



Northeast Climate Change Vulnerability Assessments

FINAL REPORT

Northern Rockies
Regional Municipality

Submitted by:
SHIFT Collaborative
November 2019



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1. Introduction

The Northeastern region of BC represents 21.8% of the land area of the province (20,494,470 ha), but is the least populated region in BC, with just 1.6% of the population (about 69,068 people). The Northeastern region is expected to undergo significant population and economic growth as a result of rapid expansion in natural gas and oil development. (The population is expected to increase by 30% over the next 25 years, BC Stats, 2014).

There are two broad types of actions relating to climate change: reducing greenhouse gas emissions (climate change mitigation), and preparing for and adjusting to changes in climate that impact human and non-human systems (climate change adaptation). The focus of this effort is climate change adaptation.

Recent Federal research¹ indicates that Canada is warming at twice the global average rate, with severe impacts already being felt and anticipated to increase in severity. Compounding this, northeastern BC has experienced a significantly more rapid rate of warming over the last 100 years (2.2 °C) than has BC overall (1.2°C). Significant changes in climate are projected for the future. The region is expected to see increases in average temperature and precipitation, the frequency and severity of extreme precipitation, drought and flood events, and other associated impacts.

Changes to the climate and extreme weather is challenging industry and communities across the Northeast region of the province. Wildfires, hail storms and floods have already impacted local infrastructure and posed health risks to communities. Ensuring the region is as prepared as possible for future climate events is critical to maintaining a thriving community, robust natural environment, and vibrant economy. “As prepared as possible” means the region understands how the climate is changing and is working together to increase resiliency and improve natural and physical infrastructure. Early efforts will reduce the reliance on emergency management and support the ability to change and thrive over time. Local governments in the region are taking a proactive approach to understand how climate change will pose risks to Northeast communities and are planning together to build resiliency across the region. Designing to current and future climate parameters is anticipated to be more cost-effective than reacting to climate shocks and stresses over time.

Recent Climate Events in the Northeast Region

- Annual near flood events across region
- 2017 Pouce Coupe Hail Storm
- 2016 Dawson Creek flood
- 2016 Chetwynd Flood
- 2014 Regional Drought

1.1 The Northeast Climate Risk Project

This project is being conducted for the Northeast Climate Risk Network (NECRN). The NECRN includes partners from: the City of Fort St. John, City of Dawson Creek, District of Tumbler Ridge,

¹ Government of Canada, Natural Resources Canada <https://www.nrcan.gc.ca/environment/impacts-adaptation/21177>

District of Chetwynd, Village of Pouce Coupe and Northern Rockies Regional Municipality who have come together to better understand and build capacity to address the impacts of climate change. NECRN is a peer-mentoring network on adaptation to climate change, which also serves as an advisory body for the overall Northeast Climate Risk Project. This project was initiated in 2018 by the [Fraser Basin Council](#), in partnership with the six local municipalities. The Project has three goals:

1. Support the Northeast BC local government partners in preparing for a changing climate and understanding the associated risks and vulnerabilities;
2. Collaboratively address climate risks at a regional and community scale through a peer network; and,
3. Increase staff and stakeholder awareness of climate change impacts through the planning process as a first step to building community, public and private sector awareness of climate change impacts.

The NECRN has been working collaboratively to produce a number of products that will support communities in the region to better prepare for and adapt to a changing climate, namely:

Northeast BC Regional Climate Projections Report

The regional climate projections report² provides Northeast BC with regional information on climate projections, precipitation indicators, summer and winter temperature indicators and hydrology for selected river catchments, for the 2050's and 2080's.

Community Scoping Reports

An internal gap analysis was conducted for each of the six municipalities, which identified priority climate change impacts, outlined related work done to date and identified priority gaps and opportunities to address changing climate conditions.

Community Vulnerability Assessments (this document)

This report is the final comprehensive report on the results of the year-long process outlined in Figure 1. Each community prioritized impacts for initial action planning employing a vulnerability and risk assessment.

