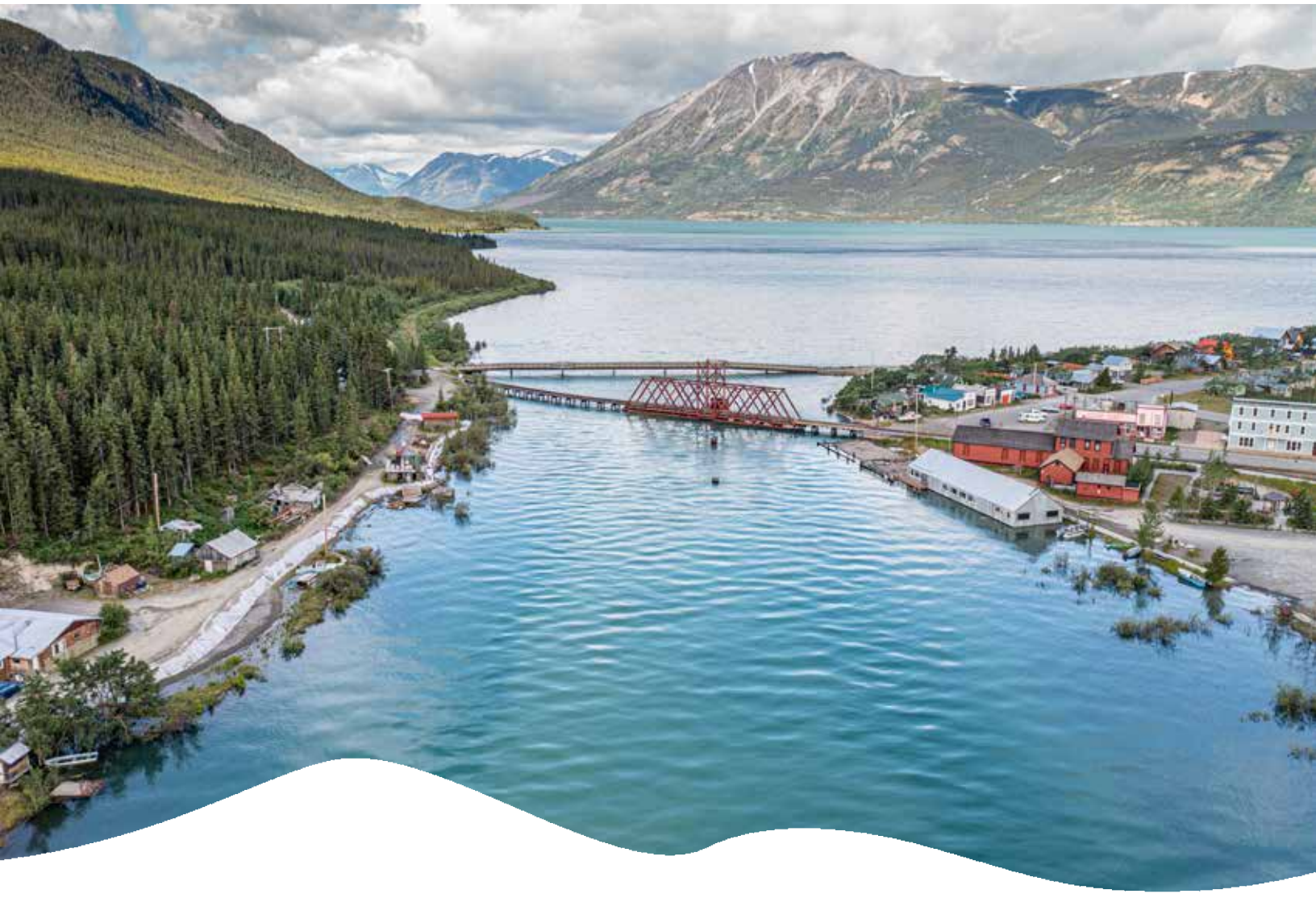
ASSESSING CLIMATE CHANGE

RISK AND RESILIENCE IN THE YUKON

EXECUTIVE SUMMARY



Yukon

Yukon University

CLIMATE RISK INSTITUTE

RESILIENT NORTH CONSULTING

Crown-Indigenous Relations and Northern Affairs Canada

Relations Couronne-Autochtones et Affaires du Nord Canada

Cover photo: Carcross, 2021. Photo: Jason Wolsky

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For more information or for questions about the report contact the Government of Yukon Climate Change Secretariat: https://yukon.ca/en/climate-change-yukon.

This is an Executive Summary of the findings of the Yukon Climate Risk Assessment.
A full-length version of the report is also available: Yukon.ca/climate-risk-assessment.

Contents

1 MESSAGE FROM THE PROJECT TEAM

We extend a warm thank-you to everyone who participated in this project. Your contributions helped to highlight the fact that while climate change continues to challenge us in unprecedented ways, Yukoners are resilient. We have a rich history of responding to changes on the land, and a wealth of knowledge to guide our understanding of risks and resilience.

We heard from people who have seen the changes on the land firsthand, and those who are working with communities to anticipate, prepare for and respond to changes. Participants in this project include Indigenous Knowledge holders and Elders, youth, and subject-matter experts working for federal, territorial, Indigenous and municipal governments, as well as academic and private-sector organizations.

Your guidance helped frame an understanding of how climate changes affect the things we value. By centring this risk assessment on a common set of core values, we are able to send the message that climate change impacts are interrelated and affect all aspects of Yukoners' lives. By adapting to climate change, we can protect and uphold the things that Yukoners value, which will make us more resilient in the long run.

We appreciate the opportunities to learn from one another by bringing together different perspectives. One of the most important lessons from this project was that bringing together diverse ways of knowing helps build resilience. Often, scientific ways of knowing focus on logic, research, data and numerical information. Indigenous world views offer teachings and stories about relying on relationships and values, learning how to live with uncertainty, and preparing for the unknown in order to increase resilience. Bringing in both these approaches can lead to creative and effective solutions for working together, sharing limited resources, and maintaining culture and ways of life.

Everyone can help build resilience to climate change impacts: individuals, municipalities, communities, First Nation and Inuvialuit governments, territorial and federal governments, academics, non-governmental organizations and the private sector. We hope this report helps us continue to work together so we can take the path to a highly resilient Yukon.

Sincerely,

The project team:

Climate Change Secretariat
YukonU - Climate Change and Indigenous Knowledge Research
Resilient North Consulting
Climate Risk Institute

2 PROJECT OVERVIEW

This project supports the implementation of *Our Clean Future*, the Yukon's climate change, energy and green economy strategy. In *Our Clean Future*, the Government of Yukon commits to assessing climate hazards and vulnerabilities to those hazards across Yukon every three to four years between 2020 and 2030 to prioritize climate change adaptation actions.[1] The assessment provides a starting point for informing how the Yukon can achieve its adaptation target, as set out in *Our Clean Future*: "by 2030, Yukon will be highly resilient to the impacts of climate change."

Objectives

The risk assessment had three main objectives:

- build an understanding of climate resilience across the Yukon;
- highlight the priorities for reducing risks; and
- identify the factors that contribute to resilience.

Method

The assessment carried out a semi-quantitative analysis[2] to understand risks and resilience. It considered the risks stemming from climate change hazards, and the respective actions that Yukoners are taking to adapt to the impacts of those hazards. The analysis considered the likelihood and consequences of climate impacts alongside lived experience and local knowledge. Including perspectives from western and Indigenous knowledge built a shared understanding of resilience.

Project participants from across the Yukon were vital to informing the assessment. They included people from a variety of backgrounds — representatives from the Government of Yukon and Canada, Yukon First Nations and transboundary Indigenous governments and organizations, municipalities, academia, non-profit organizations and sectors such as health, food, tourism, mining, and local business development.[3] They shared how climate change impacts are affecting communities across the Yukon, completed a scoring of climate risks, suggested ways to build resilience, and confirmed the findings. Youth from the Yukon Youth Panel on Climate Change and the Yukon First Nation Climate Action Fellowship also participated in the assessment, sharing their perspectives on how to achieve resilience.

1. This also stems from the 2017 December Report of the Auditor General of Canada to the Yukon Legislative Assembly's *Climate Change in the Yukon* Report, which stated that the Government of Yukon should complete a comprehensive, territory-wide risk assessment to prioritize commitments to manage the impacts of climate change.
2. The assessment relied on both numerical and observational and anecdotal sources of information to produce risk scores and then categorize the risk levels.
3. The process did not engage with community members. The risk assessment followed two rounds of engagement in the fall of 2018 and 2019 to develop *Our Clean Future*, Yukon's clean growth and climate change strategy The input received as part of that process informed this assessment.

The project team[4] drew on the steps in the International Standards Organization's (ISO's) 31000 Risk Management guidelines (ISO 2018) and adapted those steps to the Yukon context. Activities included developing a resilience framework for Yukon; hosting a series of conversations with project participants; scoring risks; compiling a risk database; reviewing the results; and developing recommendations for building resilience.

