:** Human Caused | **Figure 7**: **Hydro Pole in Yellowknife 2019**[8] |
| **Definition:** Failure to provide energy required to meet basic human needs, sustain the economy, and protect public safety and security. | |
| **Climate Change Indicator:** Projected to increase both in frequency and consequence. | |

**Mitigation Strategies:**

- Install redundant/backup power generation or alternate forms of heat/power
- Establish essential facilities with backup power as shelters, warming/cooling centers, community telecommunications hubs, or other emergency management facilities
- Update or conduct a supply chain analysis for fuel supply including identifying territorial and community storage capacity
- Develop community fuel storage capacity where required

| 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 | The temporary loss of home heating systems that rely on electrical power to operate in winter can increase the risk to people especially those who need assistance to leave the building for warmer facilities. Prolonged power outages may disproportionately impact those relying on essential medical equipment. |
| Infrastructure | Power outages can have cascading impacts on other infrastructure that relies on electrical power to operate – these include transportation, telecommunications, water infrastructure, and may include healthcare. |
| Communications | Power outages can lead to a disruption in communication systems if there are no redundant power systems in place for the communication network. |

[8] https://www.cbc.ca/news/canada/north/yellowknife-power-outages-1.5217161

| | |
|---|---|
| Environment | Fuel interruptions can be the result of environmental spills. Energy/power interruptions can also lead to environmental damage. |
| | |

| NWT Exposure/History[9] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Inuvik | July 2023 | The NWT Power Corporation issued a public apology for several unplanned power outages over a two-month period. The cause was identified as including equipment failure, bird and animal strikes and power supply issues during maintenance activities.[10] |
| Tulita | May 2023 | A power outage that lasted more than 20 hours due to a wiring issue underneath the hamlet's power plant. The exact cause of the outage was unclear.[11] |
| Colville Lake | November 2022 | Power in the community was out for 25 hours due to a generation issue that affected power distribution.[12] |
| Yellowknife and Behchokǫ̀ | September 2022 | A series of power outages over two days due to a downed tree on transmission lines at Snare Hydro, problems maintaining electrical stability and Jackfish Lake generator issues.[13] |
| Fort Smith | September 2022 | A power outage occurred in Fort Smith due to a wildfire creating an issue with transmission lines from the Taltson hydroelectric facility and difficulties in transferring the community to diesel generation power. A series of smaller outages were reported in Fort Resolution, Hay River, Enterprise and the K'atl'odeeche First Nation.[14] |
| Fort McPherson | January 2022 | There were several power outages over two days due to faulty parts on the main generator in Fort McPherson. Temperatures were below -40 and the use of backup systems and plans for rolling blackouts limited the impact to residents.[15] |
| Whatì | January 2021 | A 20-hour rotating power outage occurred in Whatì on January 13-14 after two of its three generators failed. There was no reported impact on community residents or infrastructure.[16] |
| Yellowknife and Behchokǫ̀ | June 2021 | In June, Northwest Territories Power Corporation linked a series of power outages affecting Yellowknife to a |

[9] Some information on past events included from NWT EMO files.
[10] NTPC apologizes for Inuvik power outages, expects more (nnsl.com)
[11] https://www.cbc.ca/news/canada/north/tulita-power-outage-investigation-1.6852529
[12] Power has been restored to Colville Lake, NWT after a 25-hour outage (canadatoday.news)
[13] Update on Yellowknife, Dettah and Behchoko Outages – September 10 and 11, 2022 | Northwest Territories Power Corporation (ntpc.com)
[14] https://cabinradio.ca/104757/news/south-slave/fort-smith/sustained-power-outage-hits-fort-smith-blips-in-other-areas/
[15] https://www.cbc.ca/news/canada/north/faulty-equipment-near-40-c-temperatures-cause-hours-long-power-outage-in-fort-mcpherson-1.6302961
[16] https://www.nnsl.com/nwtnewsnorth/whati-residents-risk-freezing-in-winter-due-to-shoddy-infrastructure-lafferty/

| | | |
|---|---|---|
| | | thunderstorm passing over the hydro system supplying the city. Another outage in July was the seventh outage in either Yellowknife or Behchokǫ̀ since the last week of June.[17] |
| Yellowknife | July 2016 | A city-wide power outage occurred due to a wildfire near Yellowknife damaging power lines from the Snare Lake hydro system.[18] |
| Yellowknife | June 2014 | Power went out in Yellowknife when a raven hit a hydro transmission tower near the Bluefish dam. A fire was started when the raven hit the ground. The power went out in Behchokǫ̀, Dettah and N'dilo for 1.5 hours when hydro power was provided solely from the Snare system.[19] |
| Paulatuk | October 2013 | On 10 Oct 2013 the power went out in Paulatuk. Both main generators would not start. A backup generator was only able to provide power to half the town. Phones were out and there was no lights or phones to the airport. Full power was restored on 11 Oct when a NTPC crew got into town. No State of Local Emergency was declared, and no damages resulted. Several residents were evacuated to a warming shelter.<br>Evacuated: ~29 |
| Norman Wells | January 2013 | On January 28, 2013, a power outage caused a disruption to the natural gas flow for the Town of Norman Wells. Most of the gas supply stopped at approximately 8:00am. This affected most of the residences and commercial/public buildings. The average temperature in Norman Wells through the day was -40 degrees and the Town declared a State of Local Emergency. Seniors and vulnerable residents were moved to a daycare, which was heated by diesel fuel and powered by a backup generator. Gas service was restored in about seven hours and no major damage was reported.[20] |
| Inuvik | March 2012 | The town of Inuvik natural gas supply was running out due to water getting into the supply well and shortening its lifespan. The Ikhil well was supposed to last until at least 2014. The town was faced with rising energy costs and finding a new energy supply.[21] |
| Norman Wells | April 2011 | On April 29th there was a break in the Plains Midstream Canada Pipeline in Alberta which resulted in a major oil spill. The production of natural gas which serves the town of Norman Wells depends on the continued operation of the Imperial Oil Ltd oilfields at Norman Wells supported by the pipeline. This resulted in a shutdown of the pipeline and a few days later a shutdown of oil operations. While the town |

[17] https://cabinradio.ca/66810/news/yellowknife/power-outages-occurring-across-nwt-some-blamed-on-storm/
[18] Power Line Damage from Wildfire Causes Outages in Yellowknife, NWT - Electrical Industry Newsweek
[19] Flaming raven starts forest fire, cuts power to Yellowknife | CBC News
[20] https://www.cbc.ca/news/canada/north/n-w-t-town-restoring-gas-to-homes-after-morning-failure-1.1333014
[21] Inuvik, N.W.T., struggles with dwindling gas reserve | CBC News

| | | |
|---|---|---|
| | | had back-up diesel generation power, this situation left 175 homes without heat. The Town declared a State of Local Emergency and equipment was brought in to power the town with a propane-air mixture that mimics natural gas. No major damage resulted.[22] |
| Fort McPherson | January 2004 | A fire destroyed the community's diesel power generating station in mid-January in the middle of the night during minus 30-degree temperatures. Alternate emergency power supply was provided to the community within 24 hours, but some damage due to frozen water and sewage lines occurred.<br>Estimated Total Cost: $76,000. |
| | | |

**NWT Power Systems**

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 Norman Wells and gas generators using liquid natural gas (LNG) power Inuvik. The remaining 23 communities have electricity provided by diesel-fired power plants. Resupply of gasoline and diesel fuel using the tug/barge system along the Mackenzie River and road/ice road systems is critical to most NWT communities and many of the mines and resource activities.

**Climate Change Impacts**

Climate change directly affects fuel supplies, energy production as well as the physical resilience of current and future energy infrastructure. Heatwaves and droughts are already putting existing energy generation under stress, making it even more important to reduce fossil fuel emissions. More extreme weather, water and climate events are having an impact on fuel supplies and distribution systems (World Meteorological Organization, 2022). Some of the key concerns related to climate change include:

- 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; and
- Increasing wildfires will impact on remote transmission lines and hydroelectric facilities.

[22] https://www.cbc.ca/news/canada/north/n-w-t-town-could-lose-gas-supply-due-to-oil-spill-1.1002164

### 4.3.2 Transportation Incident – Road/Ice Road Closure

| | |
|---|---|
| **Hazard:** Transportation Incidents – Road / Ice Road Closure |  |
| **Category:** Human Caused | **Figure 8: Submerged Transport Truck, Dél̨ne Ice Road 2016**[23] |
| **Definition:** Vehicle accidents which result in large loss of life, property, infrastructure damage or extended highway/road closures. | |
| **Climate Change Indicator:** Projected to increase both in frequency and consequence. | |

**Mitigation Strategies:**

- Promote safe driving practices
- Monitor for weather impacts on road safety
- Implement road safety and education programs
- Develop and maintain of emergency response plans to allow for prompt response to transportation accidents
- Monitor ice road conditions
- Adhere to ice-road travel policies and procedures

| 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 on an ice road. 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 regularly travel at 15 miles per hour, potentially for up to 30 hours, over frozen lakes. |
| 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. |
| 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 | Transportation accidents on ice roads have an increased risk of injury or fatalities due to the remoteness and distance from |

[23] https://www.cbc.ca/news/canada/north/deline-ice-road-crash-infrastructure-report-1.4545787

| | |
|---|---|
| | emergency response agencies. This risk is compounded when considering the ice roads are a winter season access. |
| Infrastructure | Any accident which occurs on the ice road can damage the roadway and therefore leave already isolated areas without any road access. |
| Communications | Given that communication hubs are mostly serviced by a single communication line, especially in the southern NWT, any accident may cut or damage these lines leading to loss of communications. |
| Environmental | Fluid leaks from vehicles or a release of hazardous materials transported could have a detrimental impact on the environment. |
| | |

| **NWT Exposure/History[24]** | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Hay River | March 2021 | A train and truck collided at a Hay River railway crossing on Balsam Drive as it meets the Mackenzie Highway. The driver of the truck sustained minor injuries.[25] |
| Inuvik Region | November 2020 | 4 vehicles broke through the ice due to the unpredictable ice conditions in the Beaufort Delta Region.[26] |
| Yellowknife | December 2017 | 3 vehicles and a few snowmobiles went through the ice near Yellowknife due to unpredictable ice conditions.[27] |
| Délįnę | March 2016 | A fuel tanker broke through the Délįnę ice road near the community. The driver was unharmed, however this incident delayed completion of the community fuel supply and threatened early closure of Délįnę's only access road.[28] |
| Chan Lake | February 2013 | An accident occurred near Chan Lake, approximately 83Km north of Fort Providence, involving a northbound truck carrying explosives and a southbound fuel truck.<br>Highway 3 between Fort Providence and Edzo was closed for approximately 45hrs. It is estimated the northbound truck was carrying 1,206 boxes of explosives consisting of 30,780 units, all of which had to be accounted for. The southbound fuel truck was empty at the time but caught fire which did not spread. There were two fatalities and one person injured.[29] |
| Tuktoyaktuk-Aklavik ice road | April 2012 | Three fuel trucks broke through the ice. No fuel leaked from the trucks, which were full, and no one was hurt. The |

[24] Some items include additional information from NWT EMO files.
[25] https://www.nnsl.com/hayriverhub/train-and-truck-collide-at-hay-river-railway-crossing/
[26] https://www.cbc.ca/news/canada/north/four-vehicles-fall-through-ice-nwt-november-1.5834410
[27] https://www.cbc.ca/news/canada/north/nwt-responds-to-3-vehicles-so-far-1.4457564
[28] https://www.cbc.ca/news/canada/north/truck-plunges-deline-ice-road-1.3477869
[29] https://www.cbc.ca/news/canada/north/2-dead-in-crash-on-n-w-t-hwy-3-1.1332706

| | | |
|---|---|---|
| | | incident backed up traffic for hours affecting dozens of people travelling to Tuktoyaktuk.[30] |
| Enterprise | December 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. The accident resulted in one fatality and two people injured.[31] |
| Near Fort Providence | January, 2000 | A Northbound super-b-train truck hauling diesel fuel crashed through the Mackenzie River ice crossing. Driver was treated for hypothermia.[32] |
| | | |

**NWT Highway Systems**

The NWT highway system includes 3,873 kilometres of all-weather highways, winter roads, and access roads (Infrastructure, n.d.). It includes 10 main highways and 28 community access roads. Winter access roads (Ice and winter roads) are usually open anywhere from mid to late December to late March/early April based on 20-year averages (Infrastructure, 2022); however, this may vary across the Territory and with weather conditions. Some ice roads are privately operated and maintained, and offer no or limited services, emergency or otherwise. 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 and hours of operation limited.

There was a total of 445 vehicle collisions reported in the NWT in 2020. Since 2008, the total number of collisions has been declining along with the number of persons sustaining injuries (Government of the Northwest Territories, 2020).

**Climate Change Impacts**

Warmer temperatures affect the safety and reliability of NWT highway systems by contributing to permafrost degradation on NWT highways, reduced operating seasons for winter roads and increased operation and maintenance costs (Government of the Northwest Territories, n.d.).

- Access via ice roads and winter roads are projected to decrease in the future – duration (season) and availability (Arctic Monitoring & Assessment Program, 2021).
- Potential for a need to shift in means of travel. For instance, shifting from driving to flying due to reduction in the availability of ice roads and bridges; and
- Accidents can be expected with thinning ice conditions on ice roads and ice bridges, which could result in the need for more rescues/emergency responses.

[30] https://www.cbc.ca/news/canada/north/3-fuel-trucks-broke-through-ice-road-near-aklavik-n-w-t-1.1281107
[31] https://www.cbc.ca/news/canada/north/n-w-t-truck-collision-kills-1-1.953668
[32] https://www.cbc.ca/news/canada/fuel-truck-breaks-through-ice-road-1.236442

### 4.3.3 Health Hazards – Human Disease (Includes Pandemic/Epidemic)

| | |
|---|---|
| **Hazard:** Human Disease (Pandemic & Epidemic) |  |
| **Class:** Natural Hazard | **Figure 9**: **Covid-19 Testing Centre**[33] |
| **Definition:** A grave or widespread illness that presents a danger to people 's health. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | |
| **Mitigation Strategies:**<br>• Monitor and follow public health recommendations<br>• Develop business continuity and essential services continuity plans | |

| **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 thousands of 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 | Illness and fatalities 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. |
| | |

[33] https://www.mytruenorthnow.com/57730/news/yellowknife-news/walk-in-time-designated-for-testing-clinic-new-covid-clinic-opened/

| NWT Exposure/History[34] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Jean Marie River, Fort Simpson | January 2021 | An outbreak of pertussis (whooping cough) was declared for the Dehcho region of the NWT with seven confirmed cases in total in Jean Marie River and Fort Simpson.[35] |
| NWT Wide | March 2020 – March 2022 | During the pandemic period March 2020 – March 2022, there were 20 COVID-19 related deaths, 100 hospitalizations and 10,773 resolved cases of COVID-19 in the NWT. (Government of the Northwest Territories, 2023). COVID-19 was a worldwide pandemic that impacted all aspects of day-to-day life. NWT response efforts included public health measures, border closures, self-isolation requirements, business and activity closures and restrictions, mandatory masking, work-from-home and learn-from-home (school) policies and other response requirements. |
| Ulukhaktok | October 2018 | An outbreak of hand, foot and mouth disease impacted Ulukhaktok. At least 10 children were confirmed to have had the disease, and Halloween celebrations were forced to be cancelled. There were no deaths reported because of this outbreak.[36] |
| NWT wide | Nov 2009 | H1N1 was a new strain of influenza and because humans had little to no natural immunity to this virus, it caused serious and widespread illness. The pandemic spread to all NWT communities and resulted in 45 hospitalizations and 1 death in the territory. |
| | | |

**Readiness for Epidemic/Pandemic**

The NWT has a long history with disease outbreaks and pandemics to include smallpox outbreaks (1862), Spanish flu (1918), Typhoid (1927), influenza (1928) and Polio (1953) and more recent experience with the H1N1 outbreaks (2009) and the COVID-19 pandemic (2020-2022). The COVID-19 experience specifically has ensured that there is broad awareness of infectious diseases, public health measures and how the public can protect itself, and that pandemic plans and readiness in the NWT for major epidemics or pandemics are up-to-date and effective.

**Climate Change Impacts**

The NWT has experienced a warming rate that is two to four times faster than the global average. Increase in temperature can lead to more precipitation (rain, snow, hail) and a loss of permafrost and sea ice. Increasing temperatures and precipitation potentially allow for the increase in diseases such as West Nile virus and Lyme disease that are passed on by insects (Health and Social Services, n.d.). There is also

[34] Unless otherwise indicated, information taken from NWT EMO files.
[35] https://www.cbc.ca/news/canada/north/whooping-cough-pertussis-deh-cho-1.5871447
[36] https://www.cbc.ca/news/canada/north/halloween-cancelled-ulukhaktok-1.4885622

a risk of being exposed to new and established diseases that can affect health and well-being (Government of Canada, 2022).

Climate change will likely drive the emergence of infectious diseases in Canada by northward spread from the United States and introduction from elsewhere in the world via air and sea transport (Government of Canada, 2019). These include:

- emergence of tick-borne diseases in addition to Lyme disease,
- the possible introduction of exotic mosquito-borne diseases such as malaria and dengue,
- more epidemics of Canada-endemic vector-borne diseases such as West Nile virus, and
- increased incidence of foodborne illnesses.