² https://www.fraserbasin.bc.ca/Northeast_BC_Climate_Risk.html



Northeast Climate Risk Network (NECRN) Climate Vulnerability Assessment Project 2018 - 2019

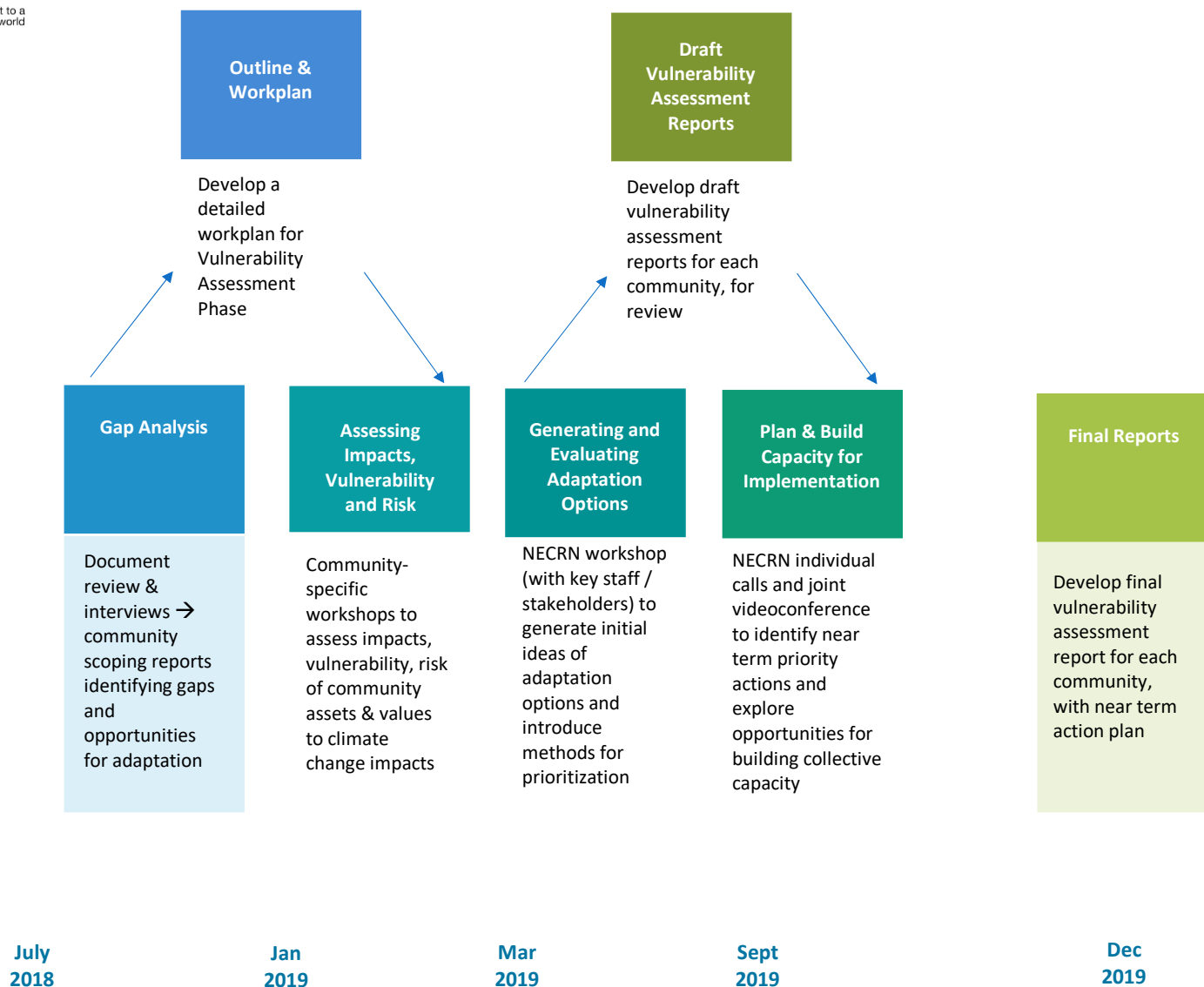


Figure 1. Northeast Climate Vulnerability Assessment Project Overview

1.2 What determines risk and vulnerability to changes in climate?

A key first step on the way to adapting to climate change is to consider what the relative risks and vulnerabilities are likely to be for the various components of the community. To do this, we have taken a commonly used approach to understanding risk and vulnerability, as represented in Figure 2:

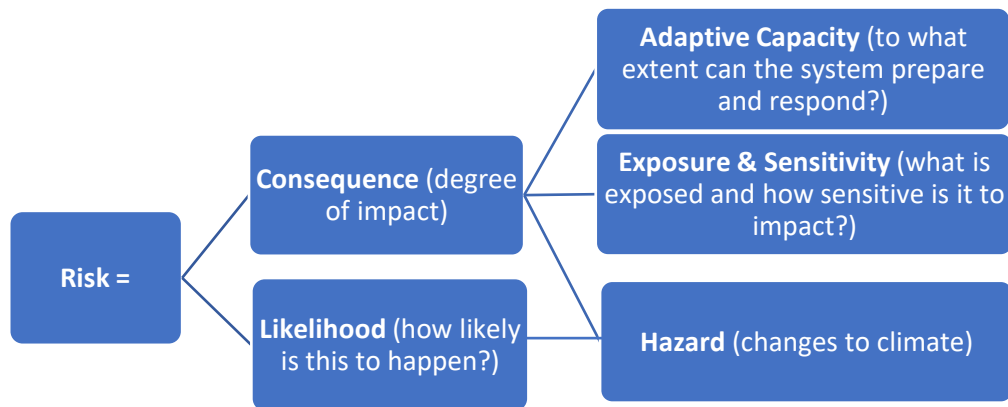


Figure 2. Assessing risk and vulnerability to changing climate conditions

The risks posed by climate change are a combination of the characteristics of the climate-induced **hazard** itself (e.g. magnitude of the hazard (such as flooding) and frequency) and how this interacts with human, built and ecological systems. The degree to which these systems are vulnerable, depends in part on whether they are **exposed** to the hazard, and how **sensitive** they are to its effects. For example, a housing development in a floodplain is exposed to flood risk while a subdivision at higher elevation is not. Similarly, a newer development built with floodproofing features is less sensitive than an older home without any such features.

But vulnerability also depends on the ways in which the affected systems can anticipate, prepare and adapt to better manage the challenge (**adaptive capacity**). For example, communities with a well-developed emergency management system or who have used tools and resources to divert development to areas outside of the floodplain, are more adaptive to an increasing flood hazard.

The degree of impact that occurs as a result (**consequence**), combined with how **likely** the event or impact is to occur, provides an indication of the degree of risk due to these changing conditions.

2. Methodology

Risk management across domains follows the basic steps listed and includes an iterative process of adaptive management and continuous improvement: identification of risk, analyzing risk to understand whether it requires a response, and choosing the best risk management options³. Several adaptation or risk-based planning tools are variations on these common steps (see Appendix A). All of these approaches use relatively qualitative assessment techniques for vulnerability and risk, which is the appropriate methodology for higher-level assessments such as this one. This Vulnerability Assessment has a specific purpose of better understanding the range of impacts the community may face and prioritizing across and between them as a basis for deciding on where to focus their limited resources and time. The need for more detailed assessments may be identified as a near-term action step resulting from this prioritization process⁴.

In order to consider the range of ways that a changing climate will impact the community and the work of the local government specifically, impacts were organized by municipal service areas, as shown in **Error! Reference source not found.**. These service areas were considered in the gap analysis, pre-workshop survey and throughout the vulnerability and risk assessment.

This Vulnerability Assessment Report is the culmination of three key components:

1. A community-level gap analysis;
2. A qualitative vulnerability and risk assessment process with stakeholders; and
3. An action planning process led by each community's Climate Adaptation Team.

Each of these components is outlined below (and in the associated appendices), followed by a discussion of the limitations of the methodology.