Three rounds of facilitated group discussions informed the assessment. The three rounds included: (1) the meaning of Yukon resilience, in theory and in practice, and the presentation of the proposed risk assessment framework; (2) discussing scenarios exploring how climate change impacts could play out in the Yukon and Yukoners' ability to reduce risks; and (3) sharing the risk scoring results to confirm priorities and findings.

The project team developed a list of 41 climate change impacts facing the Yukon. Participants scored the likelihood that each impact would occur, and the consequence if it did occur. The likelihood score was multiplied by the consequence score to equal the risk score for each of the nine values. The higher the risk score, the more severe the risk. The team reviewed the risk scores alongside the feedback from discussions with participants to identify high-risk priorities for building resilience.

Participants explored three main questions throughout the assessment:

- What climate change impacts are the most significant?
- In what ways are Yukoners undertaking actions, or ready to take actions, to manage climate risk?
- What additional support or work is required to ensure that Yukoners are resilient?

Overall, the guidance of project participants helped to describe how climate change impacts affect the things that matter to Yukoners. By centring this risk assessment on nine Yukon values — Infrastructure, Food security, Energy, Culture and Heritage, Access, Community, Livelihood, Environmental health, and Health and well-being — the resulting recommendations can lead the way to protecting and upholding these values for the Yukon.

A note on method

This assessment began to build a shared understanding of climate change risks and resilience. This required the broadening of perspectives typically considered in risk assessments. The assessment considered lived experience, stories, anecdotal evidence and local observations, and Indigenous values, as well as scores of risk likelihood and consequence. It adapted the principles and frameworks outlined in both ISO 31000 Risk Management – Principles and Guidelines, and ISO 14091 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment.

ISO 31000 outlines the standards and guidelines for risk assessments. ISO 31000 explains that risk assessments aim to manage risk through careful and systematic identification, analysis and treatment. It recommends that risk management frameworks be continually

4. Throughout this report, the "project team" refers to the Government of Yukon's Climate Change Secretariat, Brian Horton and Jocelyn Joe-Strack from Yukon University, Steve Roddick from Resilience North, and the team at the Climate Risk Institute.

improved and strengthened as they are integrated in planning and decision-making. ISO 14091, which discusses risk assessments in the context of climate change, recognizes that climate change risks differ from other risks, given the difficulty of predicting their probabilities. This means that climate change risk assessments might need to incorporate approaches that build on conventional methods. Assessments that primarily rely on statistical probabilities can be ineffective when looking at climate change impacts. This is especially true in the Yukon, where there are significant data and information gaps for climate projections, as well as capacity limitations across governments and communities to interpret and use the probabilities of climate risks in decision-making.

The approach taken in this Yukon assessment — a holistic look at societal resilience, values and challenges as they intersect with a rapidly changing climate — emphasizes the qualitative expertise and knowledge of Yukoners. Although risk analyses often focus on quantifiable information, such as economic losses or damage, the Yukon assessment created a resilience framework to understand and represent a diverse set of values and potential consequences to those values as a result of climate change impacts. Most of those consequences are not readily quantifiable.

However, similar to conventional risk assessment, a detailed and reproducible framework for ranking likelihood and consequence was established, and participants' expertise and input supported a scoring of risks. While the analysis does not provide quantitative or statistical modeling of risk, the framework nevertheless captures the primary elements of risk management: documentation and communication with its key audiences, systematic identification of risk scenarios, and risk analysis. Furthermore, the focus on resilience and areas of action strengthens the link to and supports integration with risk treatment (or adaptation planning and decision-making), and the framework is tailored to the Yukon context.

Future iterations of the risk assessment can expand and refine the list of risks identified, and continue to increase the depth of risk analysis. Qualitative and semi-qualitative risk assessments — similar to those undertaken in the Yukon that rely on the expertise and deep local knowledge of Yukoners — would benefit from additional opportunities to "workshop" and share knowledge, which were necessarily limited due to the COVID-19 pandemic. Further refinements, including but not limited to increasing regional and community-level scale of analysis, expanding the list of risks identified and analyzed, and incorporating climate and systems modeling, may also be possible.

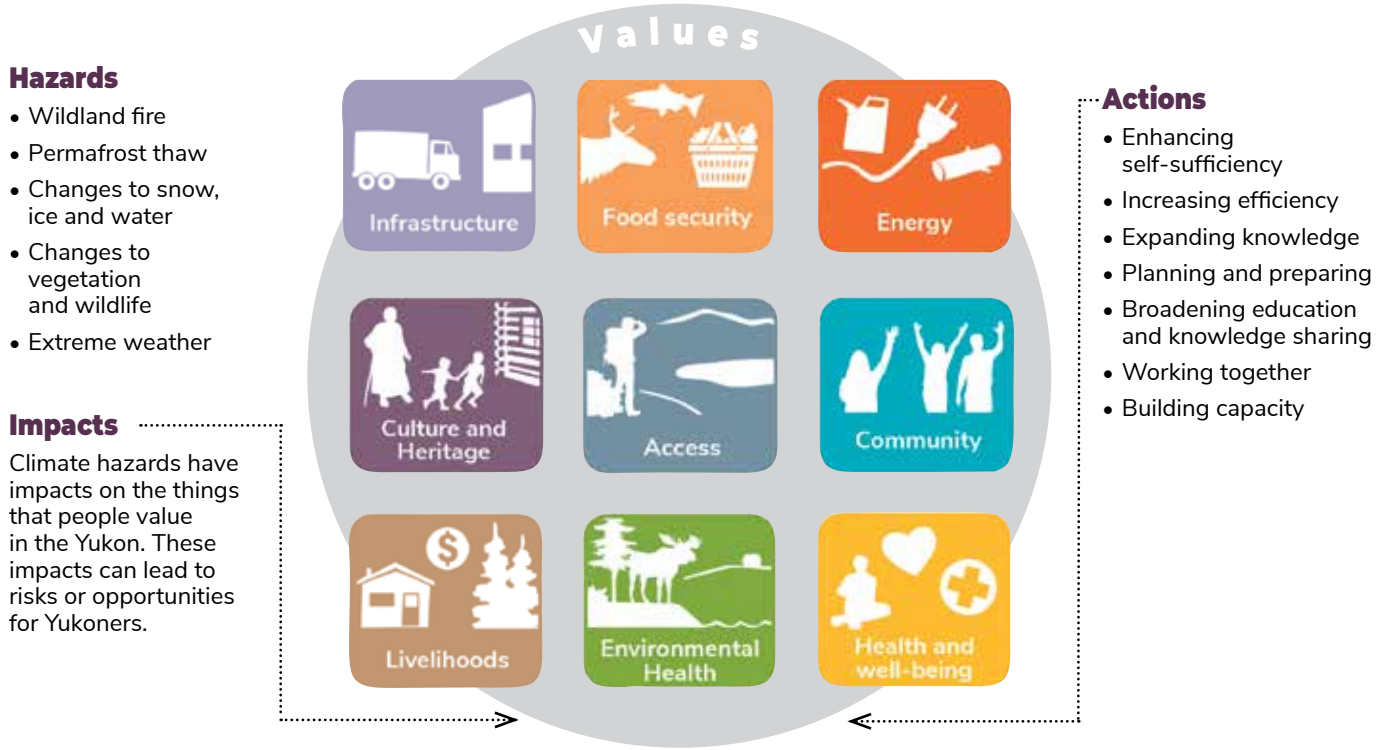
3 FINDINGS: WHAT IS RESILIENCE IN THE YUKON?

This assessment developed a framework for understanding resilience in the Yukon. The framework was developed by inviting project participants to discuss what resilience means to them and to share their experiences anticipating or coping with climate impacts while living and working in the Yukon. The project team used this framework to explore how climate change impacts pose risks to the things that Yukoners value so that society can uphold those values through policies and programs. The framework built on the Inter-governmental Panel on Climate Change (IPCC) definition of resilience: "the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance..." (IPCC 2022: 59, note 12).

The framework for resilience (Figure 1) focuses on the connections between the **impacts** of a changing climate, the **values** that are important to Yukoners; and the **actions** that build resilience to these impacts and uphold the nine core values:

- **impacts** are the results of climate change hazards on communities' health and well-being, infrastructure or delivery of services;
- **values** are the elements of Yukoners' lives that are important to safeguard in order to build resilience; and
- **actions** are the steps that Yukoners can take to make informed and forward-looking decisions to minimize risks stemming from climate change hazards, and take advantage of opportunities associated with climate change impacts.

Figure 1 The framework for resilience



Key messages

The Yukon's resilience stems from community values, strong relationships, values of self-sufficiency, communities working together, ongoing connections to the land, and making the most of limited resources.
Climate change continues to affect the Yukon at a disproportionate rate when compared to Southern Canada, and the impacts pose cross-cutting and interconnected risks to Yukoners' way of life. Everyone can help build resilience to climate change impacts: individuals, municipalities, communities, Indigenous peoples and governments, territorial and federal governments, academics, non-governmental organizations and the private sector.