### 4.3.4 Severe Weather – Extreme Cold

| | |
|---|---|
| **Hazard:** Severe Weather – Extreme Cold |  |
| **Class:** Natural Hazard | |
| **Definition:** Temperatures of -40°C or lower for a period of at least seven days. | |
| **Climate Change Indicator:** Projected to decrease both in frequency and consequence. | **Figure 10**: **Yellowknife** [37] |

**Mitigation Strategies:**

- Monitor weather conditions for extreme cold conditions
- Implement public awareness programs for extreme cold
- Consider mitigation activities identified under "Critical Services - Power Outages / Fuel Interruption"

| 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 exposed skin can freeze in 5 to 10 minutes. |
| Infrastructure | Extreme cold temperatures can cause significant property damage due to mechanical malfunctions and burst pipes. |
| Communications | A cascading effect of a power failure during an extreme cold event on telecommunications systems could lead to failures in the systems without redundant power or heat sources – extreme cold limits battery life and impacts other electronics; moving metal parts may become brittle and fail. |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Wekweètì | February 2021 | The community recorded –52 C during an extreme cold event.[38] |
| Behchokǫ̀ and Norman Wells | January 2013 | 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 |

[37] https://www.cbc.ca/news/canada/north/wekweeti-extreme-cold-record-breaking-1.5907316

[38] https://www.ctvnews.ca/climate-and-environment/the-polar-vortex-will-leave-us-soon-but-don-t-put-your-parka-away-just-yet-1.5308673?cache=baaosfalzs%3FclipId%3D89619

| | | |
|---|---|---|
| | | 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.[39] |
| Yellowknife, Norman Wells and Fort Simpson | January 2008 | 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 in Yellowknife and impelled the homeless to fill emergency shelters. Schools were closed.[40] |
| | | |

**NWT Weather**

Generally, the climate of the NWT is characterized by very cold winters and short, cool summers. Extreme cold events (-40°C) are common during the winter months. Due to the frequency of these events, weather alerts and advisories, residents are typically resilient and aware of how to safely manage. In addition, communities and critical infrastructure in the NWT are generally prepared to operate during extreme temperatures.

**Climate Change Impacts**

A number of key studies provide consistent and compelling evidence that warm extremes are increasing, and cold extremes are decreasing in the Arctic. There is strong evidence for this trend to continue and for decreases in the frequency of extreme cold events (Arctic Monitoring & Assessment Program, 2021).

[39] https://www.cbc.ca/news/canada/north/cold-weather-blamed-for-power-outage-in-behchoko-n-w-t-1.1369513#:~:text=Cold%20weather%20is%20being%20blamed%20for%20the%20power%20outage%20in,%22It%20was%20frozen%20open.
[40] https://www.cbc.ca/news/canada/north/unusual-yellowknife-power-outage-blamed-on-cold-snap-1.715010

### 4.3.5 Hazardous Materials Spill

| | |
|---|---|
| **Hazard:** Hazardous Materials - Spill<br>**Class:** Human Caused<br>**Definition:** A spill involving any material which can be hazardous to people or the environment.<br>**Climate Change Indicator:** Projected to increase both frequency and consequence. |  <br>**Figure 11: Spill Containment** [41] |

**Mitigation Strategies:**

- Ensure proper storage and containment of hazardous materials
- Maintain emergency spill plans
- Ensure adequate training for those involved
- Ensure adequate spill containment/clean up equipment is maintained at or near hazardous material storage site
- Relocate hazardous materials outside of hazard risk zones where possible (e.g., flood risk zone)

| Type | Cause/Explanation |
|---|---|
| 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. |
| Sewage Spill | The release or discharge of raw sewage or improperly treated sewage into the environment. |
| Contamination | The improper presence of a harmful substance in the natural environment, or at a workplace. |
| **Vulnerability** | **Description** |
| People | Hazardous materials spills can have an enormous impact on the health of workers and on the economy in general, which is reflected in the death, injury, 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 oil spills which could impact water treatment and supply systems. |
| Communications | Communications hubs in small communities could be damaged or become restricted access due to hazardous materials spills. |

[41] https://www.enr.gov.nt.ca/en/services/report-spill

| | |
|---|---|
| Environmental | Hazardous material spills can have a severe and long-lasting detrimental effect on the environment. |
| | |

| NWT Exposure/History[42] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Fort Providence | July 2022 | 57,399 liters of gasoline spilled from a fuel truck. |
| Fort Providence | February 2022 | 40,000 kilograms of chemicals including transformer oils spilled due to a vehicle incident. |
| Norman Wells | March 2021 | 57,600 cubic meters of petroleum – natural gas spilled due to a fitting leak. |
| Behchokǫ̀ | April 2020 | 1,000,000 liters of wastewater spilled due to a breakage in the sewage lagoon. |
| Norman Wells | April 2019 | 61,000 cubic meters of natural gas from a storage tank at the Imperial Oil Norman Wells mine/oil field. |
| Ekati Mine | March 2019 | 111,000 liters of fuel oil from a fuel tank as a result of an overflow event. |
| Yellowknife | January 2018 | 2,000,000 liters of wastewater spilled from a pipe leak. |
| Diavik Mine | August 2017 | 890,000 liters of wastewater spilled from a pipe leak. |
| Inuvik | September 2016 | 57,000 liters of fuel oil spilled from a marine vessel. |
| Ekati Mine | January 2016 | 3,000,000 liters of wastewater spilled due to a pipe leak. |
| Ekati Mine | March 2015 | 700,000 liters of other product spilled due to a pipe breakage. |
| Camlaren (South Slave) | August 2014 | 300,000 liters of petroleum spilled due to a pipe leak. |
| Yellowknife | June 2014 | 60,000 liters of fuel oil spilled from a truck due to a fitting leak. |
| Highway 3 | July 2013 | 53,197 liters of fuel oil spilled due to a truck accident. |
| Norman Wells | October 2012 | 80,000 liters of oil emulsion spilled due to a pipe leak. |
| Snap Lake Mine | July 2012 | 2,170,000 liters of wastewater spilled due to a pipe leak. |
| Diavik Mine | February 2012 | 2,400,000 liters of wastewater spilled due to a pipe leak. |
| Snap Lake Mine | May 2010 | 662,400 liters of wastewater spilled due to a pipe leak. |
| Norman Wells | November 2009 | 1,500,000 liters of wastewater spilled due to a pipe leak. |
| Diavik Mine | May 2009 | 500,000 liters of wastewater spilled from a well. |
| Diavik Mine | May 2008 | 4,000,000 liters of wastewater spilled. |
| Diavik Mine | May 2008 | 2,300,000 liters of wastewater spilled from a tailings pond. |
| Inuvik | February 2008 | 2,100,000 liters of wastewater spilled due to a pipe leak. |
| Snap Lake Mine | February 2008 | 1,000,000 liters of wastewater spilled due to a pipe leak. |
| Snap Lake | November 2007 | 500,000 liters of wastewater spilled during an overflow event. |
| Snap Lake Mine | May 2005 | 1,200,000 liters of wastewater spilled due to an overflow event. |
| Snap Lake Mine | October 2004 | 2,500,000 liters of wastewater spilled due to a pipe leak. |
| Giant Mine | June 2003 | 1,000,000 liters of wastewater spilled due to a pipe leak. |

[42] Information on spills taken from the GNWT Spills Database at https://www.gov.nt.ca/ecc/en/spills.

| | | |
|---|---|---|
| (Yellowknife) | | |
| Ekati Mine | April 2003 | 62,500 liters of fuel oil spilled due to a tank leak. |
| Yellowknife | February 2003 | 800,000 liters of wastewater spilled. |
| | | |

**NWT Environmental Spills**

Mining and oil and gas industries are the most common hazardous industries in the NWT. The NWT has vast undeveloped oil and gas reserves. It is estimated that the NWT could hold as much as 37 percent of Canada's marketable light crude oil resources and 35 percent of its marketable natural gas resources (Industry Tourism and Investment, n.d.).

The Department of Environment and Climate Change has maintained a database of all hazardous material spills reported in the NWT since 1971 and produces an annual spills report. The most recent report, 2021 Northwest Territories Spills Report indicates:

- 233 spills were reported in 2021, an increase of 21 spills or 9.9% compared to 2020.
- 64% of the reported spills were less than 100 liters or 100 kilograms.
- 41% of the spills reported occurred in the North Slave region.
- Spills at mining operations accounted for 24% of reported spills in 2021.
- Spills at all government operations combined (municipal, territorial, and federal) accounted for 45% of reported spills.
- 31% of spills reported in 2021 involved fuel oil.

Highlights of the report included:

- Wastewater, which includes sewage, mine tailings and other types of contaminated water, accounted for 37% of reported spills.
- At the end of May of 2021, unprecedented flooding occurred in the Dehcho region. Jean Marie River and Fort Simpson combined, reported 14 spill reports of primarily heating oil, sewage, and mixed hydrocarbons. The impacted sites were assessed and remediated by October of 2021.
- In 2021, there was a single event at a production facility resulting in an estimated 57,600,000 liters of natural gas escaping into the environment. 2020 in comparison, only had 8,028 liters of natural gas reported to be released into the environment (Government of the Northwest Territories, 2021).

**Climate Change Impacts**

The Assessment of Climate Change Impacts on Infrastructure in all NWT Communities report (2021) indicates that the highest risk levels at the territorial scale for civil and municipal infrastructure categories, included roads, water and wastewater treatment plants, sewage lagoons, culverts and drainage structure, as well as sanitary sewer mains. Buildings are most sensitive to snow load, permafrost, flooding, and wildfire, when surrounded by forest. Permafrost thaw and wildfires represent the most significant risks to the energy infrastructure (Government of the Northwest Territories, 2021). Permafrost thaw, severe weather, floods, and wildfires are all predicted to become more frequent and severe. The resulting impact on infrastructure will likely see an increase in frequency and severity of environmental spills.

### 4.3.6 Severe Weather – Snowstorm/Windstorm

| | |
|---|---|
| **Hazard:** Severe Weather Snowstorm/Windstorm |  |
| **Class:** Natural Hazard | **Figure 12: Blizzard** [43] |
| **Definition:** Strong weather characterized by heavy snow , freezing rain, hail and/or damaging winds. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | |

**Mitigation Strategies:**

- Implement public awareness programs for snowstorms/blizzards
- Develop redundancy for interruptions/delays to essential services during snowstorms/blizzards (e.g., delays in supply chain or emergency transportation services)
- Develop contingency plans for weather monitoring and snow removal
- Consider mitigation activities identified under "Critical Services - Power / Fuel Interruption"

| **Type** | **Cause/Explanation** |
|---|---|
| Snowstorm | The accumulation of several centimeters to meters of snow that covers roads and infrastructure. |
| 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. |
| Windstorm | Weather event that includes wind speeds that exceed what is expected for a particular area. |
| Tornado | A funnel cloud of rapidly rotating air, with an intense low pressure of rising air at the center. |
| Microburst | Pattern of intense wind that descends from rain clouds, hit the ground, and fan out horizontally. |
| **Vulnerability** | **Description** |
| People | All storms have the potential to cause injury or death due to structural damage, flying debris, cold temperatures, or storm surges. Heavy winds and cold temperatures can combine with power loss to cause injury and death. Blowing snow creates hazardous driving and working conditions. |

[43] https://www.cbc.ca/news/canada/north/blizzard-warning-nwt-weather-1.5338717

| | |
|---|---|
| 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. |
| Communications | Snow and heavy winds often cause damage to communications towers and can knock out communications systems. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| South Slave Region | December 2022 | A winter storm caused wind gusts up to 117 km/h in some parts of the NWT. Fort Smith lost power due to interruptions on the transmission lines, also impacting Fort Resolution. An Environment Canada wind warning was issued for Yellowknife, Hay River, Fort Smith, Fort Resolution, Kakisa and Enterprise.[44] |
| Ulukhaktok | December 2022 | Blizzard conditions closed many services for two days and delayed the Ulukhaktok election which was set to take place.[45] |
| Sambaa K'e | June 2021 | A significant downburst event caused widespread tree damage east of Fort Liard, from Celibeta Lake to Sambaa K'e (Trout Lake). The downburst had an estimated maximum windspeed of 190 km/h and caused visible tree damage across an area of more than 60 km by up to 9 km wide.[46] |
| Tuktoyaktuk | March 2020 | Blizzard conditions caused a power outage and closed community services. The school was setup as a warming shelter.[47] |
| Ulukhaktok | October 2019 | A major blizzard impacted Ulukhaktok, Paulatuk, and Sachs Harbour in late October. The snow and extreme wind conditions resulted in a closure of the Ulukhaktok airport for seven hours.[48] |
| Fort Smith | June 2019 | An EF1 tornado with an estimated maximum wind speed of 155 km/h caused structural and tree damage.[21] |
| Paulatuk | January 2018 | The hamlet lost power due to a windstorm with over 100 km/h winds. The winds damaged roofs and sheds. The school was set up as a shelter for impacted residents.[49] |
| Inuvik and Norman Wells | January 2012 | 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. Winds took off several roofs, including one at the Inuvik Airport, and lifted and shifted other items all around the region.[50] |
| | | |

[44] https://cabinradio.ca/111091/news/yellowknife/how-strong-were-the-nwt-storms-winds-near-you-heres-a-list/
[45] https://cabinradio.ca/111869/news/politics/blizzard-postpones-ulukhaktok-election-new-mayor-in-fort-mcpherson/
[46] https://experience.arcgis.com/experience/7fc38df5cbe34b3e9001894dc50eec17
[47] https://cklbradio.com/2020/03/16/blizzard-in-high-north-strong-winds-in-yellowknife-wreak-havoc/
[48] https://www.nnsl.com/nwtnewsnorth/blizzard-closes-ulukhaktok-airport-for-nine-hours/
[49] Buildings damaged in Paulatuk after windstorm knocks out power (yahoo.com)
[50] https://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=28CD8158-1

**NWT Severe Weather**

Many areas in the Northwest Territories are very flat and do not have much tree cover. This means strong and gusty winds can happen almost anywhere in the NWT. These conditions can lead to property damage or create unsafe travelling conditions. During spring, fall and winter months blizzards are relatively common in most areas. Defined by winds of 40 km/h or greater blizzards can cause widespread reductions in visibility (400 metres or less), due to blowing snow, or blowing snow in combination with falling snow, for a period of at least four hours. Blizzards can contribute to infrastructure damage, power outages, communications outages and health and safety risks for residents. (Municipal and Community Affairs, n.d.).

**Climate Change Impacts**

Wind can cause damage to infrastructure directly through extreme gusts, indirectly by spreading wildfire or in combination with heavy precipitation. Storms with extreme wind gust speeds occur almost annually in northernmost communities. The NWT will likely experience a slight increase in average wind speed during all seasons. Winter extreme winds will likely increase while summer extreme winds will decrease in intensity by the end of the century (Government of the Northwest Territories, 2021).

Changes in winter snow cover and in the amount of snow are projected to be minimal across northern Canada because any increased snowfall in the North is expected to be offset by increasing temperatures that will shorten the snow-accumulation season (Environment and Climate Change Canada, 2019).

### 4.3.7 Fire – Structure Fire

| | |
|---|---|
| **Hazard:** Structural Fire |  |
| **Class:** Human Caused | |
| **Definition:** Fires that occur in a residential, commercial or industrial structure. | |
| **Climate Change Indicator:** Undetermined. | **Figure 13: Yellowknife Fire** [51] |

**Mitigation Strategies:**

- Implement community wide fire prevention education campaign (e.g., promoting the need for smoke alarms and carbon monoxide alarms)
- Maintain fire alarm and sprinkler testing schedules
- Consider establishing/improving community fire departments
- Ongoing engagement with the Office of the Fire Marshal programs (e.g., Plan Review and inspections)

| Vulnerability | Description |
|---|---|
| People | High injury and fatality potential from the immediate threat of the fire as well as an increase in 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. |
| Communications | Any existing power and communications infrastructure can be damaged and destroyed causing significant impacts to communications. |
| Environmental | Depending on the fuel type burned (eg. hazardous materials), there is a risk of environmental contamination and air pollution. |
| | |

| NWT Exposure/History[52] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Yellowknife | December 2022 | Fire and explosion destroyed a home on Dagenais Drive.[53] |
| Inuvik | November 2021 | Fire destroyed the Inuvik Warming Centre.[54] |

[51] https://www.cbc.ca/news/canada/north/fire-rockhill-apartment-yellowknife-1.4846733
[52] Only fires with an estimated total cost over 1 million and involving key infrastructure included. Estimated Total Cost information take from Office of the Fire Marshal annual reports.
[53] https://www.nnsl.com/news/explosion-and-fire-causes-destruction-of-home-on-dagenais-drive/
[54] https://www.cbc.ca/news/canada/north/inuvik-fire-warming-shelter-1.6266453

| | | |
|---|---|---|
| Norman Wells | July 2020 | Industrial fire at Imperial Oil's Norman Wells site.[55] |
| Inuvik | August 2020 | Two buildings on Wolverine Road were destroyed by fire and several others damaged.[56] |
| Hay River | March 2019 | A fire in a unit caused residents to evacuate from the Hay River Highrise (Mackenzie Place Apartments) and the building closure. No injuries or deaths reported. [57]<br>Estimated total cost: undetermined. |
| Yellowknife | March 2018 | Yellowknife Catholic Schools Board Offices, 5124 49th St.[58]<br>Estimated Total Cost: 2,000,000 |
| Yellowknife | October 2018 | Rockhill Apartment Building on 54th Ave was destroyed by fire leaving 33 families without a home.[59]<br>Estimated Total Cost: $5,100,000 |
| Yellowknife | June 2017 | 23, 21, 19, and 17 Ward Crescent (3 unit town house and two others damaged).[60]<br>Estimated Total Cost: $2,500,000 |
| Yellowknife | March 2017 | A fire and evacuation at the Explorer Hotel.[61]<br>Estimated Total Cost: $750,000 |
| Whatì | November 2017 | The Hamlet 4 Bay Garage including a water truck, sewage truck and bobcat were destroyed.[62]<br>Estimated Total Cost: $800,000 |
| Inuvik | March 2016 | Housing 6 Plex on Bonnetplume Road.[63]<br>Estimated Total Cost: $2,000,000 |
| Yellowknife | April 2016 | A fire destroyed Fitzgerald Carpeting.[64]<br>Estimated Total Cost (building): $1,700,000 |
| Hinterland | July 2016 | Wildfire burned down Namushka Lodge.[65]<br>Estimated Total Cost: $1,200,000 |
| Behchokǫ̀ | July 2016 | Fire destroyed Our Video store.[66]<br>Estimated Total Cost: $840,000 |
| Yellowknife | February 2016 | Fire at Coyote's Restaurant.[67]<br>Estimated Total Cost: $1,400,000 |
| Yellowknife | June 2015 | Fire at Polaris Apartments destroyed 17 units.[68]<br>Estimated Total Cost: $3,600,000 |
| Inuvik | May 2014 | 24 May fire at the old Polaris Theatre destroys building.[69]<br>Estimated Total Cost: $1,500,000 |
| Inuvik | August 2013 | Fire at the building that houses the NWT Housing |