³ See ISO 31000 Risk Management Framework <https://www.iso.org/iso-31000-risk-management.html>

⁴ For example, an assessment of a sewerage area or a flood risk assessment can rely on damage-curves and specific calculations of consequences to provide quantitative detail where it is needed. Engineers Canada's [PIEVC protocol](#) has a specific option to undertake a more detailed engineering study, and is a common approach to climate risk assessment for engineered infrastructure.

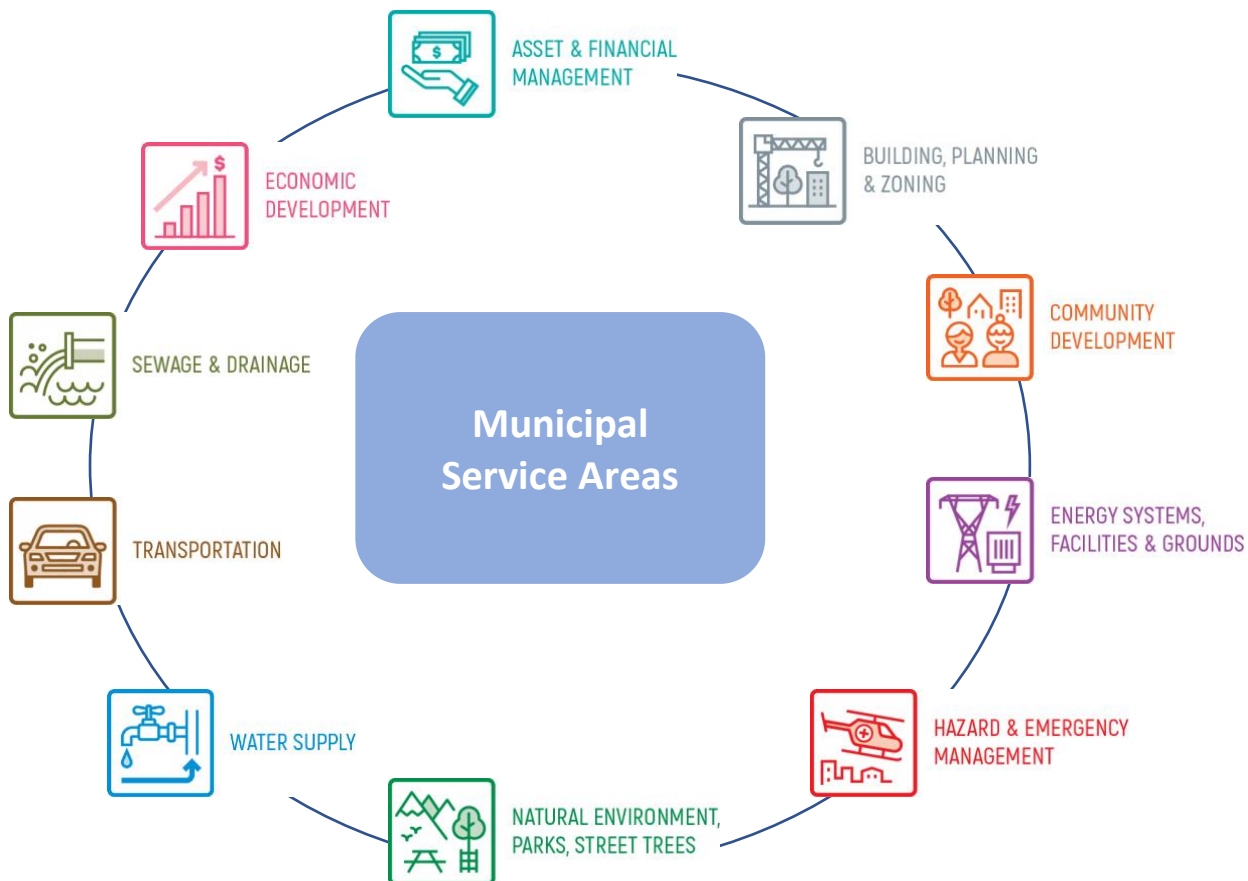


Figure 3. Municipal service areas were used to illustrate the range of areas impacted by climate change.