Urgent and continuous action is needed to keep up with the many changes already underway.
This includes timely completion of and continued work to build on actions in *Our Clean Future*. The Government of Yukon, in partnership with participating Yukon First Nations, transboundary Indigenous groups and Yukon municipalities, is already taking action on the highest risks— floods, wildfires, permafrost thaw and ecosystem changes — through actions in *Our Clean Future*. Adaptation actions often build on one another (in other words, from assessing risks to implementing strategies to reduce risks), and the Government of Yukon will need to take an adaptive management approach, continuing to evaluate and adjust actions to reduce risks and build capacity for climate resilience. In the long term, increased and sustained resources for adaptation to match observed and projected changes will be required to be able to prepare for and respond to increasing climate change risks.

Climate change impacts are interrelated and affect all aspects of Yukoners' lives.
Each of the high-priority climate change risks affects the values that matter to Yukoners. For example, impacts to transportation infrastructure came up in almost every discussion with project participants. Issues such as food security, mental health, and well-being are affected by every priority risk area identified by the assessment. This means that intergovernmental collaborations, whole-of-government responses, and partnerships are especially important for building resilience.

Climate change impacts are not equally distributed across Yukon, and equity must be considered in climate change adaptation.
The Yukon's small communities are remote, and therefore face additional challenges due to their isolation and limited financial resources. Socio-economic standing, gender, Indigeneity and other factors may affect the severity with which people experience climate change and may influence their ability to act on resilience recommendations.

Some of the most important actions that build resilience are not just about climate change — they support people who face greater risks.
This includes, for example, ensuring adequate housing, access to food, employment, education and health. Issues such as health and well-being, food security, and safe access to the land are threatened by multiple and interconnected climate change risks. Implementing strategies such as the Government of Yukon's *Putting People First* report (Government of Yukon 2020b) and 2020 Agriculture Policy (Government of Yukon 2020a) will help build climate resilience. Communities across Yukon are also leading the way in addressing some of these challenges.

Climate action should support reconciliation.
Understanding the vulnerabilities, exposure and risks that communities face means confronting the historical events that shaped Yukon — including the 19th century whaling industry at Herschel Island-Qikiqtaruk, the Klondike Gold Rush, the 1918 flu epidemic, the construction of the Alaska Highway, and residential schools. While First Nations and the Inuvialuit continue to be resilient, the lived reality of Indigenous people in the Yukon needs to be understood and incorporated into analyses of the distribution and experience of climate-related impacts. In this regard, building climate resilience cannot be separated from First Nations' and Inuvialuit' self-determination and reconciliation.

Bringing together diverse ways of knowing builds resilience.
Indigenous knowledge offers teachings about living with uncertainty, fostering relationships to cope with changes, and broadening understanding of resilience to maintain ways of life and culture. Indigenous peoples and communities are often leading adaptation efforts across Yukon. The Umbrella Final Agreement, the Inuvialuit Final Agreement and the Yukon Transboundary Agreement of the Gwich'in Comprehensive Land Claim Agreement[5] are important mechanisms to support this work. They provide resources and avenues for co-management and working together by various government bodies.

5. The Yukon Transboundary Agreement (YTA) is a core part of the Gwich'in Comprehensive Land Claim Agreement (GCLCA) and it is known as Appendix C of the GCLCA.

What participants had to say about climate change impacts and resilience in the Yukon

You're always ensuring everyone's got food; if one house is low on food, there's sharing. Teaching resilience through sharing and caring... that is our (community) value...

PROJECT PARTICIPANT

When people in a community are close to the landscape, the rapid change of that landscape can lead to a sense of loss, insecurity, uncertainty and grief.

PROJECT PARTICIPANT

It's often the next community that houses and feeds another in the case of emergency... and that's the level of planning that we need to see happen.

PROJECT PARTICIPANT, EMERGENCY MEASURES ORG.

Resilience means survival and we always have [survived].

PROJECT PARTICIPANT FROM CHAMPAGNE AND AISHIHIK FIRST NATIONS

Storytelling has been a guidebook that First Nations have always used to pass down lessons, laws, guides for the younger people.

ELDER JOE COPPER JACK

In my community, people are asking, "Are we going to keep re-leveling my house every couple of years?" How do we address the problem?"

PROJECT PARTICIPANT

4 PRIORITIES AND RECOMMENDATIONS

Overarching findings

Supporting communities' capacity to undertake climate change adaptation initiatives

Continued collaboration and partnerships across Yukon are vital for building resilience to climate impacts. Yukon communities witness climate change impacts and are aware of the risks, but often lack the resources to implement solutions. Better coordination, clarity around government roles and responsibilities, and resources and capacity to inform adaptation are needed to build resilience. Adaptation actions should include opportunities for two-way information sharing, listening to local knowledge, and capacity building. In the Yukon, local knowledge is especially important for adaptation, due to limits in data quality and availability. Intergovernmental collaborations, whole-of-government responses, and partnerships can also help buffer some of the capacity limitations at the community level. Supporting communities' and governments' capacity to meaningfully consider climate change in regional land-use plans is vital.

Government collaboration on and ownership of climate risks is an essential part of adaptation

While community response and adaptation planning is an important part of building resilience to climate change impacts, it is recommended that governments continue to take a leadership role in developing and implementing adaptation strategies. This includes action by federal, territorial, municipal and Indigenous governments. Climate change risks are distributed across government mandates, so it is important for governments to implement risk management and risk reduction strategies using a whole-of-government approach. Additionally, governments must continue to take action on areas such as social supports, housing, economic development, and food security, and supporting people who face greater risks.

Training, capacity building, and support for staff to interpret climate projections and related information is needed

There are substantive gaps in training and skills with respect to using climate projections to inform decision-making — including the skills needed to understand data availability and gaps, incorporate climate projections, and interpret and use regional climate data. Areas where training is especially needed include infrastructure development, land-use planning, emergency preparedness, agriculture, mining and tourism. Process participants who work for territorial, First Nations or municipal governments commented that their organizations or teams are often aware of the climate hazards involved, but are unsure how to interpret climate projections, apply emerging climate-related codes and standards (if they are aware of them), or assess the level of risk.

The seven priorities

Seven priorities emerged from the assessment. Each priority includes relevant climate change impact statements. The project team identified these priorities in the following ways: by reviewing the risk statements that scored high for multiple values, by highlighting recurring themes from discussions with participants, and by highlighting areas that participants identified as significant for building resilience.

The following sections summarize the findings and recommendations for each priority. Key **findings** and **recommendations** are noted for each priority.

- Priority 1: Extreme weather and precipitation events that threaten transportation infrastructure
- Priority 2: Floods and fires that threaten communities and livelihoods
- Priority 3: Permafrost thaw that affects communities, infrastructure and access
- Priority 4: Changing climate conditions that affect land, water, animals and plants
- Priority 5: Changing conditions on the land that threaten safety and access, culture and heritage, livelihoods, and health and well-being
- Priority 6: Multiple climate change impacts that affect health and well-being
- Priority 7: Risks to the Yukon's economy

Priority 1 Extreme weather and precipitation events that threaten transportation infrastructure

Findings: Transportation infrastructure came up in almost every discussion with project participants. Risks related to supply chain interruptions received high scores. The most significant impacts for transportation infrastructure include wildfires, warming winter conditions, washouts and landslides, damage from flooding, reduced access to winter roads and ice bridges, and permafrost thaw.

Interruptions and damage to Yukon's roads and highways can affect all facets of Yukoners' lives. For example, they can disrupt the flow of fuel and food, sever connections between communities, make it more difficult or impossible for Yukoners to travel for healthcare or essential services, and prevent local businesses from operating. The consequences of transportation interruptions are especially pronounced in the winter due to potential impacts to communities during periods of extreme cold.

Recommendations: Building resilience to transportation infrastructure is vital. Through *Our Clean Future*, the Government of Yukon is completing vulnerability assessments and hazard mapping along Yukon's transportation network. This work is planned for completion in 2023. The completion of the vulnerability assessments will inform the strategic deployment of staff capacity, equipment and funding for upgrades and maintenance.

Ensuring that Yukoners are food secure, have access to health and social services, have back-up heat and power, and can recover financially from interruptions to local businesses will also provide a buffer against risks to transportation infrastructure.

> "**You can give** someone 300 dollars and they can go to the grocery store and you can probably have enough food for a week or you could take that same 300 dollars for gas and ammunition and what you need on the land, and harvest meat that can last you all winter.
>
> PROJECT PARTICIPANT, OLD CROW

The Government of Yukon is in the process of completing several actions outlined in *Our Clean Future* that will build capacity to address risks to transportation infrastructure, such as this washout near the White River bridge. They include mapping flood and geohazard risks along transportation corridors, and considering climate change information in upcoming road infrastructure developments. It is important to complete these actions as quickly as possible in order to be proactive and to limit any costs associated with impacts.