[55] https://www.cbc.ca/news/canada/north/fire-imperial-oil-norman-wells-1.5671781
[56] https://www.nnsl.com/inuvikdrum/multiple-homes-in-inuvik-destroyed-by-early-morning-fire/
[57] https://www.cbc.ca/news/canada/north/hay-river-highrise-1.5058900
[58] https://www.cbc.ca/news/canada/north/fire-closes-catholic-school-board-office-1.4580794#:~:text=The%20head%20office%20of%20Yellowknife,the%20evacuation%20of%20an%20apartment.
[59] https://www.cbc.ca/news/canada/north/fire-rockhill-apartment-yellowknife-1.4846733
[60] https://www.cbc.ca/news/canada/north/condo-fire-ward-crescent-1.4178393
[61] https://www.cbc.ca/news/canada/north/yellowknife-s-explorer-hotel-evacuated-after-fire-1.4043441
[62] https://www.cbc.ca/news/canada/north/whati-hamlet-garage-fire-1.4419319
[63] https://www.cbc.ca/news/canada/north/fire-strikes-inuvik-6-plex-1.3499185
[64] https://www.cbc.ca/news/canada/north/fire-fitzgerald-carpeting-yellowknife-1.3551421
[65] https://www.cbc.ca/news/canada/north/namushka-lodge-reid-lake-fire-questions-1.3686501
[66] https://www.cbc.ca/news/canada/north/behchoko-nwt-fire-store-1.3668959
[67] https://www.cbc.ca/news/canada/north/coyotes-restaurant-fire-yellowknife-1.3457804
[68] https://www.cbc.ca/news/canada/north/polaris-apartments-fire-cause-unknown-as-evidence-destroyed-say-officials-1.3114851
[69] https://www.cbc.ca/news/canada/north/fire-destroys-historic-polaris-theatre-in-inuvik-n-w-t-1.2653543

| | | |
|---|---|---|
| | | Corporation offices, Inuvik Gas, and the Inuvialuit Development Corporation offices. [70]<br>Estimated Total Cost: between $500,000 and $750,000 |
| Inuvik | June 2012 | Fire at the Lions Club destroys building.[71] |
| Yellowknife | May 2010 | 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.[72] |
| Inuvik | November 2010 | A fire destroyed a hangar and three planes, King Air, B99 and Twin Otter.[73] |
| Tulita | October 2007 | Fire damaged Chief Albert Wright school.[74]<br>Estimated Total Cost: over $500,000 |
| Yellowknife | March 2005 | Fire at Old Airport Road hardware store (Home Hardware) resulted in two deaths.[75]<br>Fatalities: 2 |
| | | |

**NWT Fire Safety**

There is no legislative requirement for community governments in the NWT to provide fire protection services. Should a community choose to, they must meet the requirements of the *Fire Prevention Act*, the *Safety Act*, and the *Occupational Health and Safety Regulations*. The Department of Municipal and Community Affairs supports community governments and respective fire departments to improve the development and maintenance of community fire protection services. Of the 33 communities in the NWT, 10 do not have established fire departments.

Like other jurisdictions in Canada, most loss due to fire in the NWT occurs in residential settings. The impacts of these fires can place a heavy burden on families, communities, and governments due to losses which are, in many cases, quite preventable. Information from Office of the Fire Marshal Annual Reports indicate that between 2015 and 2019, the five-year average was 252 fires with 0.8 fatalities, 1 injury and an estimated total loss of over 8.5 million per year (Municipal and Community Affairs, n.d.).

**Table 5: NWT Fires - 5-year Average**

| Year | Reported Structural Fires | Fatalities | Injuries | Estimated Total Cost |
|---|---|---|---|---|
| 2019 | 238 | 1 | 3 | $3,618,750 |
| 2018 | 256 | 1 | 0 | $10,690,000 |
| 2017 | 279 | 1 | 1 | $10,218,000 |
| 2016 | 237 | 0 | 0 | $10,096,000 |
| 2015 | 251 | 1 | 1 | $8,201,000 |
| 5yr Total | 1,261 | 5 | 5 | $42,823,750 |
| **5yr Average** | **252** | **0.8** | **1** | **$8,564,750** |

[70] https://www.cbc.ca/news/canada/north/inuvialuit-headquarters-damaged-by-fire-1.1394374
[71] https://www.cbc.ca/news/canada/north/inuvik-n-w-t-lions-club-burns-down-1.1150427
[72] https://www.cbc.ca/news/canada/north/yellowknife-highrise-damaged-by-fire-1.920536
[73] https://www.cbc.ca/news/canada/north/inuvik-airport-fire-destroys-3-planes-1.933321
[74] https://www.cbc.ca/news/canada/north/tulita-school-damaged-in-morning-blaze-1.654869
[75] https://www.firehouse.com/lodds/news/10512274/one-firefighter-dead-another-critically-injured-in-canada-store-fire

**Climate Change Impacts**

The Assessment of Climate Change Impacts on Infrastructure in all NWT Communities report (2021) indicates that the highest risk levels at the territorial scale for civil and municipal infrastructure categories, included roads, water and wastewater treatment plants, sewage lagoons, culverts, and drainage structure, as well as sanitary sewer mains. Buildings are most sensitive to snow load, permafrost, flooding, and wildfire, when surrounded by forest. While increased severity and frequency of climate change impacts on infrastructure could lead to more fires, no trend or indications were identified and any link to climate change is undetermined.

### 4.3.8 Earth Movement – Erosion

| | |
|---|---|
| **Hazard:** Earth Movement – Erosion |  |
| **Class:** Natural Hazard | |
| **Definition:** The wearing away and removal of soil particles by running water, waves, currents, moving, ice or wind. | |
| **Climate Change indicator:** Projected to increase both in frequency and consequence. | **Figure 14: Tuktoyaktuk** [76] |

**Mitigation Strategies:**

- Develop erosion hazard maps
- Limit development in areas with potential for significant erosion (e.g., by bylaw or resolution)
- Reinforce or relocate infrastructure in areas with potential for significant erosion

| **Type** | **Cause/Explanation** |
|---|---|
| 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. |
| 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. |
| **Vulnerability** | **Description** |
| People | Injuries or death could occur from riverbank collapse. |
| Infrastructure | Potential for damage to buildings, roads and other infrastructure. |
| Communications | Erosion along telecommunication cable corridors could expose fiber or other communication cables and lead to them being damaged or broken. |
| Environment | Erosion near pipelines, fuel storage areas and sewage lagoons could result in environmental spills impacting the environment. |
| | |

| **NWT Exposure/History** | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Tuktoyaktuk | Ongoing | Coastal erosion in Tuktoyaktuk has been threatening residents' homes for decades and several homes have been relocated as parts of the community are at risk of falling into |

[76] https://truenorthjournal.ca/2019/08/a-vanishing-land-tnpj-13/

| | | |
|---|---|---|
| | | the Arctic Ocean.[77] |
| Fort Simpson | June 2022 | Mayor expressed concern over a 500-metre section of riverbank undercut by the 2021 flood threatening a key roadway, the water intake line and Power Corporation facility.[78] |
| Norman Wells | April 2020 | Local government concerns over riverbank erosion led to a geotechnical investigation and study report recommending the development of a drainage plan to reduce erosion and flood risk.[79] |
| Dettah | March 2020 | At an NWT Association of Communities meeting, the issue of erosion impacting cemeteries was brought up identifying the Dettah cemetery as having issues with slumping and overcrowding. Representatives from Tuktoyaktuk, Fort McPherson and Tsiigehtchic also identified issues with their cemeteries related to climate change.[80] |
| Johnson River (between Wrigley and Tulita) | September 2017 | A very large landslide (250-300 metres wide by 300 to 400 metres long) blocked the waterway creating a lake.[81] |
| Paulatuk | December 2016 | A research study on Shoreline Change along the Hamlet of Paulatuk concluded that the coastline where the majority of the population reside, is vulnerable to a high rate of erosion. The report indicates that the built infrastructure is at risk to the near-term effects of climate change and many of the invaluable cultural and environmental histories of the Inuit people in this area are at risk.[82] |
| Fort McPherson | July 2015 | An unnamed lake held back by slumping gave way releasing roughly 30,000 cubic metres of water and debris.[83] |
| Fort Simpson | March 2015 | The village expressed concerns over riverbank erosion threatening roads, power lines, power plant and possibly the water treatment plant. A 2012 report indicated that solutions would cost tens of millions of dollars.[84] |
| Fort Resolution | July 2012 | An entire cabin vanished into a sinkhole. No injuries.[85] |
| Highway 5 – 164 kilometres from Fort Smith | May 2008 | A large section of the highway near the Nyarling River collapsed creating a crater-like hole about six meters wide and six meters deep. — large enough to swallow a car.[86] |
| | | |

[77] https://www.cbc.ca/newsinteractives/features/washing-away-tuktoyaktuk-shoreline-erosion#:~:text=Powerful%20storm%20waves%20and%20thawing,before%20it%20is%20washed%20away.
[78] https://www.cbc.ca/news/canada/north/fort-simpson-restricting-access-erosion-1.6486336
[79] https://www.iclr.org/wp-content/uploads/2022/12/03_NormanWells.pdf
[80] https://ca.news.yahoo.com/n-w-t-cemeteries-crisis-120000606.html
[81] https://www.cbc.ca/news/canada/north/climate-landslide-nwt-1.4563635
[82] The Eroding Hamlet of Paulatuk | Landsat Science (nasa.gov)
[83] https://blogs.agu.org/landslideblog/2015/12/14/fort-mcpherson-a-catastrophic-mudflow-in-canada/
[84] https://www.rcinet.ca/eye-on-the-arctic/2015/03/20/fort-simpson-wants-n-w-t-to-help-with-erosion-problem/
[85] https://www.cbc.ca/news/canada/north/cabin-consumed-by-sinkhole-near-n-w-t-community-1.1268357
[86] https://www.cbc.ca/news/canada/north/sinkhole-closes-n-w-t-highway-1.768087

**Erosion in the NWT**

Across the NWT, people have experienced losses from various earth movement hazards. Coastal erosion has been severe on NWT coastal areas, especially near Tuktoyaktuk where it has been a long-standing problem. Erosion is also problematic for communities along NWT river systems. In Tsiigehtchic, for example, riverbank erosion is threatening two churches and a cemetery. Sinkholes are also common in the South Slave and Sahtu regions and landslides pose a risk, especially along the Mackenzie Valley, where it was identified that there is an average of one landslide per 5 $km^2$. (Couture & Riopel, 2008).

**Climate Change Impacts**

The NWT is warming about four times the global rate which is causing significant changes in the natural environment. These changes include increasing permafrost thaw, greater coastal and river erosion, changing ice conditions and longer ice-free seasons, changes to water quality and quantity (Environment and Climate Change, n.d.). These changes are resulting in associated erosion impacts becoming more frequent and severe.

- Increased landslides are expected, with thawing of permafrost, reducing soil strength (Black, Bruce, & Egener, 2009).
- Significant flood events have become more common in the Mackenzie River valley due to changing precipitation patterns and spring run-off conditions (Government of the Northwest Territories, 2008).
- Extreme precipitation following a low but consistent rate of long-term permafrost warming can trigger thermokarst erosion[87] (Arctic Monitoring & Assessment Program, 2021).
- Excess water draining as permafrost thaws can also lead to subsidence, and excess water creating ponds or draining away (Canadian Standards Association, 2019).
- Disappearing ice and sea level rise, associated with climate change, is leading to more coastal erosion (Auld, et al., 2010) and coastal communities are increasingly vulnerable to erosion through wave and storm action (Arctic Monitoring & Assessment Program, 2021).

[87] The term thermokarst describes the processes and landforms that involve collapse of the land surface as a result of the melting of ground ice - https://nwtdiscoveryportal.enr.gov.nt.ca/geoportaldocuments/CIMP108-Advances%20in%20Thermokarst%20Research.pdf

### 4.3.9 Transportation Incident – Aircraft Incident

| | |
|---|---|
| **Hazard:** Transportation Incident – Aircraft Incident |  |
| **Class:** Human Caused | |
| **Definition:** 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. | |
| **Climate Change Indicator:** Undetermined. | **Figure 15: C-130J Hercules Aircraft used for SAR[88]** |

**Mitigation Strategies:**

- Promote aviation travel safety, education, and prevention programs
- Develop emergency response plans to allow for prompt response to aircraft accidents
- Participate in Airport Live Exercises led by the Department of Infrastructure

| Vulnerability | Description |
|---|---|
| People | Largest loss of life in one accident usually occurs on passenger flight accidents. Crashes in or near smaller communities with limited health care facilities/provisions can increase the risk of fatalities. |
| Infrastructure | Any accident which occurs on the runway can damage the runway and therefore may close down an airport making it challenging to access several communities in the NWT. |
| Environment | Environmental damage can occur from related fuel spills or hazardous materials being transported. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Fort Providence | November 2021 | Air Tindi DHC-6-300 Twin Otter with five on board from Yellowknife to Fort Simpson was forced to land on muskeg about 14 km from Fort Providence due to insufficient fuel and engine flame out. There were no fatalities or serious injuries.[89] |
| Fort Smith | July 2021 | A Northwestern Air Lease float plane rolled over while landing on a lake 30km northeast of Fort Smith. All five people on board were safe.[90] |

[88] https://skiesmag.com/news/j-model-hercules-now-flying-sar-mission-trenton/
[89] https://www.bst-tsb.gc.ca/eng/enquetes-investigations/aviation/2021/A21W0098/A21W0098.html
[90] https://cabinradio.ca/67501/news/south-slave/five-people-safe-after-float-plane-tips-northeast-of-fort-smith/#:~:text=%E2%80%9CThe%20aircraft%20subsequently%20nosed%20over,met%20the%20group%20to%20assist.

| | | |
|---|---|---|
| Hay River | May 2019 | A Buffalo Airways DC-3 aircraft from Hay River to Yellowknife was forced to make an emergency landing five nautical miles from Hay River due to a mechanical issue. Both pilots were safe.[91] |
| Sachs Harbour | February 2019 | A Ken Borek Airplane from Sachs Harbour to Inuvik was forced to return to Sachs Harbour and make an emergency landing due to an engine failure.[92] |
| Whatì | January 2019 | An Air Tindi charter flight from Whatì to Yellowknife went missing and was later located near Behchokǫ̀ by an RCAF Hercules as part of search efforts. The pilots were the only people on board and did not survive the crash.[93]<br>Fatalities: 2 |
| Little Doctor Lake | August 2018 | A Cessna 206 float plane lost control and crashed on Little Doctor Lake.[94]<br>Fatalities: 3 |
| Délı̨nę | September 2015 | A Buffalo Airways C-46 aircraft crashed while making an emergency landing due to mechanical issues. The plane was forced to land with no landing gear. All 4 personnel on board survived.[95] |
| Yellowknife | November 2014 | An Air Tindi Cessna 208B Grand Caravan conducted an emergency landing on the Great Slave Lake 40k west of Yellowknife due to icing conditions and incomplete weight and balance calculations (overweight). The six occupants were rescued.[96] |
| McClure Strait north of Banks Island | September 2013 | A helicopter operating with the Canadian Coast Guard research icebreaker Amundsen crashed into the Arctic Ocean.[97]<br>Fatalities: 3 |
| Hay River | August 2013 | A Buffalo DC-3 crashed shortly after takeoff when making an emergency landing and hit trees crashing 100 metres short of the runway. All 24 occupants were uninjured and the aircraft was damaged beyond repair.[98] |
| Pethei Peninsula along the coast of Great Slave Lake | October 2011 | An Air Tindi Cessna 208B from Yellowknife to Łutselk'e crashed 26 nautical miles west of Łutselk'e near the crest of Pehtei Peninsula.[99]<br>Fatalities: 2<br>Injuries: 2 |

[91] https://www.cbc.ca/news/canada/north/buffalo-airways-nwt-down-1.5121833
[92] https://www.cbc.ca/news/canada/north/kenn-borek-air-plane-makes-emergency-landing-in-sachs-harbour-n-w-t-1.5002544
[93] https://www.cbc.ca/news/canada/north/air-tindi-flight-incident-1.4999103
[94] https://globalnews.ca/tag/northwest-territories-plane-crash/
[95] https://www.cbc.ca/news/canada/north/buffalo-airways-plane-deline-1.3244335
[96] https://baaa-acro.sindev.ch/crash/crash-cessna-208b-grand-caravan-great-slave-lake
[97] Arctic coast guard helicopter crash kills 3 | CBC News
[98] https://baaa-acro.sindev.ch/crash/crash-douglas-dc-3c-yellowknife
[99] https://www.tsb.gc.ca/eng/rapports-reports/aviation/2011/a11w0151/a11w0151.html

| | | |
|---|---|---|
| Yellowknife | September 2011 | 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. [100]<br>Fatalities: 2<br>Injuries: 7 |
| Resolute (from Yellowknife) | August 2011 | First Air Flight 6560 crashed in a hill during cloudy conditions on landing at Resolute.[101]<br>Fatalities: 12<br>Injuries: 3 |
| Nahanni Butte | August 2009 | A Robinson R44 Raven II helicopter operated by Wild Water Hel-fishing Ltd. crashed while aborting a landing on a narrow ridge. The helicopter was destroyed.[102]<br>Fatalities: 2<br>Injuries: 1 |
| Doctor Lake (near Norman Wells) | May 2008 | A MDHI 39D helicopter operated by Sahtu Helicopters crashed due to an uncommanded rotation. [103]<br>Fatalities: 1<br>Injuries: 2 |
| Blatchford Lake (from Yellowknife) | January 2007 | An Arctic Sunwest Cessna 185 ski plane crashed on the frozen lake near Blatchford Lake Lodge on its way from Yellowknife. The Transportation Safety Board concluded it was caused by pilot error. [104]<br>Fatalities: 3<br>Injuries: 1 |
| Fort Good Hope | August 2006 | A North-Wright Airways Cessna 337C aircraft crashed 23 nautical miles east of Fort Good Hope. The pilot and five passengers sustained fatal injuries and the aircraft was destroyed.[105]<br>Fatalities: 6 |
| Taltson River | June 2004 | A Cessna A185F seaplane operated by Big River Air Ltd crashed on landing at a site called Ferguson's Cabin due to the left float digging in and left wing striking the water.[106]<br>Fatalities: 2<br>Injuries: 2 |

[100] https://www.tsb.gc.ca/eng/rapports-reports/aviation/2011/a11w0144/a11w0144.html
[101] https://en.wikipedia.org/wiki/First_Air_Flight_6560
[102] https://www.tsb.gc.ca/eng/rapports-reports/aviation/2009/a09w0146/a09w0146.html
[103] https://www.tsb.gc.ca/eng/rapports-reports/aviation/2008/a08w0096/a08w0096.html
[104] https://www.cbc.ca/news/canada/north/pilot-error-caused-fatal-n-w-t-crash-investigators-1.751518
[105] https://www.tsb-bst.gc.ca/eng/rapports-reports/aviation/2006/a06w0139/a06w0139.html
[106] https://www.tsb.gc.ca/eng/rapports-reports/aviation/2004/a04w0114/a04w0114.html

**NWT Air Transportation**

The Department of Infrastructure is responsible for the operation and maintenance of 27 airports across the territories. To ensure the safety and security of air travel in the NWT it uses a Safety Management System including incident reporting, airport maintenance training, airport full-scale emergency exercises, and conducts quality assurance audits.