2.1 Gap Analysis

The gap analysis was conducted to produce the “Community Scoping Report” for Northern Rockies Regional Municipality as a stand-alone internal document for use by the local government. The gap analysis consisted of a combination of document review and interviews. Documents were reviewed to identify:

- Key background and contextual information about the community and systems that may be vulnerable to climate change impacts;
- Any policies or actions that directly or indirectly address potential vulnerabilities to climate change;
- Any immediate or planned windows of opportunity for incorporating a climate lens; and
- Any existing information, studies, and reports that contribute to an understanding of climate change projections or vulnerabilities in the community or the northeast region.

Following the initial review of documents, a number of interviews were conducted with local government staff and other agencies, to fill in gaps in information. Information from these two key sources was compiled in the resulting report. Information gaps and opportunities for

applying a climate lens were identified by service area (e.g. sewage and drainage, community development).

2.2 Vulnerability & Risk Assessment Process

This step in the methodology aimed to outline which impacts from a changing climate pose the greatest risk to each community, and thus form the basis for prioritizing near-term actions. To better understand the baseline knowledge and perspectives of participants about the impacts and potential for adaptation to changing climate conditions, a survey was conducted of confirmed participants in advance of the workshop. The compiled results of this survey across all participants in the region, are included in Appendix B.

On March 28th, 2019 a workshop was held in Fort Nelson with City staff and other community and regional stakeholders, to discuss the possible climate impacts for the Northern Rockies Regional Municipality, and begin to prioritize which impacts to focus on in the near term.

17 people participated in the workshop in Fort Nelson with the following organizations represented⁵:

- Northern Rockies Regional Municipality (5)
- Fort Nelson Chamber of Commerce
- School District
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (Wildfire Protection, and Resource Management)
- BC Oil and Gas Commission
- Tourism Industry (Lakeview Hotels)
- Private contractors

The workshop began with a summary of the regional climate projections outlined in the report “Climate Projections for the BC Northeast Region⁶.” Impact statements describing the types of impacts expected for the community (based on information from the Gap Analysis), were developed as the basis for discussion and input during the workshop. These impact statements were taken through a three-step process⁷, outlined in Figure 4 below:

⁵ In the workshop, the value of including rural perspectives was identified as a gap. Following the workshop, attempts were made to interview two rural stakeholders in the NRRM, but due to timing, they were not available. Efforts will be made to gather and include this information in the draft vulnerability assessments.

⁶ Produced by Pacific Climate Impacts Consortium and Pinna Sustainability, completed in 2019.

⁷ The process used borrows from the ICLEI BARC process and employed the BARC rating scale for vulnerability. The focus for impact statement generation was the climate projections to 2050. When assessing vulnerability and risk, current community characteristics were used to simplify the process.