Table 1 summarizes the risk scores for for the most significant impacts related to Priority 1. For more details about the scoring process, see Method on page 2.

Table 1 Summary of risk scores, Priority 1: Extreme weather and precipitation events that threaten transportation infrastructure

No.	Impact		Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from very low to very high	Consequences to values
2		Wildfires threaten communities, heritage values, and infrastructure	INF 17	FS 11	EN 15	**High:** more likely than not to occur multiple times per decade; may occur annually	• Supply chain interruptions • Interruptions in access to essential services such as health care and social services • Interruptions of essential supplies such as fresh food and fuel • Mental health impacts from isolation • Higher food prices due to supply chain interruptions • Disruptions to local business and tourism • Hindered repair and maintenance of power supply
			CH 16	AC 14	CM 15		
			LH 12	EH 16	HW 16		
12		Warming winter conditions reduce the availability of winter roads and ice bridges	INF 13	FS 15	EN 13	**High:** more likely than not to occur multiple times per decade; may occur annually	
			CH 12	AC 16	CM 14		
			LH 13	EH 12	HW 14		
31		Washouts and landslides lead to transportation service interruptions or failures	INF 13	FS 13	EN 12	**Moderate:** more likely than not to occur once per decade; may occur multiple times per decade	
			CH 11	AC 13	CM 12		
			LH 11	EH 10	HW 12		
33		Extreme precipitation events cause damage	INF 17	FS 16	EN 15	**High:** more likely than not to occur multiple times per decade; may occur annually	
			CH 15	AC 16	CM 16		
			LH 16	EH 15	HW 16		
39	Range of hazards	A range of climate-related factors disrupt critical supply chains	INF 14	FS 17	EN 15	**High:** more likely than not to occur multiple times per decade; may occur annually	
			CH 9	AC 18	CM 16		
			LH 16	EH 12	HW 17		

Legend:

The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods

Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high

Risk score

Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 2 shows the recommended actions to increase resilience for Priority 1.

Table 2 Summary of recommended actions, Priority 1: Extreme weather and precipitation events that threaten transportation infrastructure

Impact no.	Significant impacts, Priority 1	Recommended actions to increase resilience
2	Wildfires threaten communities, buildings, heritage values or other infrastructure	• Carry out vulnerability assessments and hazard mapping for Yukon's transportation infrastructure • Make resources available for responding to recommendations from road vulnerability assessments and hazard mapping • Support food security for store-bought and locally produced foods • Explore opportunities to support household preparedness fo power outages
12	Warming winter conditions reduce winter road and ice bridge availability	
31	Washouts and landslides lead to highway and transportation infrastructure service interruptions or failures	
33	Damage from extreme precipitation events	
39	A range of climate-related factors disrupt critical supply chains	

Priority 2 Floods and fires that affect communities and livelihoods

Findings: Yukon communities are located along rivers or lakes and in or near forested areas. This makes flooding and wildland fires critical hazards. Climate change is increasing flood risk, and the conditions for wildland fires are becoming more common due to increased temperatures, drier forests, and more extreme weather events. Floods and fires can pose health and safety risks, damage homes and community buildings, property and infrastructure, cause costly damage, and affect critical services.

The assessment found that both flood and fire hazards need further attention, but that it is especially important to continue to build capacity for flood mapping, preparedness and response. This finding was reflected in the scores and in discussions; participants gave a higher risk score to floods than they did to wildfires.

Wildland fire risk continues to be high across the territory. While wildland fires have always been a part of the landscape, they pose risks when they have impacts on human values. Special attention should be paid to high fuel loads around communities and to reducing private-property risks. The Yukon's ability to respond to wildfires sometimes depends on the availability of firefighters and personnel, and can be delayed in remote areas or due to resource constraints.

The year 2021 highlighted important lessons for emergency response. Throughout the winter, Yukon experienced unusually high precipitation. This was followed by a heat wave that lasted throughout the late spring and summer. The heat resulted in a rapid melt of the record-breaking snowpack in the alpine areas of the Southern Lakes Region. At the same time, the heat led to favourable conditions for forest fires and heightened fire risk. As a result, the Yukon experienced severe wildfires and flooding at the same time, all while emergency response was grappling with COVID-19. While emergency response efforts were considerable, the combination of floods, fires and the pandemic stretched the Yukon's capacity beyond its ability to deal with multiple stressors at once.

The 100-year flood return period, sometimes referred to as "the 100-year flood," refers to a rare flooding event that is expected to be exceeded once every 100 years on average, and has a one percent chance of happening in any year. In the past 15 years, severe floods surpassing the 100-year flood return period occurred twice in Marsh Lake: once in 2007 and again in 2021. Shown left are flooded properties at Marsh Lake, 2021.
Photo: Jason Wolsky

Recommendations: Opportunities exist to bring together those responsible for forecasting, mapping, planning and responding to emergencies to share lessons learned, and discuss resource requirements and roles and responsibilities should a similar situation occur in the coming years. Adequate capacity is required for governments and communities to implement clear and effective local emergency planning.

Actions to strengthen resilience to floods and fires include increased capacity for flood forecasting, ensuring community preparedness for floods and fires, increasing response and preparedness for floods, educating the public about household preparedness and risk reduction best practices, incorporating information on hazards into new infrastructure developments, ensuring a strong understanding of emergency response goals, and working to ensure that Yukoners can recover financially from emergencies related to floods and wildfires.

Clarity around responsibilities for emergency preparedness and response is needed across the Yukon. This includes outlining the roles and authorities of municipalities, First Nations, the territorial government and the private sector. This is vital for Yukon's remote communities, which have limited resources to plan, prepare and respond to emergencies. There is an opportunity to strengthen collaboration and clarify roles and responsibilities for emergency response through the update of the *Civil Emergency Measures Act*.

> **It's often the** next community that houses and feeds another in the case of emergency — not easy to take on residents of neighbouring community at a time of need and that's the level of planning that we need to see happen.
>
> PROJECT PARTICIPANT, YUKON EMERGENCY MEASURES ORGANIZATION

Table 3 summarizes the risk scores for for the most significant impacts related to Priority 2.

Table 3 Summary of risk scores, Priority 2: Floods and fires that affect communities and livelihoods

No.	Impact		Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
2		Wildfires threaten communities, heritage values, and infrastructure	INF 17	FS 11	EN 15	**High:** More likely than not to occur multiple times per decade; may occur annually	• Impacts to air quality (wildfire smoke) • Damage to homes, buildings and community infrastructure • Physical health and safety risks • Safety risks for getting out on the land and impacts to harvested foods, cultural practices, and well-being • Damage to community spaces can affect ability to gather • Damage to transportation infrastructure and interruptions to supply chains • Reduced access to seasonal and ice roads • Mental health impacts • Costly damage affecting household financial security • Damage to energy infrastructure
			CH 16	AC 14	CM 15		
			LH 12	EH 16	HW 16		
11		Changing water levels, conditions, and flow in rivers and lakes affect community infrastructure	INF 20	FS 15	EN 17	**Very high:** Likely annual, ongoing occurrences	
			CH 18	AC 16	CM 16		
			LH 14	EH 16	HW 14		
17		Changes to the timing of ice freeze-up and break-up on waterways	INF 14	FS 14	EN 11	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 14	AC 17	CM 14		
			LH 13	EH 11	HW 13		
18		Groundwater levels are raised in some regions or areas, posing risks to community infrastructure	Impact 18 did not receive enough responses for conclusive results. It may be worth assessing in a future climate risk assessment.				
19		Ice-jam floods occur along the Yukon River and in other important watersheds	INF 15	FS 11	EN 10	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 11	AC 13	CM 12		
			LH 9	EH 11	HW 11		
29		Flooding in communities is more frequent and severe	INF 16	FS 14	EN 14	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 14	AC 15	CM 14		
			LH 12	EH 12	HW 13		
33		Damage from extreme precipitation events	INF 17	FS 16	EN 15	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 15	AC 16	CM 16		
			LH 16	EH 15	HW 16		

Legend:
The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods
Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high
Risk score
Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 4 shows the recommended actions to increase resilience for Priority 2.