Inclement weather is a contributing factor to many aviation accidents. While pilots and airlines monitor weather conditions and avoid patches of bad weather or refrain from flying in extreme weather conditions, weather can often be unpredictable. The NWT regularly experiences several aviation weather hazards including icing, poor visibility, wind shear and turbulence, weather fronts and thunderstorms. Air transportation infrastructure may be impacted by permafrost melting, flooding, and extreme weather. On average, the NWT experiences one or two aviation incidents per year.

**Climate Change Impacts**

The expected impacts of climate change on aviation result from changes in temperature, precipitation (rain and snow), storm patterns, sea level and wind patterns. Consequences for aviation include reduced aircraft performance, changing demand patterns, potential damage to infrastructure, loss of capacity and schedule disruption (CAPA - Centre for Aviation, 2019). An EUROCONTROL study on climate change risks for European aviation indicates climate change will pose a significant and increasing risk to aviation in the years ahead and that climate change impacts are emerging faster than expected (EUROCONTROL, 2021). However, this increasing risk is somewhat offset by advances in technology and improved safety systems. The rate of fatal accidents and aircraft losses is steadily decreasing over time and accident rates are further reduced with the introduction of new technologies that helped to reduce accident rates for each generation of aircraft (AIRBUS, 2023).

### 4.3.10 Snow Load Hazard

| | |
|---|---|
| **Hazard:** Snow Load Hazard |  |
| **Class:** Natural Hazard | **Figure 16: Good Building Practice for Northern Facilities**[107] |
| **Definition:** Structural Failure, building collapse as a result of significant amounts of snow. 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. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | |

**Mitigation Strategies:**

- Assess critical infrastructure against current snow load building parameters and projected snow load risk
- Develop snow removal thresholds and plans
- Ensure future building designs incorporate climate change projected snow accumulation factors

| Vulnerability | Description |
|---|---|
| People | High numbers of injuries or fatalities 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 communications. |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Enterprise | January 2013 | The roof of an Enterprise community government garage collapsed under the weight of snow.[108] |
| Inuvik | May 2004 | Samuel Hearne Secondary School roof of the foyer collapsed caused by a record-breaking build-up of snow. Due to the timing of the event, no one was hurt in the collapse.[109] |

[107] https://www.inf.gov.nt.ca/sites/inf/files/resources/3789-gnwt_infrastructure-good_practises_manual_april07_web.pdf
[108] Information from NWT EMO files.
[109] https://nnsl-archive.blackpress.ca/nnsl/2004-05/may7_04roof.html

**NWT Snow Load**

The National Building Code of Canada was updated to a 2015 edition that includes updated calculations on the basic roof snow load factor, specific weight of snow, calculation of the accumulation factor, and the calculation for loads due to sliding snow (Government of Canada, 2019). While this helps ensure construction using the 2015 codes are able to handle expected snow loads, many legacy buildings across the NWT are not built to that standard.

In 2020-2021, the GNWT undertook an assessment to evaluate the impacts of climate change on NWT community infrastructure with Snow Load one of the risk factors being assessed. The report identified that increased precipitation as snow and /or changes to precipitation (i.e., wetter snow) have the potential to affect all assets with building structures, as an increase in snow load beyond design codes implies a greater risk for roof collapse. The report recommended that the GNWT (Government of the Northwest Territories, 2021):

- Adopt policy where all infrastructure and retrofit projects have a detailed climate risk assessment completed at the design phase and owner signs off on accepted level of risk.
- Develop a safe snow removal plan for roofs of infrastructure buildings (refer to CSA S502:14 Managing Changing Snow Load Risks for Buildings in Canada's North).
- Consult with CSAS505:20 Techniques for considering high winds and snow drifting and their impact on northern infrastructure when assessing options for reducing the risk of damage.

**Climate Change Impacts**

Climate change predictions for the NWT include increased snowpacks, earlier melting, warmer winter temperatures, rain on snow events and increased rainfalls.

- An increase in freezing rain events following snowfall events will increase the load on roof structures, which could lead to collapses (Government of the Northwest Territories, 2021).
- Rainfall may occur in the winter months triggering rain-on-snow events or freezing rain conditions. A study on rain-on-snow events over North America indicated current and future simulations suggest general increases in rain-on-snow events during the November–March period for most regions of Canada due to an increase in the rainfall frequency with warmer air temperatures in future (Il Jeong, 2017).
- Since the 1950s, precipitation has increased by 25 to 35% (Canadian Standards Association, 2019). Total annual precipitation in the Arctic (rain and snow combined) increased by more than 9% from 1971 to 2019, based on a combination of observed and modeled data. Rainfall increased by 24% during that period (Arctic Monitoring & Assessment Program, 2021).
- The snow/rain mix is changing due to warmer temperatures, and results in a heavier wetter snow thus higher snow load (Pryor & Cobb, 2007, p. 2).

## 4.4 Low Risk Category

### 4.4.1 Earth Movement – Permafrost Degradation

| | |
|---|---|
| **Hazard:** Earth Movement – Permafrost Degradation |  **Figure 17: Permafrost slump/loss** [110] |
| **Class:** Natural Hazard | |
| **Definition**: Movement of the ground due to loss of permafrost.<br><br>Permafrost soils lose strength as they warm increasing the risk of mass movements of land, such as erosion, landslides and riverbank collapse. It can also result in heaving, slope failure, sink holes and potholes. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | |

**Mitigation Strategies:**

- Implement maintenance programs to improve the life of infrastructure (e.g. snow maintenance program to insulate permafrost around buildings in spring)
- Increase monitoring of permafrost and hydrological conditions near critical infrastructure
- Increase emergency preparedness in high-risk areas
- Adapt zoning and land-use to limit or restrict development in high-risk areas.
- Develop permafrost risk maps

| Vulnerability | Description |
|---|---|
| People | Injury and fatalities could result from the unexpected collapse of land or a building. |
| Infrastructure | Infrastructure systems in permafrost depend on the stability of permafrost as a foundation material. Permafrost degradation can affect all forms of infrastructure. |
| Communications | Possible damage to communication infrastructure. |
| Environmental | Thawing permafrost can release contaminants, such as mercury, that can make their way into aquatic ecosystems. It can also impact pipelines, fuel storage areas and other hazardous materials storage and transportation systems. |

[110] https://www.cbc.ca/news/canada/north/permafrost-thaw-nwt-yukon-heat-wave-1.6086518

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Tuktoyaktuk | ongoing | As global temperatures rise, the coastline at Tuktoyaktuk retreats further inland. Coastal erosion in Tuktoyaktuk has been threatening residents' homes for decades and several homes have been relocated as parts of the community are at risk of falling into the Arctic Ocean.[111] |
| Yellowknife | January 2023 | Continued problems with settling in an area of the Yellowknife airport runway prompted the GNWT to commission a geotechnical study to investigate and determine long term solutions. The issue is thought to be shifting ground conditions brought on by thawing permafrost.[112] |
| Sachs Harbour | 2019 | Thaw slumps, or landslides caused by the melting of ice in the permafrost, have increased on the Northwest Territory's Banks Island from about 60 active slumps in 1984 to more than 4,000 in 2013 (Wright, 2019). |
| Inuvik | 2018 | Town pool was shut down for more than eight months due to leaks caused by shifting ground associated with permafrost lost.[113] |
| Inuvik | April 2017 | The Mayor expressed concern over a number of buildings in the town being demolished because of foundation problems due to permafrost melting.[114] |
| Fort McPherson | July 2015 | Major slumping due to permafrost loss resulted in an unnamed lake releasing roughly 30,000 cubic metres of water and debris.[115] |
| | | |

**NWT Permafrost History**

Throughout the NWT much of the infrastructure has been constructed in permafrost rich areas. 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. Permafrost erosion along streams and rivers is threatening dikes, bridges, and culverts. Slope failures, in communities such as Sachs Harbour, are becoming unmistakable (Government of the Northwest Territories, 2008).

For all types of civil and municipal, building and energy infrastructure across the NWT, permafrost degradation or thaw or an increase in the frequency of freeze-thaw cycles may lead to soil and slope instability, soil subsidence, and ground movement. Thawing permafrost may also alter the regional hydrogeology (Government of the Northwest Territories, 2021).

[111] https://www.cbc.ca/news/canada/north/tuktoyaktuk-climate-change-fenderal-funding-1.5644810#:~:text=Coastal%20erosion%20in%20Tuktoyaktuk%20has,amid%20the%20COVID%2D19%20pandemic.
[112] https://cabinradio.ca/118825/news/yellowknife/yellowknife-airport-seeks-engineers-to-probe-runway-issues/
[113] https://www.cbc.ca/news/canada/north/inuvik-pool-outlook-1.6168628
[114] https://www.cbc.ca/news/canada/north/it-scares-me-permafrost-thaw-in-canadian-arctic-sign-of-global-trend-1.4069173
[115] https://blogs.agu.org/landslideblog/2015/12/14/fort-mcpherson-a-catastrophic-mudflow-in-canada/

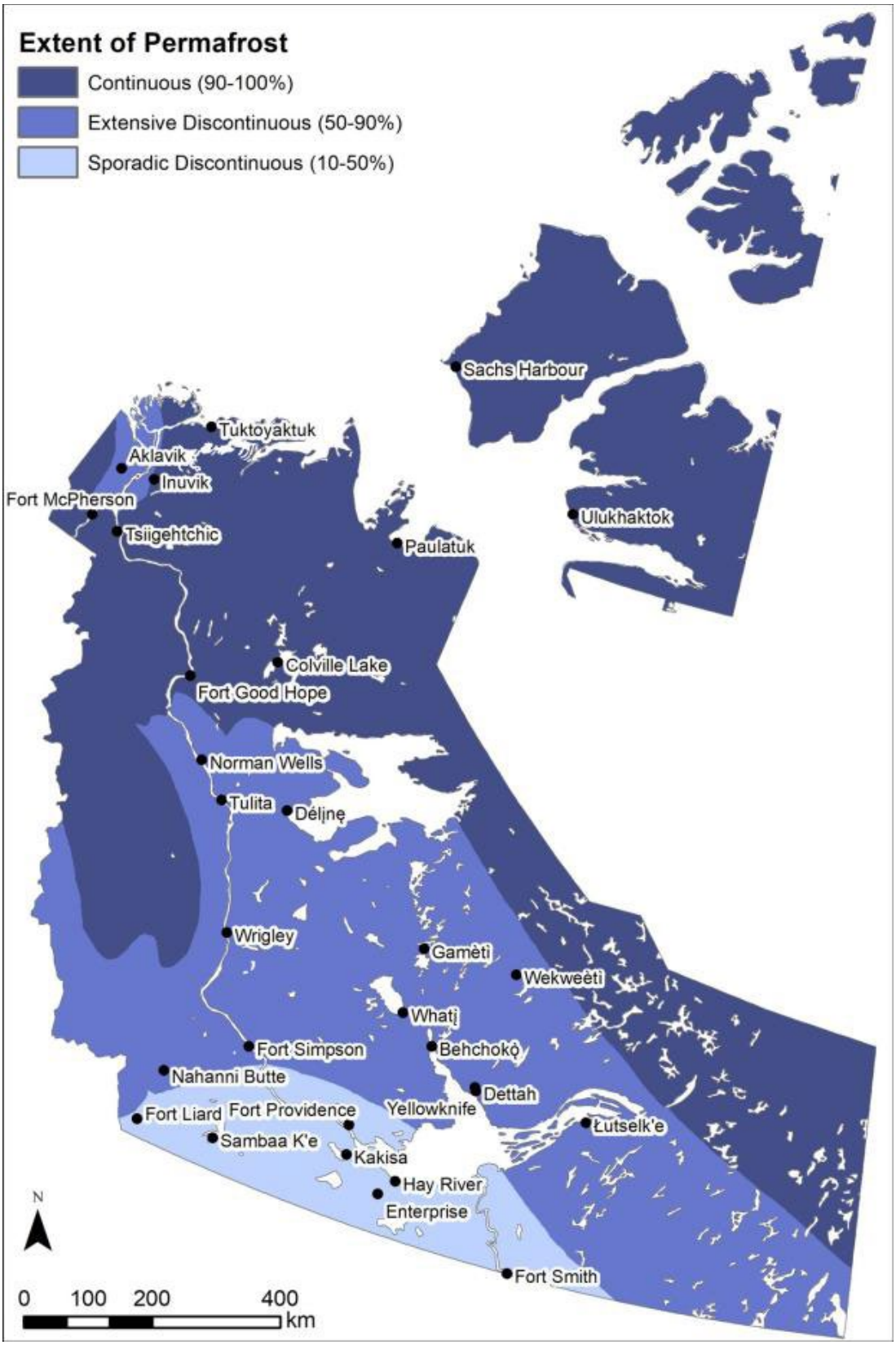



**Figure 18: Map of permafrost distribution in the Northwest Territories (Environment and Climate Change, 2022)**

**Climate Change Impacts**

Global warming is the main factor driving the deterioration and thaw of permafrost and the NWT is warming about four times the global rate (Environment and Climate Change, n.d.). A Government of the Northwest Territories Assessment of Climate Change Impacts on Infrastructure in all NWT Communities (2021) report concluded that:

- The interaction of temperature-induced permafrost thaw on water treatment plants and sewage lagoons was identified as high risk in Beaufort Delta.
- The interaction of temperature-induced permafrost thaw on schools, hospitals, fire stations, fuel storage facilities and tank farms, and fuel resupply and shoreline manifolds, were also identified as high risk in the Sahtu and Beaufort Delta regions.
- Temperature-induced permafrost thaw was identified as moderate-high risk for all infrastructure except street signs, stormwater sewer mains, and drinking water wells in at least one region of the NWT. and
- Cumulative rain-induced permafrost thaw was also identified as moderate-high risk for schools, hospitals, fire stations, fuel storage facilities and tank farms, power plants, and fuel resupply and shoreline manifolds in at least one region (Government of the Northwest Territories, 2021).

### 4.4.2 Critical Services - Water Services Interruption

| | |
|---|---|
| **Hazard:** Critical Services – Water Services Interruption |  |
| **Class:** Human Caused | |
| **Definition:** A deficit, interruption contamination or failure of water systems, services, supplies or resources. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | **Figure 19: Water Treatment Plant - Łutselk'e September 2012 (Source: GNWT, MACA)** |

**Mitigation Strategies:**

- Develop and maintain essential services continuity plans
- Adhere to all testing and maintenance schedules for water treatment plan and related infrastructure
- Ensure alternative water source/supply available in case of interruption (e.g., bottled water supply)
- Ensure adequate sewage removal/treatment capacity

| Vulnerability | Description |
|---|---|
| People | Interruption of critical services can have adverse health effects and disruption to NWT residents. |
| Infrastructure | Disasters that destroy infrastructure may result in water contamination and the contamination of water distribution systems. |

| NWT Exposure/History[116] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Yellowknife | September 2022 | The City was forced to draw water from Yellowknife Bay (close to Giant Mine contaminated site) instead of the Yellowknife River due to a failure between the Yellowknife River pumphouse and the water treatment plant caused by multiple power outages.[117] |
| Kakisa | May 2022 | Boil Water Advisory issued as water supply was from Hay River which was under evacuation due to flooding. |
| Behchokǫ̀ (Edzo) | January 2022 | A water pump failed resulting in many buried lines bursting and leaving about 50 homes without water for a month.[118] |

[116] Boil Water Advisory information from Health and Social Services website at https://www.hss.gov.nt.ca/en/services/boil-water-advisories/past-boil-water-advisories
[117] https://cabinradio.ca/104985/news/yellowknife/power-outages-caused-yellowknife-water-issue-city-says/
[118] https://www.cbc.ca/news/canada/north/edzo-residents-water-1.6357687

| | | |
|---|---|---|
| Behchokǫ̀ | June 2021 | Boil Water Advisory due to a mechanical issue at the community's water treatment plant that resulted in turbidity in the water. |
| Fort Providence | December 2021 | The intake pump that delivers water to the water treatment plant broke down. For more than a week, residents were asked to conserve water and water was brought in from Hay River. An old fire truck was used to pump water as in interim measure.[119] |
| Łutselk'e | January 2018 | Boil Water Advisory due to delivery of unchlorinated water to residents. |
| Tulita | May 2016 | Boil Water Advisory due to high turbidity levels combined with issues with the chlorine disinfection systems. |
| Délı̨nę | August 2015 | Boil Water Advisory due to the presence of fecal coliforms in the water. |
| Inuvik | July 2012 | Boil Water Advisory due to high turbidity and problems with maintaining correct chlorine levels. |
| Tulita | July 2011 | Boil Water Advisory for 13 days due to bacterial and chlorine issues.[120] |
| Sachs Harbour | June 2011 | Boil Water Advisory due to high turbidity and problems with the treatment plant's water intake. The advisory was in place for five months. |
| Paulatuk | August 2007 | Boil Water Advisory due to the presence of fecal coliforms in the water. |
| Colville Lake | 2004 | Under a Boil Water Advisory for more than 14 years as community failed to submit required water samples and residents prefer not to use chlorinated water.[121] |
| | | |

**Drinking Water in the NWT**

In the NWT there are a total of 34 public drinking water systems. 27 of these systems draw water from rivers or lakes, four draw water from underground wells, and three communities' truck in treated water for another NWT community. Yellowknife, Inuvik, Hay River, Norman Wells, Fort Smith, and Fort Simpson use piped water systems while most smaller communities use trucks to deliver drinking water to residents (Ripley, 2009).