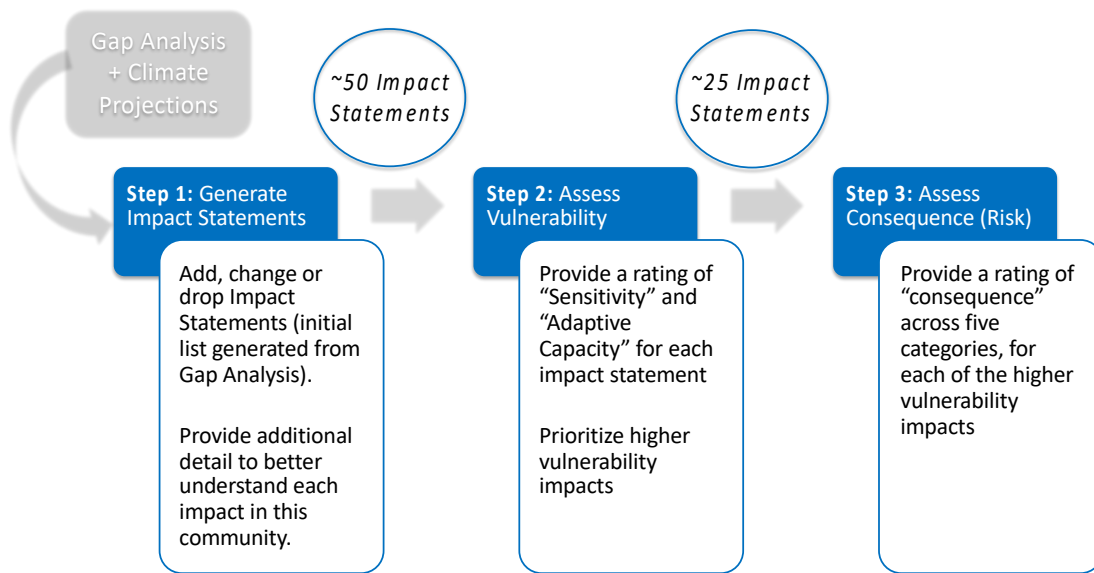


Figure 4. Three step vulnerability and consequence assessment method used in workshop 1

See Appendix C for further detail on the assessment process used to qualitatively assess vulnerability (sensitivity x adaptive capacity) and consequence during Workshop 1.

Three University-based experts with background in the Northeast region and climate change provided likelihood scores for the impact statements. The consequence ratings for the higher vulnerability impacts generated during the workshop were combined with these likelihood ratings to provide an overall risk score. Those impact statements that fall into the medium to high risk category were then cross-referenced with the gap analysis results and reviewed by the community’s Climate Adaptation Team in Workshop 2 to arrive at the final list of priority impacts.

2.3 Initial Steps Toward Action Planning

In order to operationalize the findings of this assessment process each community was invited to form a Climate Adaptation Team to attend the second workshop and lead the initial action planning. A description of the purpose, potential membership and functions of these teams is outlined in Appendix F.

The final list of higher risk impacts was used as the basis for action planning. Action planning focuses on exploring options and next steps to reduce these key risks and enhance resilience to these climate impacts. Lower risk impacts were provided to the teams as well, to scan for those that could easily be addressed by low-effort/no-regret actions. The action planning process was introduced in Workshop 2, and then completed by each Climate Adaptation Team working with the support of the project team. Each community’s action plan was shared with NECRN

members, who together identified opportunities for regional collaboration and learning. This process is outlined in Figure 5.



Figure 5. Action planning process

2.4 Limitations of the Methodology

Efforts have been made at each step of the process to “ground-truth” results with those who have local knowledge and/or topic-specific expertise. However, there will be inevitable gaps and omissions due to the breadth of what is being considered. This report is to be considered a working document – as communities take the next steps to address priority impact areas, more information will emerge and be developed that will inform further steps. Adaptation assessment and planning is an inherently iterative process as understanding and conditions (i.e. the climate, political will, priorities, land use patterns, infrastructure needs, innovations, etc.) develop over time.

Due to time and availability, the number of interviews for each community during the Gap Analysis was constrained and this limits the range or depth of perspectives that we were able to gather on specific aspects of system vulnerability. While additional information and perspectives were incorporated through stakeholder feedback on the impact statements in Workshop 1, this was still limited by the knowledge of participants who were able to attend.

Numerous adaptation methodologies (i.e. see Appendix A for examples) rely on stakeholder opinions as a basis for vulnerability and risk assessment. That said, the qualitative approach to

risk and vulnerability assessment has a number of limitations. Ratings for sensitivity, adaptive capacity and consequence were all based on informed judgment of stakeholders who were present for Workshop 1. As such, there are gaps in the expertise and understanding of the relationships between future climate conditions and how these would affect various parts of the system. This was mitigated by having multiple people rate each impact statement and deliberate on the final rating assigned to each, along with two additional steps to double-check the results with participants and a further step of cross-referencing with information compiled during the Gap Analysis. Still, these are subjective ratings and may contain biases, for example:

- 1) Recently experienced impacts may be rated higher in vulnerability and/or consequence
- 2) More familiar impacts may be rated differently than less familiar impacts
- 3) Impacts of general importance to participants may be rated more highly than others (e.g. someone who works on water treatment may rate associated risks more highly than those to emergency volunteer capacity)

It is important to remember that the purpose of this assessment is to provide a basis for prioritizing more important impacts for the purposes of allocating time and resources to addressing these. This is a first step, providing a high-level assessment that supports the community to make more informed choices about how to prepare and adapt to the projected changes in climate conditions.