Table 4 Summary of recommended actions, Priority 2: Floods and fires that affect communities and livelihoods

Impact no.	Significant impacts, Priority 2	Recommended actions to increase resilience
2	Wildfires threaten communities, heritage values, and infrastructure.	• Build capacity for flood forecasting and flood mapping • Expand monitoring and modelling to support flood forecasting • Build capacity to predict areas vulnerable to groundwater flooding and to mitigate the potential adverse impacts of groundwater floods in those areas • Support community preparedness for floods • Support preparedness for floods and fires on private and commercial properties • Increase capacity for incident response • Support preparedness for fires on publicly owned properties • Incorporate information on flood risks into community infrastructure development • Ensure that Yukoners work together on flood-related emergency response • Explore how collaboration can support emergency planning and response • Ensure adequate financial recovery is available for emergencies related to floods and wildfires
11	Changing water levels, conditions and flow in rivers and lakes affect community infrastructure	
17	Changes to the timing of ice freeze-up and break-up on waterways	
18	Groundwater levels are raised in some regions or areas, posing risks to community infrastructure	
19	Ice-jam floods occur along the Yukon River and in other important watersheds	
29	Flooding in communities is more frequent and severe	
33	Extreme precipitation events cause damage	

Priority 3 Permafrost thaw that affects communities, infrastructure and access

Findings: Permafrost thaw affects most communities across the Yukon, and communities with limited resources and ice-rich permafrost (which is more likely to thaw) will see more significant impacts. Yukoners are already seeing the impacts of permafrost thaw. Some people are dealing with damage to local buildings that serve as important gathering places. Others worry about their families' health and safety when homes slump or shift. People in communities downstream from mining sites worry about impacts to their fish camps and nearby waterways, as permafrost thaw can pose hazards for critical mine infrastructure. Costly and recurring damage to roads and buildings is leading to difficult conversations about whether to move homes or to shut down community buildings.

The frozen ground that anchors Herschel Island-Qikiqtaruk, located off the Yukon's north coast, is thawing, and affecting Inuvialuit history and culture. In Old Crow Flats/Van Tat, people are seeing the dramatic ways that landscapes can change, with entire lakes draining because of permafrost thaw. These impacts are specific to place, and efforts to identify hazards, monitor changes, and upgrade infrastructure must be coordinated with community participation and the input of local values.

Recommendations: Proactive action to reduce risks is important. Although hazards related to permafrost thaw received moderate climate risk scores, team members identified this as a priority after considering the scores and having discussions with project participants and subject matter experts. Experts noted that permafrost thaw may be a slow process, which can reduce the sense of urgency in responding to this risk. However, permafrost is also vulnerable to other climate hazards, such as wildfires, river erosion and changing hydrology, and it can thaw rapidly once it is disturbed.

Permafrost thaw and erosion at the Takhini River thaw slump (left) are encroaching on the Alaska Highway. Many participants noted that the Alaska Highway was particularly vulnerable to permafrost thaw. A study done in 2015 (Calmels et al. 2015) found that, of the 200-km section between Burwash Landing and the Yukon-Alaska border, 42.7 per cent — almost half — is highly vulnerable.

Responding quickly can be hard because of the time and expertise required to secure permits.[6] In addition, addressing permafrost damage is costly: according to the Government of Yukon, Highways and Public Works, stabilizing the Ross River school cost more than $1.6 million.

> **More work is needed** to create standards and guidance to ensure mine infrastructure is resilient to climate change and to include appropriate provisions in regulatory instruments..
>
> DISCUSSION HIGHLIGHT FROM THE ASSESSMENT

Through *Our Clean Future*, the Government of Yukon is completing geohazard maps of all Yukon communities and assessing geohazard risks along transportation corridors. The Government of Yukon is also compiling a Yukon Permafrost Database, which will include geotechnical and ground temperature data. In order to build resilience to permafrost thaw, it is important to ensure that information to support decision-making is available to those responsible for planning, developing and upgrading infrastructure. This information includes permafrost data and geohazard maps, northern infrastructure standards, and guidelines for key sectors, such as mining and transportation. Building community capacity and ensuring adequate and sustained resources to plan for, monitor and upgrade infrastructure at risk from permafrost thaw will strengthen resilience.

More research is needed to understand the magnitude, timing and extent of impacts; for example, the impacts of permafrost thaw on ecosystem health and human health, the impacts of thawing permafrost on groundwater, and the possible release of greenhouse gases from thawing permafrost. Change in these systems has already been observed, but a comprehensive understanding of how much change is still to come is lacking.

6. This includes hiring engineering firms, obtaining land-use permits and completing YESAB reviews

Table 5 summarizes the risk scores for for the most significant impacts related to Priority 3.

Table 5 Summary of risk scores, Priority 3: Permafrost thaw that affects communities, infrastructure and access

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high	Consequences to values
4		Permafrost thaw and ground subsidence damages buildings and infrastructure	INF **17**	FS **12**	EN **12**	**High:** More likely than not to occur multiple times per decade; may occur annually	• Damage to homes and community gathering places • Damage to critical infrastructure • Health and safety concerns for community members living in or accessing buildings with permafrost damage • Difficulty accessing the land • Changes to the landscape and impacts to wildlife • Exposure of traditionally harvested ecosystems to contamination • Damage to mining infra-structure and downstream impacts to communities • Mental health impacts associated with changing landscapes • Impacts to cultural and community values from reduced access to the land • Impacts to culture, community gathering, ability to share knowledge, bring together Elders and youth
			CH **14**	AC **15**	CM **14**		
			LH **11**	EH **12**	HW **11**		
8		Permafrost thaw alters land forms and ecology	INF **11**	FS **10**	EN **9**	**Moderate:** More likely than not to occur once per decade; may occur multiple times per decade	
			CH **13**	AC **11**	CM **11**		
			LH **11**	EH **11**	HW **10**		
9		Permafrost thaw causes critical infrastructure failures	INF **16**	FS **9**	EN **13**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **12**	AC **11**	CM **11**		
			LH **11**	EH **11**	HW **10**		

Legend:

The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods

Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high

Risk score

Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 6 shows the recommended actions to increase resilience for Priority 3.

Table 6 **Summary of recommended actions, Priority 3: Permafrost thaw that affects communities, infrastructure and access**

Impact no.	Significant impacts, Priority 3	Recommended actions to increase resilience
4	Permafrost thaw and ground subsidence damages buildings and infrastructure	• Ensure that permafrost data are available to those responsible for planning, developing and upgrading infrastructure; continue to support research efforts that characterize permafrost • Raise awareness and build capacity for adopting northern infrastructure standards • Build the capacity of key sectors to consider climate projections and impacts • Ensure that the mining sector is planning for and reducing risks to its infrastructure stemming from permafrost thaw
8	Permafrost thaw alters land forms and ecology	
9	Permafrost thaw causes critical infrastructure failures	

Priority 4 Changing climate conditions that affect land, water, animals and plants

Findings: Climate change is one of the biggest threats facing ecosystems, given the range of impacts already experienced, the speed of change, and the vastness and diversity of the Yukon's terrain. Changing conditions and temperatures affect ecosystems on land and in water, as well as the composition, distribution and movement, health, availability, and spread of illness and parasites in plants and animals. This poses risks to environmental health, and to Yukoners' food security, livelihoods, community and cultural values. For Yukoners, and Indigenous peoples in particular, cultural identity depends on accessing the land, and environmental health is closely linked to human health and well-being.

> **I've been involved** with the Committee on the Status of Endangered Wildlife in Canada since 2006 or so. It's quite amazing how quickly climate change went from a minor consideration affecting species at risk to being one of the greatest threats. Certainly, it's one of the biggest threat to species in [the] Yukon.
>
> PROJECT PARTICIPANT

Resilience to ecosystem impacts is difficult to describe due to the complexity of the relationships between humans, plants and animals, the localized nature of some impacts, and the diversity of ecosystems and communities throughout the territory. A comprehensive review of the impacts of climate change on plants, fish, wildlife and biodiversity in the Yukon is beyond the scope of this report. However, the assessment suggests that the Yukon's ability to adapt to the range of impacts is limited. In many cases, the changes outpace the Yukon's ability to gather and analyze the information needed to adapt (i.e., data collection, monitoring and modeling).

Recommendations: The assessment found that more can be done to identify ecosystems and species that require urgent action, managing invasive species, and support communities' access to harvested foods. Models that predict the impacts of climate change on species, particularly species at risk, are still being developed. Although monitoring is carried out throughout the Yukon, it needs

Climate change is projected to affect habitat across the territory. Participants noted the urgency of action; climate change is one of the biggest threats facing species in the Yukon, given the range of impacts already experienced.

to increase given the pace of climate change impacts, and the persisting gaps in information. Experts who work on environmental health noted that there are significant gaps in managing invasive species and their impacts on biodiversity.[7] Building capacity for prevention, early detection, rapid response and management is needed.

Through *Our Clean Future*, work on parks and protected areas and the Yukon Parks Strategy, programming related to fish and wildlife, and the implementation of Yukon First Nations Final Agreements, the Inuvialuit Final Agreement, and Gwich'in Comprehensive Land Claim Agreement, the Government of Yukon is monitoring the health of certain species to indicate climate change impacts on ecosystems, assessing the health status of wetland ecosystems, tracking new and invasive species, monitoring climate change impacts in parks and protected areas, and working with Indigenous governments and organizations on protected area management, monitoring, and stewardship. Yukon's protected area network is not yet complete. For example, the *Parks and Land Certainty Act* commits the Government of Yukon to have one core protected park within each ecoregion. This has not yet been achieved.