Safe drinking water in the NWT is a shared responsibility between territorial and community governments. The Government of the Northwest Territories has public health legislation that regulates 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 (Municipal and Community Affairs, n.d.).

[119] https://ca.style.yahoo.com/fire-truck-thats-keeping-n-140000805.html
[120] https://www.gov.nt.ca/fr/newsroom/tulita-boil-water-advisory-rescinded
[121] https://www.cbc.ca/news/canada/north/colville-lake-water-supply-1.4590709

Community governments have the authority and responsibility under Territorial legislation 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*, submitting 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 (Municipal and Community Affairs, n.d.).

**Climate Change Impacts**

Climate change may impact community water and wastewater treatment systems in a number of different ways (Ripley, 2009):

- Source water quality may be affected by increased turbidity and changes in concentrations of organic compounds, inorganic minerals, and trace metals such as mercury and arsenic.
- A potential positive impact of climate change is that it may increase the biological treatment season, which could improve wastewater effluent quality.
- Changing permafrost conditions may increase maintenance and construction requirements, and costs for water and wastewater infrastructure including cisterns, pipes, buildings, and roads.
- Permafrost melting may also alter hydrological conditions around wastewater lagoons and in wetlands used for wastewater treatment which could increase the impacts that wastewater effluent has on the surrounding environment.
- Permafrost melt may alter leachate flow from solid waste facilities, which could change the pathway of contaminants into nearby freshwater ecosystems and wastewater treatment facilities.

### 4.4.3 Hazardous Materials – Explosion

| | |
|---|---|
| **Hazard:** Hazardous Materials – Explosion |  |
| **Class:** Human Caused | |
| **Definition:** Ignition of a flammable substance resulting in instantaneous combustion. | |
| **Climate Change Indicator:** Projected to increase in both frequency and consequence. | **Figure 20: Aftermath of an Explosion at industrial building in Inuvik** [122] |

**Mitigation Strategies:**

- Adhere to safety and storage requirements for all explosive products
- Ensure land-use planning identifies appropriate low-risk locations for property with an increased risk of explosions
- Ensure emergency response agencies are trained and equipped for potential explosion incidents

| Vulnerability | Description |
|---|---|
| People | High injury and fatality potential from the immediate impact of the blast as well as an increase in 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. |
| Communications | Any existing power lines and communications cables can be damaged and destroyed by explosion cutting off communication links. |
| Environment | Explosions at fuel storage areas, pipelines or industrial facilities could lead to environmental damage. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Yellowknife | December 2022 | House destroyed by explosion. Propane was found to be a factor.[123] |
| Hay River | November 2022 | House destroyed by explosion, injuring 2 residents, and damaging multiple homes. Propane was found to be a factor.[124] |

[122] https://www.cbc.ca/news/canada/north/inuvik-explosion-bobs-welding-1.5055301
[123] https://www.cbc.ca/news/canada/north/hay-river-explosion-fire-marshal-yellowknife-no-cause-1.6679749
[124] https://cabinradio.ca/110458/news/south-slave/hay-river/two-injured-and-homes-damaged-in-hay-river-explosion-update/

| | | |
|---|---|---|
| Inuvik | March 2019 | Explosion at industrial building. The explosion occurred while a welder was working on a fuel tank.[125] |
| | | |

**NWT Context**

While there are a wide range of legislation governing the use, transportation and storage of dangerous goods in Canada, there is are relatively large quantities of dangerous goods stored, transported and use in the NWT on a daily basis. This relates to fuel resupply and storage in most communities, explosives used in construction, materials and fuel used in mining including supply of diamond mines, and industrial activity related to oil and gas development and extraction.

**Climate Change Impacts**

A GNWT Assessment of Climate Change Impacts on Infrastructure in all NWT Communities identifies a number of risks and concerns that could cause or result in explosions (Government of the Northwest Territories, 2021):

- Snow load is a major concern for buildings;
- Fuel storage facilities and tank farms and fuel resupply and shoreline manifolds were identified as high risk at the territorial scale;
- All energy infrastructure was identified as moderate-high risk at the territorial scale;
- Permafrost thaw was identified as high risk for fuel storage facilities and tank farms, and fuel resupply and shoreline manifolds in Sahtu and Beaufort Delta;
- Cumulative rain-induced permafrost thaw was also identified as moderate-high risk for fuel storage facilities and tank farms, power plants, and fuel resupply and shoreline manifolds in at least one region.
- Permafrost thaw could seriously damage energy infrastructure with the potential for loss of infrastructure function and fuel spills.
- Wildfires were identified as moderate-high risk for fuel storage facilities and tank farms, power plants, solar farms, power poles, and fuel resupply and shoreline manifolds.
- Wildfires could seriously damage energy infrastructure due to the potential for loss of infrastructure and explosion.
- Sea level rise, stronger storm surges, higher tides and coastal erosion were identified as moderate-high risk for fuel storage facilities and tank farms, power plants, and fuel resupply and shoreline manifolds in Beaufort Delta,
- fluvial flooding was identified as moderate-high risk for fuel storage facilities and tank farms in Beaufort Delta due to the potential for loss of infrastructure function.
- A moderate-high risk from snowstorms to fuel resupply and shoreline manifolds due to possible delayed distribution of fuel to communities and accidents leading to fuel spills.
- Extreme precipitation was also identified as moderate-high risk for fuel storage facilities and tank farms as it could impact the containment capacity of the infrastructure, which would subsequently reduce a level of safety in the event of a fuel spill.

[125] https://www.cbc.ca/news/canada/north/inuvik-explosion-bobs-welding-1.5055301

### 4.4.4 Public Safety – Cyber Security

| | |
|---|---|
| **Hazard:** Public Safety – Cyber Security |  |
| **Class:** Human Caused | **Figure 21: Cyber Security**[126] |
| **Definition:** The protection of digital information, as well as the integrity of the infrastructure housing and transmitting digital information. More specifically, cyber security includes the body of technologies, processes, practices and response and mitigation measures designed to protect networks, computers, programs and data from attack, damage or unauthorized access so as to ensure confidentiality, integrity and availability.[127] | |
| **Climate Change Indicator:** Undetermined. | |

**Mitigation Strategies:**

- Implement cyber security awareness training programs
- Ensure all computer systems have updated software, anti-virus software and data backup
- Develop policies and guidelines for use of computers and mobile devices
- Consider government and other Cyber Security protocols/advice

| Type | Cause/Explanation |
|---|---|
| Cyber Attack | The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device. |
| Denial-of-Service Attack | Any activity that makes a service unavailable for use by legitimate users, or that delays system operations and functions. |
| Malware | Malicious software designed to infiltrate or damage a computer system, without the owner's consent. Common forms of malware include computer viruses, worms, Trojans, spyware, and adware. |
| Phishing | An attempt by a third party to solicit confidential information from an individual, group, or organization by mimicking or spoofing a specific, usually well-known brand, usually for financial gain. Phishers attempt to trick users into disclosing personal data, such as credit card numbers, online banking credentials, and other sensitive information, which they may then use to commit fraudulent acts. |
| Ransomware | A type of malware that denies a user's access to a system or data until a sum of money is paid. |

[126] https://www.fin.gov.nt.ca/en/services/cyber-security
[127] Definitions from the Canadian Centre for Cyber Security at https://www.cyber.gc.ca/en/glossary

| Vulnerability | Description |
|---|---|
| People | Phishing, denial of service and other cyber security threats can impact people in several ways for example: by exposing sensitive personal information, defrauding people, or preventing access to vital information in critical times, all which could have cascading effects on people. |
| Infrastructure | Cyber security attacks on critical infrastructure or other connected components can lead to the failures of those components that impacts the management, monitoring, or controls within the infrastructure (e.g., banking, electrical generation, health/hospital records) |
| Communications | Cyber security attacks on communications systems could lead to the failure of those systems prevent urgent or life critical communications, remote monitoring of infrastructure components for hazardous materials, etc. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Yellowknife | November 2022 | The GNWT indicated that it spent $716,000 to address a cyberattack that occurred in November. Few details were released due to confidentiality reasons.[128] |
| Yellowknife | April 2020 | Northwest Territories Power Corporation's (NTPC) website was hit with a ransomware cyber-attack.[129] |
| Nunavut | November 2019 | The GNWT blocked all emails from the Government of Nunavut after a ransomware attacked knocked out Nunavut government services.[130] |

**NWT Cyber Security**

The GNWT provides cyber security information and guidance to the public on protecting your identity, use of anti-virus software, installing the latest operating system updates, backing up your files, protecting your wireless network, deleting emails from unknown senders, surfing the web safely and how to get help when needed. It also requires all government employees to take mandatory Information Security Awareness Training (Finance, n.d.).

**Climate Change Impacts**

While cyber security threats have no direct link to climate change, they are a complicating factor that could lead to cascading events during a climate change induced disaster.

[128] https://www.cbc.ca/news/canada/north/n-w-t-gov-t-spent-716-000-to-address-cybersecurity-breach-1.6807899
[129] https://www.insurancebusinessmag.com/ca/news/cyber/energy-companys-website-takes-ransomware-hit-from-unknown-hackers-221492.aspx
[130] GNWT blocks Government of Nunavut emails after cyber attack (nnsl.com)

### 4.4.5 Animal Disease

| | |
|---|---|
| **Hazard:** Animal Disease<br>**Class:** Natural Hazard<br>**Definition:** Diseases with the potential to spread between animals and sometimes to humans.<br><br>**Climate Change Indicator:** Undetermined. |  <br>**Figure 22: Anthrax outbreak in the NWT (2012)** [131] |
| **Mitigation Strategies:**<br>• Promote awareness of animal diseases in the NWT and how to protect yourself<br>• Report all suspected serious disease (Tuberculosis, Anthrax, Brucellosis, Chronic Wasting Disease, Erysipelas, and Rabies) animals to the local Renewable Resource Officer | |

| **Type** | **Cause/Explanation**[132] |
|---|---|
| Tuberculosis | Tuberculosis is caused by bacteria (Mycobacterium bovis and M. avium) and is spread by direct contact with material coughed up by infected animals and birds. You can get tuberculosis by eating contaminated meat that has not been cooked well or by inhaling bacteria from open wounds, droppings or discharge from the nose and mouth of infected animals. |
| Anthrax | Anthrax is a disease caused by the bacterium Bacillus anthracis. It is generally a disease of ungulates (hoofed animals), where it is usually rapidly fatal. Anthrax can infect any mammal, but in the NWT, it occurs almost exclusively in bison. You can get anthrax through contact with infected animals, and especially through fluids that leak from carcasses. |
| Brucellosis | Brucellosis is a highly contagious disease caused by bacteria called Brucella suis type 4 (in caribou, reindeer) and Brucella abortus (in bison). Brucella suis has also been seen in muskoxen and moose. It is spread in the afterbirth and fluids during calving. You can get brucellosis through exposure to contaminated parts. |
| Rabies | Rabies is caused by a virus spreading in the saliva of infected animals. All warm-blooded mammals and birds can be infected. You can get rabies if you are bitten or licked by an infected animal or if saliva from an infected animal comes into contact with your skin, eyes, nose, lips, cuts or scratches. |

[131] https://www.enr.gov.nt.ca/en/services/wildlife-diseases
[132] Animal disease information taken from A Field Guide to Common Wildlife Diseases and Parasites in the Northwest Territories at https://www.gov.nt.ca/sites/ecc/files/field_guide_wildlife_diseases.pdf

| Vulnerability | Description |
|---|---|
| People | Animal diseases can pose a serious threat to human health because of our consumption of a range of animal species for food and the risk of infection from a virus or disease carried by an animal. |
| Environment | Animal disease could impact animal populations reducing available resources for food and traditional harvesting. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Slave River Lowlands (between Fort Smith and Fort Resolution | July 2023 | Environment and Climate Change reported 27 bison found dead due to an anthrax outbreak.[133] |
| Near Fort Providence | August 2012 | Wildlife officials report approximately 340 bison died due to an anthrax outbreak. The last big outbreak in 1994 affected 172 animals.[134] |
| Slave River Lowlands (between Fort Smith and Fort Resolution | July 2006 | Anthrax outbreak in the Slave River Lowlands with 28 bison carcasses found.[135] |

**NWT Wildlife**

Although most wild animals in the NWT are healthy, diseases and parasites can occur in any wildlife population. Some of these diseases can infect people or domestic animals. In order to regularly monitor and assess diseases in wildlife populations to reduce their impact on healthy animals and people, the department of Environment and Climate Change produces a Field Guide to Common Wildlife Diseases and Parasites in the NWT. This field guide is to help hunters recognize sickness in animals before they shoot, identify a disease or parasite in an animal they have killed, know how to protect themselves from infection, and help wildlife agencies monitor wildlife disease and parasites (Government of the Northwest Territories, 2017).

NWT animal diseases that can infect humans include Tuberculosis, Anthrax, Brucellosis and Rabies. In the past there have been major outbreaks of Anthrax in the Bison population in the Mackenzie, Slave River Lowlands, and Nahanni herds (Environment and Climate Change, 2023). Anthrax is a federally and territorially reportable disease, requiring timely reporting and appropriate management after detection and diagnosis. Environment and Climate Change maintains an Anthrax Emergency Response Plan to ensure a rapid and effective response should an outbreak occur in bison populations managed by the

[133] https://www.cbc.ca/news/canada/north/bison-outbreak-grows-2023-1.6900656#:~:text=N.W.T.-,bison%20anthrax%20outbreak%20grows%20to%2027%20dead%20animals,12%20have%20since%20been%20found.
[134] https://www.cbc.ca/news/canada/north/n-w-t-bison-anthrax-outbreak-largest-ever-in-territory-1.1238010
[135] https://www.researchgate.net/publication/6494345_Northwest_Territories_An_outbreak_of_anthrax_Bacillus_anthracis_in_free-roaming_bison_in_the_Northwest_Territories_June-July_2006

GNWT. The overall objectives of the plan are to reduce the size and impact of anthrax outbreaks in wood bison and reduce the risk of public exposure.

**Climate Change Impacts**

Infectious disease outbreaks among wildlife have surged in recent decades alongside global climate change. However, the circumstances under which climate change is most likely to promote or inhibit infectious disease remain unknown (Cohen JM, 2020):

- Researchers know little about how climate change will alter disease risk across hosts and parasites with diverse life history traits;
- Not all parasites will be affected by climate change, but it remains unclear how the relative risk of disease caused by bacteria, viruses, fungi, and helminths is changing;
- impacts of temperature abnormalities and variability, rather than increasing mean temperatures alone, remain largely unexplored; and
- It is not clear which regions of the globe may become more amenable to disease and which may become less suitable.

In the NWT the impacts of climate change on wildlife are not immediately obvious, but because of the changes in ecosystem conditions that are known to be occurring, effects on wildlife are expected in the longer-term. Some of the noted changes include (Government of the Northwest Territories, 2008):

- There has been an increased incidence of some southern species in the NWT, including magpie, skunk, coyote, white-tailed deer, elk, cougar, raccoon, salmon and some insect species;
- New species have brought new diseases and parasites that might become established in resident wildlife species;
- There have been observed changes in the types of parasites and their distribution as well as the frequency, intensity and rate of development of infections;
- A decrease in the number of days per year in which sea ice covered the continental shelf coastline has been linked to decreases in the height and weight of cub and male polar bears in the southern Beaufort Sea polar bear population; and
- There is increasing evidence that the timing of insect hatch is shifting, so that some bird species are arriving on their Northern breeding grounds too late to take advantage of the peak in insects. Over time this will probably lead to population declines for ducks, geese, and shorebirds.