Likelihood was rated by four academics with firsthand research experience in the Northeast region, in related fields. Their ratings were generally quite similar but not identical for all impacts, and were averaged where they did not converge.

3. How Will Climate Conditions Change in Northeastern BC?

The Northeast region can expect significant changes to its climate in the coming decades, including:

- **Increased precipitation across all seasons.** The largest increases in precipitation will take place during the spring & autumn months during which, on average, the region can expect 30% more precipitation by the 2050s. This can lead to more frequent ***flooding*** and stress to ecosystems.
- **Summers will be considerably warmer.** In the past, the region experienced an average of 12 days over 25°C annually. We can expect 32 days by the 2050s (49 days by the 2080s). Lower elevations, where the majority of the population in the region resides, are expected to experience 40 days above 25°C by the 2050s and 60 days by the 2080s, with 10 days above 30°C by the 2050s and ***21 days over 30°C by late century***. By the 2080s, summer temperatures in Fort St John are projected to be about as warm as Kelowna's past summers (1980s).

- **Summer is expected to remain the wettest season, though by a smaller margin.** Even though precipitation is projected to increase slightly over summer months, on average, normal seasonal variability in precipitation plus hotter temperatures (and thus increased evaporation) could lead to drier, hotter summers, posing ***increased risk of wildfire and associated physical and mental health impacts.***
- Temperatures projected will ***trigger significant heat stress*** across the region. The ability to provide clean drinking water as a shared resource to communities, industry and agriculture may be strained. Higher demand for water during longer, hotter summers as well as during dry spells, could create ***challenges for water supply, water quality, livestock and crop yields.***
- **Winter temperatures are also projected to warm.** By the 2080s, January temperatures are projected to feel like March temperatures of the past, with warmer nights, 28% less frost days and 37% longer growing seasons than the past. More winter precipitation and later onset of freezing temperatures could potentially lead to ***additional annual freeze thaw cycles*** and ***more frequent rain-on-snow events.*** Shifting seasonal temperatures could also result in ***premature pollination of crops and increased invasive species and pests,*** impacting agriculture and forestry.
- **More extreme storm events in the future.** As the climate warms, more moisture is held in the atmosphere, resulting in more intense precipitation during extreme events. Future storms may also bring stronger winds and hail events. These events will challenge regional infrastructure, and may ***overwhelm sewerage and drainage systems.*** Other extreme weather events of concern include river floods, high winds, drought, and wildfire.
- **Summer streamflow will decrease in all basins.** Warmer temperatures means that relatively more precipitation will fall as rain rather than snow, which in general means an increase in winter runoff, reduced snowpack and ***an earlier freshet.*** Less water stored over winter and melted earlier in the year also means reduced summer and early fall streamflow. These changes will be exacerbated by increased evaporation, further contributing to ***increased stress to water resources.***

The projected changes to climate conditions for Northeastern BC⁸, are summarized in the tables below.

⁸ Data as generated by Pacific Climate Impacts Consortium (www.pacificclimate.org) in the Regional Climate Projections Report. All projections are to the year 2050 unless noted. Change is relative to the baseline period of 1971 – 2000. All projections are averages from Global Climate Models.