Joint management initiatives among federal, territorial and Indigenous governments — and the implementation of Yukon First Nations Final Agreements, the Inuvialuit Final Agreement, and the Yukon Transboundary Agreement of the Gwich'in Comprehensive Land Claim Agreement — are identifying priorities for conservation, management and stewardship. The implementation of co-management and joint management agreements over lands and waters can build meaningful relationships, advance reconciliation, and build capacity to adapt to climate change impacts. Additionally, land guardian programs can support and/or facilitate community-based monitoring and can help fill gaps in information and build capacity to adapt to changes to plants and animals.

7. Participants explained that in the Yukon, there is no single government department that has a mandate to manage or respond to impacts of biodiversity outside specific sectors or areas (such as parks). Plants, fungi and invertebrates are examples. The Department of Environment manages wildlife (vertebrate animals) and their habitat, which is harvest focused. Fungi and plants fall under the responsibility of the Department of Energy, Mines and Resources, but they are considered in the context of forestry and agriculture. This leads to a gap in managing many invasive species and their effects on biodiversity more broadly.

Table 7 summarizes the risk scores for for the most significant impacts related to Priority 4.

Table 7 Summary of risk scores, Priority 4: Changing climate conditions that affect land, water, animals and plants

No.	Impact		Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
15		Changing winter conditions affect ecosystems, wildlife and biodiversity	INF 12	FS 15	EN 13	**High:** More likely than not to occur multiple times per decade; may occur annually	• Threats to wildlife and plant health and abundance • Changes to migration patterns • Stress to wildlife habitats (terrestrial and aquatic) • Threats to biodiversity • Food security concerns • Health and well-being impacts from reduced food security • Impacts to cultural and community values from reduced access to country food
			CH 13	AC 14	CM 14		
			LH 15	EH 17	HW 12		
20		Freshwater temperatures rise in some rivers and lakes, disrupting ecosystems	INF 7	FS 13	EN 7	**Moderate:** More likely than not to occur once per decade; may occur multiple times per decade	
			CH 10	AC 7	CM 9		
			LH 12	EH 13	HW 10		
23		Changing climate affects composition, distribution and movement of plants and animals	INF 9	FS 11	EN 9	**Moderate:** More likely than not to occur once per decade; may occur multiple times per decade	
			CH 11	AC 9	CM 11		
			LH 11	EH 15	HW 12		
24		Changing climate conditions affect health and availability of plants and animals	INF 8	FS 19	EN 9	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 18	AC 10	CM 15		
			LH 17	EH 20	HW 14		
26		A warming climate worsens the spread of illness and parasites in plant and animals	INF 6	FS 14	EN 6	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH 12	AC 6	CM 14		
			LH 12	EH 16	HW 16		

Legend:

The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods

Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high

Risk score

Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 8 shows the recommended actions to increase resilience for Priority 4.

Table 8 Summary of recommended actions, Priority 4: Changing climate conditions that affect land, water, animals and plants

Impact no.	Significant impacts, Priority 4	Recommended actions to increase resilience
15	Changing winter conditions affect ecosystems, wildlife and biodiversity	• Identify the ecosystems and species at most risk from climate change impacts • Increase monitoring capacity in order to forecast, assess and respond to changes • Build capacity for responding to invasive species • Continue to expand the network of protected areas • Continue to build capacity to consider climate change impacts in parks, protected areas and managed areas • Continue to manage parks and protected areas collaboratively with First Nations and Inuvialuit, and explore how the idea of Indigenous Protected and Conserved Areas may apply in the Yukon • Explore how nature-based solutions may apply in the Yukon
20	Freshwater temperatures rise in some rivers and lakes, disrupting ecosystems	
23	Changing climate affects composition, distribution and movement of plants and animals	
24	Changing climate conditions affect health and availability of plants and animals	
26	A warming climate worsens the spread of illness and parasites in plant and animals	

Priority 5 Changing conditions on the land that pose risks to safety, access, culture and heritage, and livelihoods

Findings: Climate change impacts pose risks for Yukoners, Yukon First Nations people and transboundary Indigenous people who use important places on the land and water for food security, livelihoods, cultural and traditional activities, and recreation. Hazards that contribute to significant risks include increased forest fires; changing conditions on rivers and lakes; extreme weather conditions, and landscape-level changes from permafrost thaw. Conditions are becoming increasingly unpredictable. These impacts pose health and safety risks for travel, affect hunting and fishing seasons, restrict or prevent access to important gathering places and cultural sites, reduce tourism operators' and visitors' ability to access the backcountry, and affect peoples' sense of belonging, community and well-being.

These risks affect the health and well-being of Yukon communities, as these values are closely connected to the land. People who access the land for food and subsistence, who live in remote areas, and who already face food insecurity are at particularly high risk. In remote areas, store-bought food can be expensive, with poor quality and selection. Access to the land can also be restricted because of the costs of the equipment and fuel needed to reach remote areas. Additionally, getting out on the land may also require taking time away from wage work, which may not be possible for some low-income families.

Both experienced and inexperienced travelers face safety concerns accessing backcountry areas. Established routes through remote areas, known to be safe for decades, may be hazardous due to changing climate conditions. Participants gave some of the highest scores to changing snow and ice cover, which create unsafe or unreliable conditions (Impact 16). It scored among the top impacts for almost every one of the nine values.

Citizens of White River First Nation have noted that changes in creeks and rivers affect their access to cabins and hunting and fishing sites. In remote areas of the Yukon, there is limited access, greater dependence on local food sources or traditional foods (left), and fewer grocery stores. According to one risk assessment participant, "Over the last three years, we have not been able to access [our] cabins in certain areas when we usually would, due to changes in ice."

> **What I'm seeing** is a broad range of folks getting in trouble. Both experienced travelers but also inexperienced. What I'm seeing is a changing demographic in the Yukon that involves folks coming up and getting out onto the land that don't necessarily have the experience that was once gleaned by years on the land.
>
> PROJECT PARTICIPANT, KLUANE NATIONAL PARK AND RESERVE

Community-based research across the Yukon (Guyot et al. 2006) highlights cases where impacts are especially pronounced. In Beaver Creek, community members have noted that the river no longer freezes over, leaving them with no ice to travel on. In the Kluane area, community research (KFN and AICBR 2016) noted that many fishing spots are no longer safely accessible due to the changing environment and thin ice.

The level of capacity for risks related to safety on the land is unknown, and likely varies across the Yukon. While some people have adapted to changing climate and weather by changing when, where and what they hunt, fish or gather, others are finding it harder to adapt. The ability to predict and adapt to these conditions is vital in order to increase resilience.

Recommendations: Recommendations to build resilience include clarifying how governments and communities can work together to monitor and predict conditions on the land, providing the equipment and safety gear needed for accessing remote areas, and providing search and rescue assistance; exploring ways to support food security for harvested foods; and protecting heritage sites at risk from climate change impacts.

Table 9 summarizes the risk scores for for the most significant impacts related to Priority 5.

Table 9 Summary of risk scores, Priority 5: Changing conditions on the land that pose risks to safety, access, culture and heritage, and livelihoods

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
1		Wildfire smoke is transported long distances, affecting local and regional air quality	INF **15**	FS **16**	EN **15**	**High:** More likely than not to occur multiple times per decade; may occur annually	• Health and safety risks when traveling on the land • Difficulty accessing cultural and heritage sites • Damage to historic buildings and structures, natural heritage sites, and traditional and cultural sites; for example, traditional camps along river-banks and lakeshores at risk from flooding or erosion • Damage to community gathering places, such as fishing and hunting camps, cultural sites and harvest sites, for example, roofs of smokehouses, fishing and hunting camp structures, and family cabins caving in from high snow loads • Food insecurity, particularly remote communities • Reduced access for businesses operating in remote areas • Increased pressure on communities for search and rescue • Negative impacts to cultural values, health and well-being, and community values
			CH **16**	AC **16**	CM **15**		
			LH **16**	EH **17**	HW **17**		
7		Permafrost thaw destabilizes soil conditions	INF **18**	FS **12**	EN **10**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **10**	AC **16**	CM **12**		
			LH **10**	EH **10**	HW **8**		
10		Storm surges, shoreline erosion and decreasing near-shore ice alter the Yukon North Slope	INF **12**	FS **10**	EN **7**	**Moderate:** More likely than not to occur once per decade; may occur multiple times per decade	
			CH **13**	AC **12**	CM **12**		
			LH **10**	EH **12**	HW **10**		
16		Changes to snow and ice cover create unsafe or unreliable conditions that reduce access to the land	INF **21**	FS **21**	EN **16**	**Very high:** Likely annual, ongoing occurrences	
			CH **19**	AC **23**	CM **19**		
			LH **20**	EH **21**	HW **20**		
17		The timing of ice break-up on waterways changes, including earlier spring break-up	INF **14**	FS **14**	EN **11**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **14**	AC **17**	CM **14**		
			LH **13**	EH **11**	HW **13**		
28		Health and safety of people on the land are at risk from variable, uncertain and extreme weather	INF **12**	FS **14**	EN **12**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **15**	AC **12**	CM **15**		
			LH **16**	EH **13**	HW **14**		

Legend:
The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods
Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high
Risk score
Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 10 shows the recommended actions to increase resilience for Priority 5.