### 4.4.6 Public Safety – Social Action

| | |
|---|---|
| **Hazard:** Social Action<br>**Class:** Human Caused<br>**Definition:** Social action is a gathering of a group of like-minded people at a designated location and at a specified time to make demands, show strong disapproval or disagreement, or perform an indicated action such as a sit-in, protest (demonstrations), or blockade; these actions may or may not be reinforced with non-violent action or civil disobedience.<br>**Climate Change Indicator:** Undetermined. |  <br>**Figure 23: Covid 19 Protest**[136] |

**Mitigation Strategies:**

- Maintain awareness of Social Action activities
- Work cooperatively with social groups to ensure safety-oriented planning for social demonstrations
- Consider business continuity plans for potential work interruptions

| Type | Cause/Explanation |
|---|---|
| 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 | Social action may directly or indirectly impact the safety and security of individuals or groups of persons whether they are targeted by or involved in a gathering. There is also a threat of injury to public responders and those persons involved in the gathering. |
| Infrastructure | Damage to public and private property can occur where the gathering or elements within the gathering turn to violent actions. |
| Communications | Social action that turns into riots or terrorism can impact communications which disrupt public authorities' ability to |

[136] https://www.cbc.ca/news/canada/north/around-40-yellowknife-residents-gather-in-30-c-to-protest-public-health-measures-1.6324411

| | |
|---|---|
| | deal with the incident. |
| Environment | Social action can result in damage or willful acts to oil and gas, and other infrastructure resulting in spills and other environmental damage. |
| | |

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Yellowknife | April 2023 | Federal workers picketed in front of the Greenstone building as part of a nationwide strike by the Public Service Alliance of Canada. Delays at RCMP front desks, disruption to tax returns and passport services, and reduced service from Indigenous Services Canada were some of the most readily felt effects in the North.[137] |
| Yellowknife | February 2023 | Unionized City of Yellowknife workers went on strike and set up picket lines at various city locations. A court injunction was issued to limit their strike action to allow reasonable public access to facilities.[138] |
| Yellowknife | January 2022 | Close to 70 people joined what was dubbed a Freedom Convoy in Yellowknife to protest government-mandated COVID-19 vaccinations.[139] |
| Yellowknife | June 2020 | Hundreds of people turned out for a Black Lives Matter solidarity march and motorcade through the downtown city core.[140] |
| Yellowknife | September 2019 | Several hundred students and adults conducted a march through downtown Yellowknife and noon-hour protest at Somba K'e Plaza as part of a world-wide protest to denounce a lack of action on climate change.[141] |
| Fort Providence | January 2013 | About 150 Idle No More activists blocked traffic across the NWT's Dehcho Bridge on a Saturday afternoon for about 40 minutes.[142] |
| Yellowknife | December 2012 | 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.[143] |
| | | |

[137] https://cabinradio.ca/126613/news/yellowknife/federal-picket-line-begins-outside-yellowknifes-greenstone-building/
[138] https://nationalpost.com/pmn/news-pmn/canada-news-pmn/yellowknife-says-union-left-bargaining-monday-without-responding-to-latest-offer
[139] https://www.nnsl.com/news/trudeau-has-got-to-go-yellowknife-freedom-convoy-protests-at-city-hall/
[140] https://cabinradio.ca/38875/news/yellowknife/black-lives-matter-protest-draws-hundreds-in-yellowknife/
[141] https://cklbradio.com/2019/09/28/hundreds-turn-out-for-climate-change-march-and-protest-in-yellowknife/
[142] https://www.cbc.ca/news/canada/north/idle-no-more-activists-blocked-deh-cho-bridge-1.1359813
[143] https://www.cbc.ca/news/canada/north/idle-no-more-protests-held-in-north-1.1136370

**NWT Social Action**

Social action related to a wide variety of national and international causes, and union activities have taken place in the NWT with little concern over public safety or criminal action. The 1992 Giant Mine strike and resulting disaster is the most recent event of notable concern in the NWT.

**Climate Change Impacts**

While social action activities have no direct link to climate change, some protests and actions in the NWT have taken place raising concern over climate change inaction. As climate change impacts become more of an issue, we can likely expect more similar activities.

## 4.5 Negligible Risk Category

### 4.5.1 Earth Movement – Earthquake

| | |
|---|---|
| **Hazard:** Earth Movement - Earthquake<br>**Class:** Natural Hazard<br>**Definition:** Violent shaking of the earth's surface.<br><br>**Climate Change Indicator:** Undetermined. |  <br>**Figure 24: Rock avalanche triggered by October 5, 1985 Nahanni earthquake[144]** |
| **Mitigation Strategies:**<br>• Ensure building/engineering standards with earthquake parameters are in place for earthquake prone areas<br>• Consider using ShakeOut (https://www.shakeout.org/) resources for developing safety and awareness programs<br>• Plan and communicate "safe areas" for community members to go to in the event of an earthquake or tsunami. | |
| **Type** | **Cause/Explanation** |
| 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 and are produced by fracturing and frictional slipping of pre-existing faults along a tectonic plate. |
| Subduction Earthquakes | The most powerful type of earthquake, these occur when there is a massive shift at the junction of multiple tectonic plates. |
| **Vulnerability** | **Description** |
| People | Injury or fatalities could occur during or after an earthquake due to collapsed structures, falling objects, or from being knocked to the ground by the shaking. |
| Infrastructure | Structural damage to buildings and infrastructure could be caused by a major earthquake in the western part of the territory or by 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. |
| | |

[144] https://www.earthquakescanada.nrcan.gc.ca/historic-historique/events/19851223-en.php

| NWT Exposure/History[145] | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| Beaufort Sea | March 2021 | Magnitude 5.3 earthquake at a depth of 35 km located 271 km west of Sachs Harbour.[146] |
| Fort McPherson | December 2017 | Magnitude 5.5 earthquake at a depth of 10 km located 218 km south of Fort McPherson.[147] |
| Délįnę | August 2014 | Magnitude 5.0 earthquake at a depth of 10 km located 57 km northeast of Délįnę.[148] |
| Fort Liard | July 2013 | Magnitude 5.0 earthquake at a dept of 8 km located 209 km north of Fort Liard.[149] |
| Aklavik | December 2012 | Magnitude 5.1 earthquake at a depth of 9.9 km located 59 km west of Aklavik.[150] |
| Délįnę | September 2011 | Magnitude 5.3 earthquake at a depth of 1 km located 240 km southwest of Délįnę.[151] |
| Aklavik | January 2008 | Magnitude 5.0 earthquake at a depth of 10 km located 66 km west of Aklavik.[152] |
| Inuvik | January 2008 | A 5.8 magnitude earthquake located 40 km northwest of Fort McPherson shook buildings in Inuvik. No damage was reported.[153] |
| | | |

**NWT Earthquakes**

Many areas of the NWT along the Mackenzie valley have a medium to high seismic hazard risk. Most earthquakes are small and most are not felt by communities in the NWT. The largest took place in October 1985 when a Magnitude 6.6 earthquake took place on October 5th followed by a 6.9 magnitude quake on December 23rd. The quakes shook a number of communities in the Dehcho region, but no serious damage was reported.

[145] Only earthquakes 5.0 or higher magnitude are listed. For a full list of earthquakes in the NWT see https://www.volcanodiscovery.com/earthquakes/northwest-territories/largest.html
[146] https://www.volcanodiscovery.com/earthquakes/quake-info/6182467/mag5quake-Mar-30-2021-Beaufort-Sea-Canada.html
[147] https://www.volcanodiscovery.com/earthquakes/quake-info/1825636/mag5quake-Dec-22-2017-Northern-Yukon-Territory-Canada.html
[148] https://www.volcanodiscovery.com/earthquakes/quake-info/788126/mag5quake-Aug-29-2014-191-Km-E-of-Norman-WellsNT.html
[149] https://www.volcanodiscovery.com/earthquakes/quake-info/358394/mag5quake-Jul-12-2013-135km-SSW-of-Wrigley-Canada.html
[150] https://www.volcanodiscovery.com/earthquakes/quake-info/139881/mag5quake-Dec-11-2012-100km-NW-of-Fort-McPherson-Canada.html
[151] https://www.volcanodiscovery.com/earthquakes/quake-info/3399013/mag5quake-Sep-26-2011-Northwest-Territories-Canada.html
[152] https://www.volcanodiscovery.com/earthquakes/quake-info/3156792/mag5quake-Jan-17-2008-northern-Yukon-Territory-Canada.html
[153] https://www.cbc.ca/news/canada/north/quake-near-inuvik-shook-buildings-1.725103

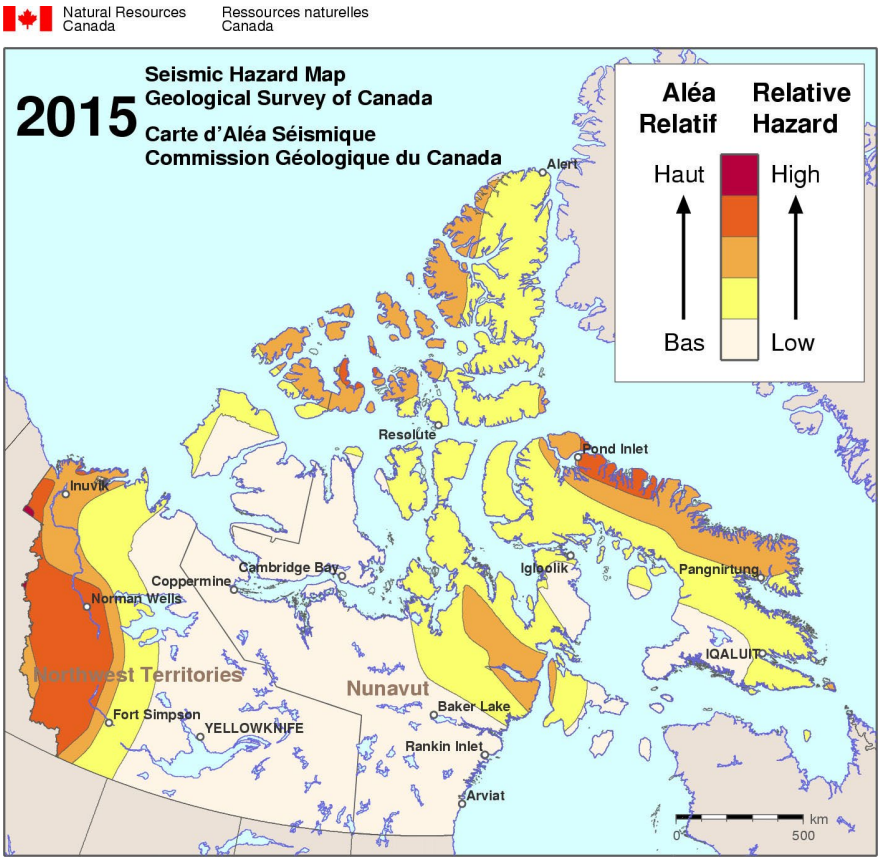



**Figure 25: Seismic Hazard Map of Northwest Territories/Nunavut[154]**

**Climate Change Impacts**

While the latest seismic and meteorological technologies have confirmed that weather events are not capable of causing an earthquake, a number of studies have indicated that climate change has acted as a trigger for several quakes. Precipitation and glacial melt are two of the changes that can lead to seismic activity (Picazo, 2021).

The U.S. Arctic Research Commission reported that the consistent rise in the temperature is a serious concern in Alaska and Arctic because often melting of glaciers and permafrost due to air and surface warming lead to ground destabilization as well as ecosystem changes and increased seismic activity. The report noted 10 times increase in the number of earthquakes of a magnitude of 5 or more from 2001 to 2015 corresponding to a phenomenal rise in global temperature during this period. The trend according to the proposed hypothesis shows that rising temperature due to global warming in Alaska might have contributed to the sharply increased cumulative earthquake frequency in recent decades. It seems that rise in regional temperature due to global warming causing the glaciers to melt, which in turn depressurizing the underlying rocks, hence affecting the earth to rebound and faults to reactivate, therefore labeling the region seismically active with obvious increase in the frequency of volcanoes and earthquakes. The results are preliminary therefore more research is required (Masih, 2018).

[154] https://earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-en.php

### 4.5.2 Space Debris

| | |
|---|---|
| **Hazard:** Space Debris<br>**Hazard:** Human Caused/Natural Hazard<br>**Definition:** Debris from satellites and space vehicles, as well as natural objects like meteorites and planetary particles that travel through the solar system.<br><br>**Climate Change Indicator:** Undetermined. |  <br>**Figure 26: Debris found from the crashed Cosmos 954 Soviet Satellite, 1978**[155] |
| **Mitigation Strategies:**<br>• Have monitoring and notification protocols in place with appropriate agencies | |
| **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. |
| 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. |
| Environment | Some rockets and satellites have used highly toxic fuels and in the past radioactive materials. These elements can damage sensitive ecosystems and contaminate the environment. |
| | |

[155] https://en.wikipedia.org/wiki/Kosmos_954

| NWT Exposure/History | | |
|---|---|---|
| **Where** | **When** | **Impact** |
| South-Central Pacific Ocean | November 2022 | A 23-ton piece of space debris from China's launch of a Long March 5B rocket fell into the south-central Pacific Ocean.[156] |
| Indian Ocean | July 2022 | A 25-ton core stage from a Long March 5B rocket crashed back to earth uncontrolled over the Indian Ocean. Some debris was found along the reentry path in Southeast Asia (Indonesia and Malaysia).[157] |
| South Pacific Ocean | January 2022 | The Persei upper stage of a Russian Angara A5 heavy-lift rocket crashed back to earth in an uncontrolled fashion reentering over the Pacific Ocean. The debris was expected to weigh about 3.5 tons.[158] |
| Indian Ocean | May 2021 | A piece of space junk from a Chinese rocket fell uncontrolled back to Earth and landed in the Indian Ocean near the Maldives.[159] |
| Washington State, U.S. | March 2021 | A pressure vessel from a SpaceX Falcon 9 rocket stage fell on a man's farm in Washington State leaving a 4-inch dent in the soil.[160] |
| Ivory Coast | May 2020 | The core of a Chinese Long March 5B rocket weighing nearly 18 tons came back to earth in an uncontrolled entry with debris landing in at least two villages in the Ivory Coast.[161] |
| Nunavut | August 2019 | The Government of Nunavut advised of the risk of falling debris from a Russian Rokot/Briz-KM Rocket that was set to launch. The three-stage rocket carries a highly toxic fuel. Any debris was expected to fall in the Baffin Bay area and a NOTAM was issued.[162] |
| Nunavut | October 2017 | The Government of Nunavut and residents raised concern over a Russian rocket launch expected to result in debris falling in a sensitive area of Baffin Bay due to the highly toxic fuel being used.[163] |
| Nunavut | April 2018 | Debris from an European Space Agency launch of a new satellite using a Russian rocket was expected to land in the Baffin Bay area. Concerns were raised over the highly toxic fuel use on the rocket.[164] |
| Nunavut | June 2016 | Debris from a Russian rocket was expected to fall into Baffin Bay. Many residents of Nunavut, environmentalists and academics raised concerns over the highly toxic fuel being used.[165] |
| Isles of Scilly | November 2015 | A large chunk of an American rocket was found in the sea off |

[156] https://www.space.com/china-long-march-5b-rocket-falls-into-pacific-ocean
[157] https://www.space.com/chinese-rocket-crash-space-debris-found
[158] https://www.space.com/russian-space-junk-angara-a5-rocket-fall
[159] https://phys.org/news/2021-05-space-law-falling-debris-legal.html
[160] https://www.theverge.com/2021/4/2/22364582/spacex-rocket-debris-falls-farm-washington
[161] https://www.forbes.com/sites/jonathanocallaghan/2020/05/12/parts-of-a-chinese-rocket-may-have-fallen-on-an-african-village/?sh=46ade0ff65a2
[162] https://nunatsiaq.com/stories/article/russian-rocket-launch-could-release-debris-into-nunavut-waters/
[163] https://www.nunavutnews.com/nunavut-news/worries-russian-rocket-debris/
[164] https://nunatsiaq.com/stories/article/65674more_space_junk_bound_for_nunavuts_baffin_bay/
[165] https://www.cbc.ca/news/canada/north/russian-rocket-baffin-bay-1.3610344

| | | |
|---|---|---|
| | | the Isles of Scilly believed to be from a SpaceX Falkon 9 which exploded after take-off in Florida in June.[166] |
| Calgary | September 2011 | NASA's bus-size Upper Atmosphere Research Satellite fell back to earth breaking up into 26 pieces with some debris landing near Calgary. The largest piece was estimated to be 300 lbs.[167] |
| Tulsa Oklahoma | March 2001 | A resident, Lottie Williams, was hit on the shoulder by a six-inch piece of blackened metallic material believed to be debris from a Delta II rocket body that had reentered the atmosphere.[168] |
| South Pacific | March 2001 | The MIR space station conducted a controlled deorbit and reentry resulting in debris landing in the South Pacific east of New Zealand.[169] |
| | | |

**NWT Context**

While there is negligible direct threat to the NWT from space debris, the amount of space junk continues to increase and any debris reentering the earth's atmosphere can be highly unpredictable in terms of how much debris survives reentry and how wide an area it can be spread. One example was on January 24, 1978 when the nuclear powered Soviet satellite Cosmos 954 crashed to earth scattering radioactive debris across 124,000 square kilometres of the NWT, Alberta and Saskatchewan. The cleanup took months to complete at an estimated cost of 6 million dollars.

Over the past 30 years (1992–2022), more than 1,500 rocket bodies have deorbited with an estimate of over 70% deorbiting in an uncontrolled manner. In 2020, over 60% of launches to low Earth orbit resulted in a rocket body being abandoned in orbit. Remaining in orbit for days, months or even years, these large objects pose a collision hazard for operational satellites and a risk when intact stages return to Earth. A substantial fraction of their mass survives the heat of atmospheric reentry and debris poses serious risks to people on land and at sea including ships and aircraft. In a recent study a team of researchers from the University of British Columbia said there's a six to 10-per-cent chance someone could be severely injured or killed by falling abandoned rocket debris over a 10-year period (Michael Byers, 2022).

**Climate Change Impacts**

The planet's atmosphere naturally pulls orbiting debris downward and incinerates it in the thicker lower atmosphere, however increasing carbon dioxide levels due to Climate Change are lowering the density of the upper atmosphere, which may diminish this effect. Research indicates that since 2000, the atmosphere at 250 miles has lost 21 percent of its density because of rising carbon dioxide levels. By 2100, if carbon dioxide levels double their current levels, in line with the worst-case scenario assessment by the Intergovernmental Panel on Climate Change, that number could rise to 80 percent (O'Callaghan, 2021).

[166] https://www.bbc.com/news/uk-england-cornwall-34941462
[167] https://www.csmonitor.com/USA/2011/0924/NASA-satellite-falls-on-Canada-as-space-junk.-No-one-hurt
[168] https://abcnews.go.com/Technology/story?id=98700&page=1
[169] https://www.nasa.gov/feature/20-years-ago-space-station-mir-reenters-earth-s-atmosphere

With more than 2,500 pieces of space junk, larger than four inches in size, currently in orbit at or below an altitude of 250 miles, the impact could be serious. In the worst-case scenario, increased orbital lifetimes of up to 40 years would mean fewer items are dragged into the lower atmosphere. Objects at this altitude would proliferate by 50 times to about 125,000. While in a best-case scenario, where carbon dioxide levels stabilize or even reverse, the amount of space junk would still be expected to double. A more likely scenario would be a somewhere between 10 and 20 times increase in space junk (O'Callaghan, 2021).

# 5. VULNERABILITY

Vulnerability is one of the main components in assessing disaster risk. It is characterized by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (United Nations Office for Disaster Risk Reduction, 2022). Vulnerability is more than the susceptibility or direct impact of a hazard; there are broader environmental and social situations that can make the ability of people and communities to deal with the impact of a hazard difficult.

Examples of vulnerability factors include (United Nations Office for Disaster Risk Reduction, 2022):

- Physical – The design and construction of buildings and other infrastructure to cope with the impacts or threats from hazards; land-use planning that doesn't fully take into consideration the threats from hazards;
- Social – Poverty and inequality, marginalization, social exclusion and discrimination by gender, social status, disability and age (amongst other factors);
- Economic – Those that work informally, those that rely on rural livelihoods that may be vulnerable if lost, areas with a single or limited source of employment (e.g., single resource industry communities), supply chains for essential commodities (e.g., food, fuel, pharmaceuticals, etc.);
- Environmental – climate change affects, environmental management policies (or the lack thereof) that do not consider the balance between protecting the environment and the extraction/consumption of resources, the loss of risk regulating ecosystems (i.e., natural processes that minimize the threats for hazards); and
- Those historical, political, cultural, institutional, and natural resources factors and decisions that may have shaped the current social and environmental conditions people are in where there may be a range of unsafe conditions such as living in dangerous locations or in poor housing, ill-health, political tensions or a lack of local institutions or preparedness measures.

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

- Limited infrastructure and redundancies;
- Remoteness and isolation;
- Issues associated with cultural duress and the legacies of Indigenous policies;
- Underdeveloped private sector;
- Limited local capacity; and
- Socio-economic impediments.

## 5.1 Vulnerability Reduction

Vulnerability reduction seeks to decrease community susceptibility and increase a community's resilience. Examples include (United Nations Office for Disaster Risk Reduction, 2022):

- Implementing or adjusting building codes that consider hazard vulnerability;
- Insurance and social protection support thereby reducing the impacts of a hazard;
- Diversifying the economy and making livelihoods more resilient;
- Raising awareness and knowledge of hazards, their impacts, and ways to reduce the hazard risk;

- Increasing the understanding of people's and community's capacity to resist and recover from disasters; and
- Incorporating local and traditional knowledge with outside concepts to reduce disaster risk.

## 5.2 Community Resilience

Community Resilience is defined as the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change (Community and Regional Resilience Institute, 2013). Residents of the NWT possess several qualities that have proven advantageous 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 significant weather conditions. Several recurring themes and elements have been found to contribute to community resilience (Conference Board of Canada, 2022):

- local knowledge;
- community networks and relationships;
- effective and credible communication;
- health and well-being;
- governance and leadership;
- resources and economic investment; and
- mental outlook (health) and preparedness.

The challenges and vulnerabilities found to degrade resilience in remote Indigenous communities are as follows (Conference Board of Canada, 2022):

- environmental change and degradation;
- inadequate physical infrastructure;
- social infrastructure challenges, such as poor or limited education and training opportunities and challenges to health and well-being;
- a lack of economic diversity; and
- ineffective support and coordination on the part of key jurisdictional partners and governments.

While some communities cope better than others during major emergencies and disasters, six key strengths common to many remote Indigenous communities that nurture resilience are as follows (Conference Board of Canada, 2022):

- self-organization (through formal or informal community practices);
- learning and adapting;
- connections to the land;
- increased self-determination and rights recognition;
- expanding opportunities for economic development and own-source revenue; and
- social capital (relationships, bonds, and communications channels between community members).

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). Land-based activities such as hunting and the gathering of country foods can be critical to community wellbeing, cultural vitality, and mental and physical health. These activities can also play a direct role in the development of skills and knowledge linked to emergency management capacity. For instance, they can enhance backcountry survival skills, search-and-rescue capacity, food security, and the ability to manage extreme weather events as well as changing snow and ice conditions (Conference Board of Canada, 2022).

Success in the North depends upon the connection of people with one another, with the environment, and with their heritage. Research identified overarching findings related to building and supporting resilience in remote Indigenous communities (Conference Board of Canada, 2022):

- **Identify resilience in context**. Each remote community is unique. Culturally and historically appropriate engagement strategies are necessary to identify each community's level of resilience alongside its vulnerabilities.
- **Understand the close ties between communities and their surrounding ecosystems**. Natural hazards and disasters have big impacts on remote Indigenous communities due to their interconnectedness and interdependence with the surrounding environment. Understanding the role of ecological systems in remote community resilience is critical to successful disaster preparedness.
- **Nurture existing resilience**. Traditional Knowledge includes the values and beliefs that shape the outlook of communities. The emergency management and disaster mitigation literature, in addition to Elders and knowledge keepers, stress the importance of incorporating local and Traditional Knowledge in risk management and emergency planning.
- **Acknowledge strengths and vulnerabilities**. Unique strengths exist in different forms and measures in each remote Indigenous community. These strengths provide meaningful entry points for supporting disaster management planning. Building on what people already know and do well leads to simple, implementable resilience enhancement strategies. Such strategies will make sense to community members and encourage ownership.
- **Support remote Indigenous communities to sustain resilience**. Indigenous societies in Canada have demonstrated resilience against natural and human-induced disturbances such as climate change and the legacies of colonial policies for centuries. However, they cannot do it alone. Better collaboration with jurisdictional partners is essential for disaster resilience in small remote communities.

# 6. 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 redundancies in infrastructure services; and
- capacity constraints in the form of finances and human resources (True North, 2009).

This section considers critical infrastructure in the NWT context as defined by Public Safety Canada. Critical Infrastructure in Canada spans ten sectors as list in Table 14 below (Government of Canada, 2009):

Note: The impacts to critical infrastructure from the hazards in the NWT are described within the specific hazard narratives section of this report (Section 4).

**Table 6: Public Safety Canada Critical Infrastructure Sectors**

| No. | 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., industrial base, chemical industry |

## 6.1 Energy & 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 Norman Wells and gas generators using liquid natural gas (LNG) power Inuvik. The remaining 23 communities have electricity provided by diesel-fired power plants. In addition, 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 (Industry, Tourism and Investment, 2011). Fuel supplies must be shipped into the communities by pipeline, barge, all-season/ice road or air.

The destruction or interruption of any part of the bulk fuel supply and storage system could 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 residents including communications.

Overall due to the climate of the North, the continuity of the energy and utility infrastructure in the NWT is essential to ensure the safety of the population. In addition, most other critical infrastructure relies on the efficient functioning of energy and utilities.

## 6.2 Communications and Information Technology

The NWT communications system is a mixture of land-based services and satellite served communities. 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 (Arctic Counil, 2005). For example, there is no cell phone coverage along most highways in the NWT, frequent outages of 9-1-1 services and dead spots in satellite phone reception. In addition, it is very difficult to send photos or large amounts of data from the remote areas during an emergency (Arctic Counil, 2005).

In November 2021, the Standing Committee on Economic Development and Environment tabled a Report on Telecommunications highlighting concerns about the growing digital divide in the NWT, and the overall accessibility, connectivity and quality of internet service across the NWT (Standing Committee on Economic Development and Environment, 2021). In Committee's view the GNWT has not completed a comprehensive business plan required to provide internet access in the NWT at a comparable level of service to southern Canada and the GNWT continues to fall short with federal partners and industry to achieve this end.

Communication infrastructure in the North remains fragile, often relying on a single key provider. This creates a high level of vulnerability for communications systems and can jeopardize the safety and security of residents and visitors.

## 6.3 Finance

There are six 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 several

independently owned bank machines throughout the city. Most regional centres have bank services such as Hay River, Inuvik, Fort Simpson, Norman Wells and Fort Smith. Other smaller communities rely on on-line banking, alternate banking arrangements or local businesses. All of these institutions and arrangements are vulnerable to power and telecommunications disruptions.

## 6.4 Health Care

All healthcare facilities across the NWT are deemed critical infrastructure. Most health services outside Yellowknife or regional centers are very limited with a reliance on communication systems to deliver services and programs. Health and Social Services continues implementing new technology to reduce cost and improve service delivery to patients; however, a heavy reliance on data and communication systems can make them more vulnerable to power outages and cyber events. Efforts include increased telehealth for specialist connections, electronic record management, and increased computing radiography. Any of these services can be disrupted by hazards which affect communications.

## 6.5 Food

The isolation of many parts of the NWT, and the cost of transporting food to remote communities, contribute to a high level of food insecurity in the territory. Hazards that impact transportation can lead to food scarcity. The NWT has little conventional agriculture with much of the local food economy based on traditional harvesting. There are significant hunting, trapping, and fishing industries in the territory and 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.

## 6.6 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 in the NWT. 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. Disruptions to power, flooding, and cyber events all have the potential to impact NWT water systems.

## 6.7 Transportation

NWT transportation infrastructure includes a network of roads, ports, and airports, including a rail connection to Hay River. Overall, the NWT has over 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. NWT transportation systems are considered critical infrastructure in that they connect communities, allow for delivery of goods and provide access to the rest of Canada. The transportation network in the NWT can be disrupted by natural hazards such as wildfires, flooding, severe weather, landslides and erosion events.

## 6.8 Safety

The safety sector is mostly concerned with responding to emergency events and ensuring the safety and security of NWT residents. All facilities housing the fire/ambulance, RCMP, 9-1-1 services, military, Search and Rescue, Coast Guard and Ranger Patrols across the territory are considered critical facilities. Other critical facilities are those essential for emergency management officials to carry out emergency management and response activities to large-scale disaster events. These critical facilities include Emergency Operations Centers (regional and territorial), working areas and stockpiles.

Critical facilities in communities include the emergency/public safety facilities (Fire Halls, Police Stations, Ambulance stations) as these both house the responders and their equipment, they can store essential disaster supplies and communications equipment; the hospitals and health care facilities; and buildings designated as evacuation/reception centers, warming/cooling centers and clean air shelters.

Critical facilities may be impacted by natural and human caused hazards, however the impacts should be limited allowing continued operation during a disaster event. Many communities throughout the NWT have limited facilities, first responder personnel or resources.

## 6.9 Government

All facilities housing territorial and local government operations and supporting communications/IT infrastructure in each community are considered critical infrastructure. Some examples in Yellowknife include the Legislative Assembly, City Hall, and North Slave Correctional Complex. Natural hazards like wildfires and floods involving government facilities would impact essential government services. Interruption or loss of GNWT data and communications systems due to natural hazards, cyber-attacks or power outages could impact on all government services across the territories. Business continuity plans are essential to mitigate the impacts of natural and man-made hazards on government operations.

## 6.10 Industry

Industry is critical to creating jobs and supporting the NWT economy. Required facilities for industry functioning is considered Critical infrastructure. Industries that support the local economy such as mines or oil and gas extraction are essential and when impacted by natural and man-made hazards, could result in long-term impacts to the economic well-being of communities.

# 7. GLOSSARY OF TERMS AND ACRONYMS

| | |
|---|---|
| CCG | Canadian Coast Guard |
| Climate Change | a long-term shift in weather conditions identified by changes in temperature, precipitation, winds and other indicators. |
| Community Resilience | a community's ability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change |
| Critical Infrastructure | essential underlying systems and facilities upon which our standard of life relies. |
| Disaster | serious disruptions to the functioning of a community that exceed its capacity to cope using its own resources. Disasters can be caused by natural, man-made and technological hazards, as well as various factors that influence the exposure and vulnerability of a community.[170] |
| Emergency | a current or imminent event that requires prompt coordination of action or special regulation of persons or property in order to protect the safety, health or welfare of people, or to limit or prevent damage to property or the environment. |
| Emergency Management | the prevention and mitigation of, preparedness for, response to and recovery from emergencies. |
| EMO | Emergency Management Organization |
| GNWT | Government of the Northwest Territories |
| 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. |
| HIRA | Hazard Identification Risk Assessment |
| Mitigation | the measures taken before an emergency occurs to adapt to, eliminate or reduce the risks of disasters to protect lives, property, the environment, and reduce economic disruption. |
| NWT | Northwest Territories |
| 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. |
| 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. |
| Vulnerability Reduction | to decrease community susceptibility and increase a community's resilience |

[170] Taken from https://www.ifrc.org/our-work/disasters-climate-and-crises/what-disaster

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# ANNEX A – HIRA CONSEQUENCE RATINGS

## A1 – Infrastructure and Services Impacts

| Consequence Rating Level | | Infrastructure & Services Impacts | | | | |
|---|---|---|---|---|---|---|
| | | Critical Infrastructure | Access to Critical Services | Access to Government Services | Economic | Transportation Network |
| 1 | **Limited** | No appreciable infrastructure impacts; negligible systems issues, resolved in day-to-day management and workaround solutions. | Little to no interruption of access to regular services, including access to water, communications, electrical, health, and other services, any impacts resolved in one or two hours. | Little to no interruption of access to government services, any impacts resolved in one or two hours. | Little to no impact to economy of small and large communities. People have little to no change in purchasing power or access to goods. | Little to no damage to key transportation routes. |
| 2 | **Minor** | Minor damages only; inconvenient system interruptions causing no long-term issues; other impacts quickly resolved. | Minor interruption of access to regular services, including access to water, communications, electrical, health, and other services; impacts resolved in less than 12 hours. | Minor interruption of access to regular government services including essential/vital government services. Impacts resolved in less than 12 hours. | Minor impact on economy within smaller communities, large cities experience minimal impacts. People may experience temporary changes to their purchasing power and/or access to goods. | Minor damage to key transportation routes requiring minimal repairs, possible damage to non-primary roadways. Alternate transportation can be arranged until repairs are completed. |

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|---|---|---|---|---|---|---|
| **3** | **Moderate** | Moderate damage to one or two sectors, system interruptions cause undue stress to residents for a period of days to weeks. | Moderate interruption of access to regular services, including access to water, communications, electrical, health, and other services; impacts may result in extended outages lasting over 12 hours. | Moderate interruption of access to all government services; essential and vital government services may need to operate under Business Continuity Plans to meet requirements. Impacts may result in extended outages lasting over 12 hours. | Impacts on economies within both large and small communities. People will likely have reduced purchasing power and/or access to goods for a short duration of time. | Damage to primary transportation routes requiring extensive repairs however alternate arrangements can ensure ongoing movement of people and goods with minor delay. |
| **4** | **Major** | Major damage to numerous CI sectors, system interruptions cause significant issues for residents for a period of weeks to months. | Major interruption of access to regular services, including access to water, communications, electrical, health, and other services; impacts may result in extended outages lasting days to a week. Critical shortages of supplies and resources may result in secondary hazards. Evacuation to areas with access to services may be required. | Major interruption of access to regular government services, impacts may result in extended outages lasting days to a week. Government Essential and Vital Services may only be available, and only under Business Continuity Plan provisions. | Major impacts on economy within both large and small communities. People will have reduced purchasing power and/or access to goods for an extended timeframe. | Major damage to primary transportation routes requiring extensive repairs. Alternate arrangements can enable limited movement of goods and services with significant delays. |

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|---|---|---|---|---|---|---|
| **5** | **Catastrophic** | Significant, or total destruction to numerous CI sectors/assets. System interruptions cause residents to be unable to access critical services for an extended timeframe. Relocation of residents may be required if services completely removed. | Complete loss of access to regular services, including access to water, communications, electrical, health, and other services; with impacts lasting multiple weeks to months. Critical shortages of supplies likely to result in secondary impacts and cause serious danger to the public. Evacuation to areas with access to services is required. | Complete loss of access to regular government services with impacts lasting multiple weeks to months. Losses or Delays to Essential and Vital Government services may occur. | Significant impact on economies of both large and small communities. A large percentage of the population will have extremely reduced or no purchasing power and/or access to goods for an extended timeframe. | Primary transportation routes are completely incapacitated and require significant long-term repairs. Movement of goods and people is entirely halted until repairs can be completed. |

# A2 – Human and Social Impacts

| Consequence Rating Level | | Human & Social Impacts | | | | | |
|---|---|---|---|---|---|---|---|
| | | Fatalities (Loss of Life) | Physical health | Cultural | Evacuation/Displacement | Support System | Psychosocial |
| 1 | **Limited** | Incident does not result in any loss of life. | Not likely to result in injuries or illness. | Minimal impact to culture including minor damage or temporary restriction of access to cultural items, events, or people, that can be managed with little impact to transmission of culture across generations. | Incident would not result in evacuation of any homes or communities or disruption of daily life in any area. | Not likely to impact access to supports or networks. Community reciprocity, trust, and cooperation are unaffected. | Minimum impact on people and their daily lives; Minor first aid incidents with limited impacts on mental health and social cohesion. |
| 2 | **Minor** | Loss of life may occur; however, the broader impact on the community is minor. | Illnesses or injuries that are manageable at the community level. | Minor impact to culture including minor damage or short-term loss of access to cultural items, events, or people, including language, ceremonies, medicines, etc. that can be restored quickly or as soon as the incident is resolved. | Incident may result in temporary evacuation or displacement for a small number of homes that are closest in proximity to hazardous areas (e.g., waterfront homes or camps). Support can be provided within the community. | Hours to days-long disruption to daily life. Likely to result in some localized reduced access to supports or networks. Community reciprocity, trust, and cooperation are affected. | Minor impact on people and their day to day lives; small impact to people with pre-existing conditions or trauma, some displacement and small impact to social cohesion. |