Table 10 Summary of recommended actions, Priority 5: Changing conditions on the land that pose risks to safety, access, culture and heritage, and livelihoods

Impact no.	Significant impacts, Priority 5	Recommended actions to increase resilience
1	Wildfire smoke is transported long distances, affecting local and regional air quality	• Clarify roles and capacity to address risks related to access • Support food security for harvested foods. Examples include food preservation and storage (e.g., root cellars, community freezers), hunter support programs and subsidies, culture camps, and camps for training and knowledge transmission for small and big game for family members, youth, and middle generations • Continue to build resilience to climate change impacts on the North Slope • Document and protect heritage sites to adapt to a changing climate • Continue to develop community-based monitoring and safety programming
7	Permafrost thaw destabilizes soil conditions	
10	Storm surges, shoreline erosion and decreasing near-shore ice alter the Yukon North Slope	
16	Changes to snow and ice cover create unsafe or unreliable conditions that reduce access to the land	
17	The timing of ice break-up on waterways changes, including earlier spring break-up	
28	Health and safety of people on the land are at risk from variable, uncertain and extreme weather	

Priority 6 Multiple climate change impacts that affect health and well-being

Findings: Human health and well-being are linked to environmental health, and climate change is affecting places and species that are important for Yukon communities, cultures, health and well-being, and food security. Communities' health and well-being are also affected when people are unable to harvest animals and plants that are important to their diet and culture.

Health risks stem from increased risk of fires, floods and other extreme weather events. People who face higher risks include older adults, children and people with pre-existing health conditions, people with disabilities, people who are economically disadvantaged, and those who are pregnant.

Mental health concerns can also arise from impacts to community infrastructure. For example, when the Ross River School closed because of unsafe conditions due to permafrost thaw, it affected the community's ability to gather, carry out ceremonies, stay active, and bring together Elders and youth. Participants explained that communities such as Mayo, Old Crow and Lower Post are also seeing that damage related to flooding, permafrost thaw or wildfires is affecting local buildings that people rely on for gatherings and ceremonies.

Project participants often spoke about the past and present-day burdens of colonialism, and climate change worsens many of these challenges. This includes the legacy of forced relocation, residential schools, and the restriction of traditional languages and practices. Surviving families continue to face ongoing challenges, as these affect their skill set, experience and comfort accessing the land.

Recommendations: Special attention needs to be paid to mental health risks. Mental health effects are associated with a range of climate impacts, and include an increasing sense of uncertainty, fear and anxiety. Changes to the landscape that people rely on can also lead to a loss of identity and cultural connection and to reduced self sufficiency.

Climate change is affecting places and species that are important for Yukon communities (such as Klukshu, left), cultures, health and well-being, and food security.

> **We need more support** for mental health and organizations that support, protect and empower Indigenous women and people who are vulnerable. People who are struggling. The LGB(T)Q2+ community. My mom and my grandma are residential school survivors. It's so hard, trying to walk in a path of light … It would help if there could be places for people to go to feel safe if they need it. Resilience is community and people. And holding each other up and supporting them. That means holding them up through their addictions and their personal problems. The mental health crisis is not a joke. I'd like to see more action about that."
>
> YUKON FIRST NATIONS CLIMATE ACTION FELLOW

Recommendations for building resilience include supporting culturally appropriate health and social programs and services; implementing recommendations from related efforts, such as the Government of Yukon's Putting People First strategy; and creating safe spaces for Yukoners to cope with environmental anxiety.

Table 11 summarizes the risk scores for for the most significant impacts related to Priority 6.

Table 11 Summary of risk scores, Priority 6: Multiple climate change impacts that affect health and well-being

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
16		Changes to snow and ice cover create unsafe or unreliable conditions that reduce access to the land	INF **21**	FS **21**	EN **16**	**Very high:** Likely annual, ongoing occurrences	• Decline in mental health and well-being • Climate-change-related grief and loss • Health impacts from changes to environmental health • Community isolation • Impacts to culture, community gatherings, ability to share knowledge, bring together Elders and youth
			CH **19**	AC **23**	CM **19**		
			LH **20**	EH **21**	HW **20**		
24		Changing climate conditions affect the health and availability of plants, wildlife and fish	INF **8**	FS **19**	EN **9**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **18**	AC **10**	CM **15**		
			LH **17**	EH **20**	HW **14**		
38		Mental health concerns associated with climate change increase	INF **11**	FS **15**	EN **11**	**Very high:** Likely annual, ongoing occurrences	
			CH **19**	AC **14**	CM **20**		
			LH **19**	EH **13**	HW **22**		

Legend:

The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods

Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high

Risk score

Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 12 shows the recommended actions to increase resilience for Priority 6.

Table 12 Summary of recommended actions, Priority 6: Multiple climate change impacts that affect health and well-being

Impact no.	Significant impacts, Priority 6	Recommended actions to increase resilience
16	Changes to snow and ice cover create unsafe or unreliable conditions that reduce access to the land	• Support health and social programs and services, with a focus on land-based activities • Provide culturally appropriate mental health measures; for example, those that promote forming relationships and reciprocity between healthcare providers and community members • Implement recommendations from strategies focused on health and well-being, such as Putting People First. • Create opportunities for people to cope with environmental anxiety through arts and culture
24	Changing climate conditions affect the health and availability of plants, wildlife and fish	
38	Mental health concerns associated with climate change increase	

Priority 7 Risks to the Yukon's economy

Findings: The assessment did not complete a comprehensive analysis on climate change impacts on Yukon's economy. It did outline preliminary findings for the agriculture, energy, tourism and mining sectors (see Table 13).

Climate projections show that in Yukon, agriculture has the potential to expand due to warmer temperatures and longer growing seasons (Streicker 2016). Although this may increase food security by reducing Yukon's reliance on southern imports, the assessment suggests that local food production will need to be scaled up extensively to take advantage of climate-related opportunities. This includes securing a labour force, land, storage facilities and economic support. Potential solutions are outlined in the Government of Yukon's 2020 agriculture policy, and the City of Whitehorse 2020 Local Food and Urban Agriculture Study.

For the electricity sector, climate change impacts pose risks for hydroelectricity transmission and storage. In the Yukon, the Yukon Energy Corporation (YEC) found that the territory's generation of hydro power is not expected to be negatively impacted by climate change (NCE 2014). This is because anticipated increases in temperatures and precipitation will generally lead to increased water flow from early spring to late fall, which will enable more electricity for a longer period (ibid.). YEC is currently evaluating the potential for climate change impacts to pose risks to the transmission of energy; for example, from damage to powerlines from forest fires or permafrost thaw. YEC is considering this information as part of its ongoing operations and maintenance. Through *Our Clean Future*, YEC is evaluating how changing water conditions, changing water levels and increased river flows could affect the Aishihik and Mayo dams, and the potential downstream impacts to communities. This information will be used in dam classification (per the Canadian Dam Association) and will inform adaptation planning. Completing these actions on time will help build resilience.

Climate change impacts pose risks for activities such as snowmobiling, because of environmental conditions that are increasingly variable and difficult to predict. This includes changes to snow and ice cover as well as variable, uncertain and extreme weather.

The mining sector employs a significant number of Yukoners, and often requires access to remote areas, where snow and ice cover and other climate impacts can affect the ability to travel to and from work sites, store equipment, excavate and extract materials. Impacts such as changing conditions on rivers and lakes, extreme weather, and wildfires pose risks for safe access to and from work sites and at work sites. Additionally, permafrost thaw and extreme precipitation can pose hazards for critical mining infrastructure. This can lead to environmental impacts to surrounding ecosystems and can affect communities. Ensuring that mining companies are working to incorporate climate-related risks into their operations will help build resilience.

For the tourism sector, risks stem from environmental conditions that are increasingly variable and difficult to predict. This includes changes to snow and ice cover, as well as variable, uncertain and extreme weather. These changes may have significant implications for winter tourism activities that rely on access to stable snow and ice conditions, such as dog mushing, snowmobiling, skiing and snowshoeing. In the summer, changes to water conditions on lakes and rivers may affect the ability of tourism operators to safely conduct land- and water-based activities such as boat trips, canoe trips and guided hikes. Visitors to backcountry areas are increasingly requiring assistance, in some cases despite having good-quality equipment and experience. This is a sector where capacity to predict and adjust to changing conditions can help build resilience. This includes providing decision-making tools for tourism operators, their clients, and unguided visitors and residents; emergency response planning for visitors; gathering information on the implications of climate change on insurance policies; and providing financial incentives for the purchase of safety equipment.

Recommendations: There is a need to enhance understanding of how climate change will affect Yukon businesses, and to a greater extent, the Yukon's economy as a whole. These include identifying potential risks and emerging economic opportunities. These topics need further consideration, especially in the context of COVID-19 economic hardship and recovery.

Table 13 summarizes the risk scores for for the most significant impacts related to Priority 7.

Table 13 Summary of risk scores, Priority 7: Risks to the Yukon's economy

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
Agriculture							
27		Longer growing seasons and warmer temperatures increase agricultural opportunities	INF **3**	FS **3**	EN **3**	**Very low:** Not likely to occur in planning period	• Increased food security • Increased business opportunities *The assessment found that risks to local food production likely outweigh the possible opportunities associated with warmer temperatures*
			CH **3**	AC **3**	CM **4**		
			LH **4**	EH **4**	HW **4**		
Energy							
11		Changing water levels, conditions and flow in rivers and lakes affect communities and infrastructure	INF **20**	FS **15**	EN **17**	**Very high:** Likely annual, ongoing occurrences	• Increased capacity for hydroelectricity generation • Possible damage to energy infrastructure
			CH **18**	AC **16**	CM **16**		
			LH **14**	EH **16**	HW **14**		

Table 13 (continued)

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
Mining							
7		Permafrost thaw destabilizes soil conditions	INF **18**	FS **12**	EN **10**	**High:** More likely than not to occur multiple times per decade; may occur annually	• Reduced access to work sites • Possible infrastructure failure and risks to surrounding ecosystems and communities
			CH **10**	AC **16**	CM **12**		
			LH **10**	EH **10**	HW **8**		
8		Permafrost thaw alters land forms and ecology	INF **11**	FS **10**	EN **9**	**Moderate:** More likely than not to occur once per decade; may occur multiple times	
			CH **13**	AC **11**	CM **11**		
			LH **11**	EH **11**	HW **10**		
9		Permafrost thaw causes critical infrastructure failures	INF **16**	FS **9**	EN **13**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **12**	AC **11**	CM **11**		
			LH **11**	EH **11**	HW **10**		
11		Changing water levels, conditions, and flow in rivers and lakes affect communities and infrastructure	INF **20**	FS **15**	EN **17**	**Very high:** Likely annual, ongoing occurrences	
			CH **18**	AC **16**	CM **16**		
			LH **14**	EH **16**	HW **14**		
16		Changes to snow and ice cover create unsafe or unreliable conditions that reduce access	INF **21**	FS **21**	EN **16**	**Very high:** Likely annual, ongoing occurrences	
			CH **19**	AC **23**	CM **19**		
			LH **20**	EH **21**	HW **20**		
35		Extreme precipitation and flash flooding causes physical and chemical instability in mine sites	Impact 35 did not receive enough responses for conclusive results. It may be worth assessing in a future climate risk assessment				

Table 13 (continued)

Impact			Risk score (1–25) = Likelihood x Consequence			Likelihood based on a score from 1 (very low) to 5 (very high)	Consequences to values
Tourism							
1		Wildfire smoke is transported long distances, affecting local and regional air quality	INF **15**	FS **16**	EN **15**	**High:** More likely than not to occur multiple times per decade; may occur annually	• Safety risks and reduced access for tourism activities such as dog mushing, snowmobiling, hunting and fishing, boating, skiing and snowshoeing, and backcountry access
			CH **16**	AC **16**	CM **15**		
			LH **16**	EH **17**	HW **17**		
16		Changes to snow and ice cover create unsafe or unreliable conditions that reduce access	INF **21**	FS **21**	EN **16**	**Very high:** Likely annual, ongoing occurrences	
			CH **19**	AC **23**	CM **19**		
			LH **20**	EH **21**	HW **20**		
28		The health and safety of people on land are at risk from variability, uncertainty and extreme weather	INF **12**	FS **14**	EN **12**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **15**	AC **12**	CM **15**		
			LH **16**	EH **13**	HW **14**		
29		Flooding in communities is more frequent and severe	INF **16**	FS **14**	EN **14**	**High:** More likely than not to occur multiple times per decade; may occur annually	
			CH **14**	AC **15**	CM **14**		
			LH **12**	EH **12**	HW **13**		

Legend:

The nine values: AC = Access CH = Culture and heritage CM = Community EH = Environmental Health EN = Energy FS = Food security HW = Health and well-being INF = Infrastructure LH = livelihoods

Likelihood score: 1 = very low 2 = low 3 = moderate 4 = high 5 = very high

Risk score

Low 0–4 Low 5–8 Moderate 9–12 Moderate 13–15 High 16–20 High 21–25

Table 14 shows the recommended actions to increase resilience for Priority 7.

Table 14: Summary of recommended actions, Priority 7

Impact no.	Significant Impacts, Priority 7	Recommended actions to increase resilience
Agriculture		
27	Longer growing seasons and warmer temperatures increase agricultural opportunities	• Implement food strategies developed by Yukon governments, First Nations and municipalities.
Energy		
11	Changing water levels, conditions and flow in rivers and lakes affect communities and infrastructure	• Continue to use climate projections into hydrological modeling and incorporate climate-related risks into adaptation planning.
Mining		
7	Permafrost thaw destabilizes soil conditions	• Ensure that the companies operating in the Yukon are considering climate change impacts and adjusting operations to reduce risks. • Ensure that mining companies are adopting building standards and guidelines that take into account climate change hazards, such as permafrost thaw, hydrological changes and extreme weather events.
8	Permafrost thaw alters land-forms and ecology	
9	Permafrost thaw causes critical infrastructure failures	
11	Changing water levels, conditions and flow in rivers and lakes affect communities and infrastructure	
16	Changes to snow and ice cover create unsafe or unreliable conditions that reduce access	
35	Extreme precipitation and flash flooding cause physical and chemical instability in mine sites	
Tourism		
1	Wildfire smoke is transported long distances, affecting local and regional air quality	• Support tourism operators, their clients, and unguided visitors and residents with better access to key information on snowpack, weather conditions and flows and water levels in rivers and lakes. • Develop decision-making tools for tourism operators, their clients, and unguided visitors and residents to help them make quality decisions with respect to safety in the back-country. • Ensure emergency response planning, for situations like fires and floods, for example, account for visitors. • Support tourism operators by gathering more information on the implications of climate change on insurance policies. • Help offset the cost of safety equipment required by tourism operators to safely take clients into the backcountry.
16	Changes to snow and ice cover create unsafe or unreliable conditions that reduce access	
28	The health and safety of people on land are at risk from variability, uncertainty and extreme weather	
29	Flooding in communities is more frequent and severe	

5 CONCLUSION

This Yukon risk and resilience assessment demonstrates that climate change impacts will continue to affect every facet of Yukoners' lives. By centring this risk assessment on nine Yukon values — Infrastructure, Food security, Energy, Culture and Heritage, Access, Community, Livelihood, Environmental health, and Health and well-being — the recommendations stemming from the assessment can pave the way for protecting and upholding them for the Yukon.

This assessment is a starting point. It provides a foundation for taking a strategic approach to climate change adaptation in the Yukon. Adaptation actions often build on one another (i.e., from assessing risks to implementing strategies to reduce risks), and the Government of Yukon will need to take an adaptive management approach, continuing to evaluate and adjust actions to reduce risks and build capacity. This is because climate change is not a linear process and what was (or was not) identified at a given point in time may not be valid at a later date.

The assessment provides a snapshot of seven priority risk areas and current capacity to reduce risks. It also identifies a range of possible actions to build climate resilience. The Government of Yukon will work to respond to these recommendations, and will engage with partners and stakeholders on issues where they may be best placed to take action. The Government of Yukon will also evaluate the recommendations to determine which actions should be taken right away to reduce the highest risks.

To build on this assessment, complementary work on climate risks and resilience could include these steps:

- implementing the recommendations focused on monitoring, capacity building and collaboration on risk management;
- identifying the ecosystems and species at most risk from climate change impacts;
- conducting research and/or monitoring to address topics that need further attention (see Chapter 4 of the main report);
- completing a comprehensive analysis of risks and climate resilience across identity factors, including geographical location, socio-economic status, gender, Indigeneity and other factors;
- completing a more in-depth analysis of climate change risks and opportunities for the top economic sectors in the Yukon;
- continuing to find opportunities to meaningfully bring together Indigenous and scientific perspectives on risk and resilience in climate change adaptation;
- continuing to build a shared understanding of climate risks, thresholds and adaptation actions among those responsible for predicting, planning for, and responding to climate change impacts; and
- Incorporating participants' confidence levels into the assessment of likelihood and consequence of risks.

The risk assessment will be repeated on an ongoing basis to inform future actions in *Our Clean Future*. In *Our Clean Future*, the Government of Yukon commits to assess climate hazards and vulnerabilities to those hazards across Yukon every three to four years between 2020 and 2030 to prioritize climate change adaptation actions. This current assessment also provides a starting point for informing how the Yukon can achieve its adaptation target, as set out in *Our Clean Future*: "by 2030, Yukon will be highly resilient to the impacts of climate change."

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