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|---|---|---|---|---|---|---|---|
| **3** | **Moderate** | Incident may result in one or two fatalities which will have a significant impact on the community. | Illness or injury that is beyond the scope of local capacity and may require additional capacity and/or resources, and/or the activation of response systems and community emergency plans. May require medical evacuation to other community /hospitals. | Moderate impact to culture including moderate damage or temporary loss of access to cultural items, events, or people, including language, ceremonies, medicines, etc., that are able to be restored with moderate effort, time and resources. | Incident will likely result in the evacuation of numerous homes, camps or other properties, or may result in a small number of permanent evacuations. Outside supports would be required. | Days-long disruption to daily life. Likely to result in reduced access to supports or networks. Community reciprocity, trust, and cooperation are affected. | Moderate impact on performance. i.e., low morale/stress noticeable; reduced service causes some stress (e.g., delays, closures) to the general public, those affected require supports for mental health and social cohesion. |

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|---|---|---|---|---|---|---|---|
| **4** | **Major** | Incident is likely to involve more than one fatality that will have a major impact on the community, possibly requiring outside assistance to support. | Extensive mass illness or injury requiring extra capacity and/or resources from outside the community /region and most likely require medical evacuation for enhanced/specialized care from other communities/hospitals. | Major impact to culture including cultural items, performances, ceremonies, and other events is majorly damaged, or limited or restricted for significant amounts of time and/or loss of Elders/knowledge keepers in the community; this takes significant time and resources to recover/restore. | Incident will result in the evacuation of whole neighbourhoods or communities for days to weeks until immediate danger from incidents has passed, or may result in a moderate number of permanent evacuations. | Weeks or months-long disruption to daily life. Significantly reduced access to supports or networks. Community reciprocity, trust, and cooperation are severely affected. | Major impact on people requiring significant access to services for mental health or social cohesion, shortage of critical skills, people are taking on roles they are unprepared or untrained for to fill gaps. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **5** | **Catastrophic** | Incident is likely to involve significant number of fatalities and result in a mass-casualty situation needing out-of-community transportation and support resources. | Extraordinary mass illness or injury. Broader Territorial or National resources may be required. | Catastrophic impact on access and transmission of culture. Community members, especially elders and knowledge keepers, are displaced in disconnected locations and lose access to each other for extended periods; transmission of culture is limited for a significant amount of time. | Incident will result in the evacuation of whole communities for an extended timeframe until homes, camps and properties can be rebuilt or a new, safer location is chosen to rebuild. Possibility of large number of permanent evacuations. | Months to years-long disruption to daily life. Supports or networks may be permanently changed. | Catastrophic impact on daily life. i.e., inability to provide service over an extended time period due to loss or resources or people, requirement of supports from an external partner. |

## A3 – Physical and Environmental Impacts

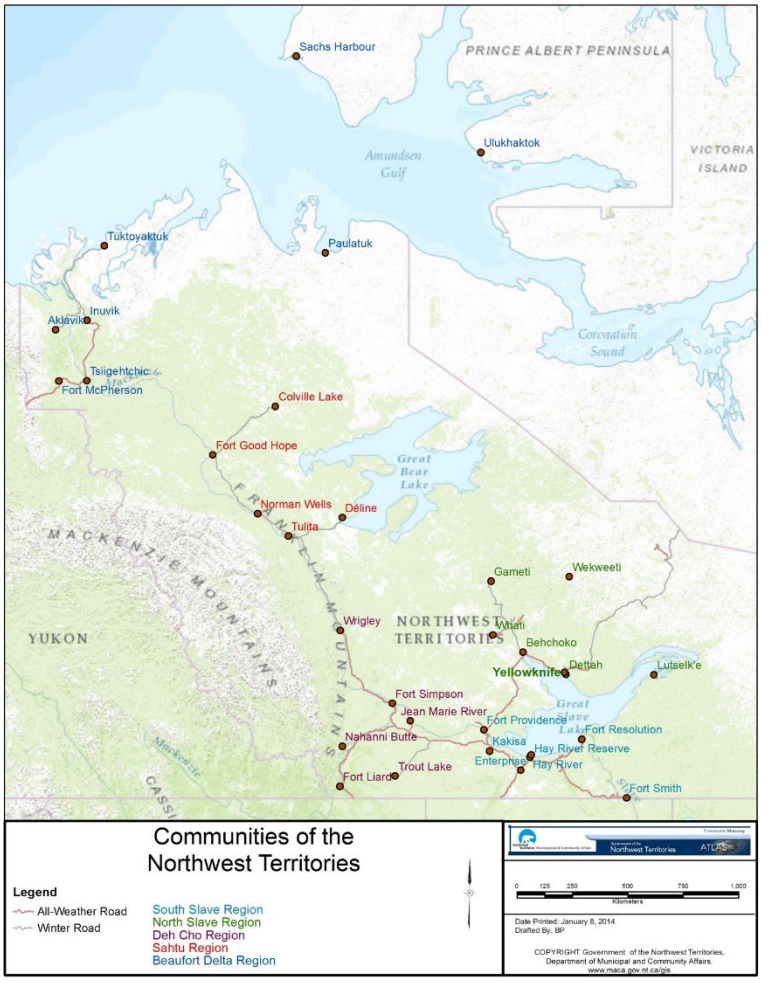
| Consequence Rating Level | | Physical & Environmental | | |
|---|---|---|---|---|
| | | Fatalities (Loss of Life) | Physical health | Cultural |
| 1 | **Limited** | Little to no damage to personal homes, camps or other property. | Little to no impact on aspects of the environment such as air and water quality and quantity, greenhouse gas emissions, flora and fauna, and species and ecosystems. | Little to no impact on traditional use of land for hunting, gathering, and/or ceremony. Regular activities can be resumed after the immediate threat is resolved. |
| 2 | **Minor** | Minor damage to personal homes, camps or other property that can be addressed with minor repairs. | Minor and temporary impact on aspects of the environment such as air and water quality and quantity, greenhouse gas emissions, flora and fauna, and species and ecosystems, likely to be resolved when the threat is resolved. | Minor impact on traditional use of land for hunting, gathering, and/or ceremony. Regular activities can be resumed in under a week after the threat. |

| | | | | |
|---|---|---|---|---|
| **3** | **Moderate** | Damage to personal homes, camps or other property that can be addressed with significant repairs. | Moderate impact on aspects of the environment such as air and water quality and quantity, greenhouse gas emissions, flora and fauna, and species and ecosystems. Can be resolved with existing resources and time. | Moderate impact on traditional use of land for hunting, gathering, and/or ceremony. Regular activities can be resumed after time, effort and resources have been put toward resolving the threat. |
| **4** | **Major** | Major damage to personal homes, camps, or other property that requires professional repairs and potential insurance claims. | Major impact on aspects of the environment such as air and water quality and quantity, greenhouse gas emissions, flora and fauna, and species and ecosystems. Can be resolved with significant input of resources and time. | Major impact on traditional use of land for hunting, gathering, and/or ceremony. Regular activities can be resumed with modifications after time, effort and resources have been put toward resolving the threat. |

| | | | | |
|---|---|---|---|---|
| **5** | **Catastrophic** | Total, or near total destruction of homes, camps or other property that requires complete restoration of buildings and insurance claims. | Catastrophic or permanent impact on aspects of the environment such as air and water quality and quantity, greenhouse gas emissions, flora and fauna, and species and ecosystems that cannot likely be resolved with available resources. | Catastrophic or permanent impact on traditional use of land for hunting, gathering, and/or ceremony. Regular activities cannot be resumed in this location. |

# ANNEX B – REGIONAL HAZARD SUMMARIES

The Department of Municipal and Community Affairs (MACA), supports community governments in providing a safe, sustainable and healthy environment for community residents. Emergency management is one area of responsibility that is supported by MACA through the NWT Emergency Management Organization. Like other support services provided to communities, this support is provided through the five regional offices.




MACA provides services to community governments through its headquarters in Yellowknife and five regional offices located in Inuvik, Norman Wells, Fort Simpson, Fort Smith and Yellowknife. Similarly, the EMO consists of the territorial EMO situated in Yellowknife and five regional EMOs situated in MACA regional offices and led by MACA regional superintendents.

Each region has its own unique culture and language, geography, climate and weather, infrastructure, vulnerabilities and risk exposure. To account for these differences and ensure valid HIRA results at the regional level, stakeholder engagement sessions were conducted virtually for each of the five regions. Participants included members of the NWT EMO, representatives from community governments, and emergency management partners and other organizations within each. Feedback from these sessions and data analysis were used to update the hazard summary for each region.

# B1 – Dehcho Region Hazard Summary

The Dehcho Region is in the southwestern part of the NWT, bordering British Columbia and the Yukon. There are 6 communities in the Dehcho Region. The 2022 census reported a population of 2,169, with 1216 people in the regional centre Fort Simpson. It is the commercial and administrative centre for the Region.

The Dehcho Region consists of the following communities:

- Fort Liard (523)
- Fort Simpson (1,230)
- Jean Marie River (92)
- Nahanni Butte (101)
- Sambaa K'e (97)
- Wrigley (126)

The Dehcho Region Hazard Summary is the result of a stakeholder engagement session with regional EMO, community government and other key regional representatives. The HIRA process was used to identify the hazards and examine the risks that pose a threat to the people, property, environment, and economy of the Dehcho Region.

This assessment identified and rated twenty hazards that could affect the Dehcho Region, and then ranked them in order of emergency planning priority. Each region of the NWT has some unique features that were taken into consideration in rating and ranking regional hazards.

The rankings were determined using best practices methodology combined with insight from communities and local experts.

## Dehcho Region Hazard Summary

**Extreme**

1. Flood (Ice Jam/Freshet)

**High**

2. Wildfire/Interface Fire

**Medium**

3. Critical Services – Power/Fuel Interruption
4. Transportation Incident – Road/Ice Road Closure
5. Human Disease (Pandemic/Epidemic)
6. Severe Weather – Snowstorm/Windstorm
7. Hazardous Materials – Spill
8. Severe Weather – Extreme Cold
9. Structural Fire
10. Transportation Incident – Aircraft Incident
11. Snow Load Hazard
12. Earth Movement - Erosion

**Low**

13. Critical Services – Water Services Interruption
14. Hazardous Materials – Explosion
15. Earth Movement - Permafrost Degradation
16. Public Safety – Cyber Security
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

# B2 – Inuvik Region Hazard Summary

The Inuvik Region borders the Yukon Territory to the west, Nunavut to the east and the Arctic Ocean to the north. It has a population of 6888 people (2022 census). The town of Inuvik is the third largest community in the NWT and Inuvik Region's major commercial and administrative center. The region's physical features include the Mackenzie Mountains, the Arctic Ocean, and the Mackenzie Delta.

The Inuvik Region consists of the following communities:

- Aklavik (708)
- Fort McPherson (759)
- Inuvik (3,214)
- Paulatuk (327)
- Sachs Harbour (118)
- Tsiigehtchic (205)
- Tuktoyaktuk (1,058)
- Ulukhaktok (499)

The Inuvik Region Hazard Summary is the result of a stakeholder engagement session with regional EMO, community government and other key regional representatives. The HIRA process was used to identify the hazards and examine the risks that pose a threat to the people, property, environment, and economy of the Inuvik Region.

This assessment identified and rated twenty hazards that could affect the Inuvik Region, and then ranked them in order of emergency planning priority. Each region of the NWT has some unique features that were taken into consideration in rating and ranking regional hazards.

The rankings were determined using best practices methodology combined with insight from communities and local experts.

## Inuvik Region Hazard Summary

**Extreme**

1. Flood (Ice Jam/Freshet)

**High**

2. Wildfire/Interface Fire

**Medium**

3. Critical Services – Power/Fuel Interruption
4. Transportation Incident – Road/Ice Road Closure
5. Severe Weather – Snowstorm/Windstorm
6. Human Disease (Pandemic/Epidemic)
7. Severe Weather – Extreme Cold
8. Earth Movement - Permafrost Degradation
9. Hazardous Materials – Spill
10. Earth Movement - Erosion
11. Structural Fire
12. Transportation Incident – Aircraft Incident
13. Snow Load Hazard

**Low**

14. Critical Services – Water Services Interruption
15. Hazardous Materials – Explosion
16. Public Safety – Cyber Security
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

# B3 – North Slave Region Hazard Summary

The North Slave Region is central to the NWT situated along the shore of the Great Slave Lake and includes the Tłı̨chǫ region. According to the 2022 census, the North Slave Region has a population of 25,330. It is the most populous of the five regions. with more than half the population of the NWT. The region consists of seven communities with the regional offices situated in Behchokǫ̀ and Yellowknife. Yellowknife is the capital and only city in the NWT.

The North Slave Region consists of the following communities:

- Behchokǫ̀ (2,057)
- Gametì (277)
- Łutselk'e (356)
- Wekweètì (140)
- Whatì (553)
- Yellowknife (21,720)
- Dettah (227)

The North Slave Region Hazard Summary is the result of a stakeholder engagement session with regional EMO, community government and other key regional representatives. The HIRA process was used to identify the hazards and examine the risks that pose a threat to the people, property, environment, and economy of the North Slave Region.

This assessment identified and rated twenty hazards that could affect the North Slave Region, and then ranked them in order of emergency planning priority. Each region of the NWT has some unique features that were taken into consideration in rating and ranking regional hazards.

## North Slave Region Hazard Summary

**High**

1. Wildfire/Interface Fire

**Medium**

2. Critical Services – Power/Fuel Interruption
3. Transportation Incident – Road/Ice Road Closure
4. Human Disease (Pandemic/Epidemic)
5. Severe Weather – Extreme Cold
6. Hazardous Materials – Spill
7. Structural Fire
8. Transportation Incident – Aircraft Incident
9. Earth Movement - Erosion

**Low**

10. Hazardous Materials – Explosion
11. Critical Services – Water Services interruption
12. Snow Load Hazard
13. Severe Weather – Snowstorm/Windstorm
14. Earth Movement - Permafrost Degradation
15. Public Safety – Cyber Security
16. Flood (Ice Jam/Freshet)
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

The rankings were determined using best practices methodology combined with insight from communities and local experts.

# B4 – Sahtu Region Hazard Summary

The Sahtu Region borders the Yukon Territory on its western side, Inuvik Region to the north, the North Slave Region on the east and Dehcho Region to the south. The population of the region is 2,669 people (2022 census). Norman Wells is the commercial and administrative centre and serves as a regional air hub and the region's primary service and supply centre. The Sahtu Region has the NWT's only producing oil field, and ships oil via the Norman Wells - Zama Lake (Alberta) pipeline.

The Sahtu Region Consists of the following Communities:

- Colville Lake (161)
- Délı̨nę (633)
- Fort Good Hope (628)
- Norman Wells (704)
- Tulita (543)

The Sahtu Region Hazard Summary is the result of a stakeholder engagement session with regional EMO, community government and other key regional representatives. The HIRA process was used to identify the hazards and examine the risks that pose a threat to the people, property, environment, and economy of the Sahtu Region.

This assessment identified and rated twenty hazards that could affect the Sahtu Region, and then ranked them in order of emergency planning priority. Each region of the NWT has some unique features that were taken into consideration in rating and ranking regional hazards.

The rankings were determined using best practices methodology combined with insight from communities and local experts.

## Sahtu Region Hazard Summary

**Extreme**

1. Flood (Ice Jam/Freshet)

**High**

2. Wildfire/Interface Fire

**Medium**

3. Critical Services – Power/Fuel Interruption
4. Transportation Incident – Road/Ice Road Closure
5. Human Disease (Pandemic/Epidemic)
6. Severe Weather – Extreme Cold
7. Hazardous Materials – Spill
8. Severe Weather – Snowstorm/Windstorm
9. Structural Fire
10. Transportation Incident – Aircraft Incident
11. Snow Load Hazard

**Low**

12. Critical Services – Water Services Interruption
13. Hazardous Materials – Explosion
14. Earth Movement - Permafrost Degradation
15. Earth Movement - Erosion
16. Public Safety – Cyber Security
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

## B5 – South Slave Region Hazard Summary

The South Slave Region is located south of Great Slave Lake and borders the Provinces of Alberta and Saskatchewan to the south and Nunavut to the east. The population of the region is 8,168 people (2022 census). Hay River and Fort Smith, respectively, are the second and fourth largest communities in the NWT. Fort Smith provides many public services to the South Slave Region. It is home to Aurora College Thebacha Campus and Wood Buffalo National Park, one of the largest national parks in Canada.

The South Slave Region Consists of the following Communities:

- Enterprise (121)
- Fort Providence (711)
- Fort Resolultion (556)
- Fort Smith (2,607)
- Hay River (3,796)
- Kakisa (36)
- Kátł'odeeche First Nation (341)

The South Slave Region Hazard Summary is the result of a stakeholder engagement session with regional EMO, community government and other key regional representatives. The HIRA process was used to identify the hazards and examine the risks that pose a threat to the people, property, environment and economy of the South Slave Region.

This assessment identified and rated twenty hazards that could affect the South Slave Region, and then ranked them in order of emergency planning priority. Each region of the NWT has some unique features that were taken into consideration in rating and ranking regional hazards.

### South Slave Region Hazard Summary

**Extreme**

1. Flood (Ice Jam/Freshet)

**High**

2. Wildfire/Interface Fire

**Medium**

3. Critical Services – Power/Fuel Interruption
4. Transportation Incident – Road/Ice Road Closure
5. Human Disease (Pandemic/Epidemic)
6. Severe Weather – Extreme Cold
7. Hazardous Materials – Spill
8. Severe Weather – Snowstorm/Windstorm
9. Earth Movement - Erosion
10. Structural Fire
11. Transportation Incident – Aircraft Incident
12. Snow Load Hazard

**Low**

13. Critical Services – Water Services Interruption
14. Hazardous Materials – Explosion
15. Earth Movement - Permafrost Degradation
16. Public Safety – Cyber Security
17. Animal Disease
18. Public Safety – Social Action

**Negligible**

19. Earth Movement - Earthquake
20. Space Debris

The rankings were determined using best practices methodology combined with insight from communities and local experts.