Table 1. Temperature <i>Expect summers and winters to warm with summer days getting hotter</i>	
Description of Metric	Anticipated change for NEBC Lowlands
Annual average temperature increase	Average Annual temperature will increase +3.7°C by 2050 and +6°C by 2080s
Overall Change: Summers get warmer with hotter “hot days”	
Number of days where maximum temperature is above 25°C	Number of summer days increases by 50% (from 16 up to 24)
Maximum daytime temp of the warmest summer day	Warmest summer day is 3.7°C warmer
Maximum night time temperature in the summer	Hottest summer night is 3.3°C warmer
Hot summer days = days above 30°C in any one year	The number of summer days above 30°C is projected to occur 9 times/year by the 2050s and 20 times/year by 2080s. (previously occurred ~1 time/year)
Maximum daily temp expected to occur on average 1:20 years (5% chance in any year that the temp could reach this magnitude).	Very hot days increase in intensity from 31°C to 38°C by the 2080s
Overall Change: Winters get warmer, especially nights	
Min temp of the coldest night time in winter	Coldest winter nights: 6.5°C warmer
Max temp of the warmest night time in winter	Warmest winter night: 2.4°C warmer
Minimum daytime temperature of the coldest day in winter	Coldest winter day: 6.2°C warmer
Max daytime temperature of the warmest day in winter	Warmest winter day: 1.5°C warmer
Minimum night time temp expected to occur on average 1:20 years (5% chance in any year that the temp could reach this magnitude).	Very cold nights are projected to warm from -44°C to -38°C
Ice Days is an annual count of days when daytime high temp is less than 0°C	17% fewer ice days

Table 2. Heating and Cooling <i>Greater need for summer cooling while winter heating demand decreases slightly</i>	
Description of Metric	Anticipated change for NEBC Lowlands
Indicator for heating demand. (Total of the number of degrees below 18°C that occur daily, summed over each day of the year)	18% fewer Heating Degree Days
Indicator for cooling demand. (Total of the number of degrees above 18°C that occur daily, summed over each day of the year)	600% more Cooling Degree Days (18 – 94 days lowlands)

Table 3. Growing Season <i>Longer growing season with a doubling of Growing Degree Days (GDD)</i>	
Description of Metric	Anticipated change for NEBC Lowlands
Growing season length is the length between the first span of six days above 5°C in spring, and the first span of six days below 5°C in the fall.	Growing season length increases from 160 to 189 days in 2050, and 205 days in 2080.
Annual count of days when daily minimum temp is below 0°C	17% fewer frost days
GDD is an indicator for plant growth: Total of the number of degrees above 5°C that occur daily, summed over each day of the year.	Lower elevations can expect 2000 GDD by 2080s (81% increase from the past)

Table 4: Precipitation <i>Expect more precipitation annually with the largest increases in the spring and autumn. Summer remains the wettest season to the 2050s. Expect an increase in frequency and intensity of rain events.</i>	
Description of Metric	Anticipated change for NEBC Lowlands
Average seasonal changes in precipitation	19% increase in spring precipitation, 15% increase in autumn, 7% in summer and 11% in winter
Overall Change: Intensity (volume/ size of event) of significant rain events will increase	
Wettest day is the largest amount of rain that falls on any single day in the year on average	17% increase (from 28mm) in amount of rain on the wettest day of the year
Largest amount of precipitation that falls over a period of 5 consecutive days in the year.	19% increase in rain amount over 5 consecutive days to 68mm by the 2080s
Overall Change: More frequent intense precipitation events and more rain to fall during these events.	
Annual total precipitation that falls on the wettest days of the year (days where precipitation exceeds the 95 th percentile amount recorded during the baseline period).	The amount of precipitation falling on very wet days of the year, increases by 35% by 2050 and 51% by 2080.

As above but 99 th percentile	The amount of precipitation falling on the wettest days of the year, increases by 59% by 2050 and 78% by 2080 (from 35mm).
Max daily precipitation expected to occur on average once in 20 years (5% chance in any given year)	A 1:20 year return precipitation event will increase in intensity by 25% (to 61mm of precipitation) in a day

4. What Impacts Can We Expect from These Changing Conditions?

Workshop 1 participants from each community were invited to complete a survey (see Appendix B) that asked about climate-related hazards of concern for their community (Figure 6). The top concern across all communities was wildfire (78% of respondents ranked this as something they are most concerned about), followed by flooding (56%), other extreme events such as storms, hail, freezing rain (53%) and extreme rainfall events (51%). The climate-related hazard communities were least concerned about was extreme heat (20%).

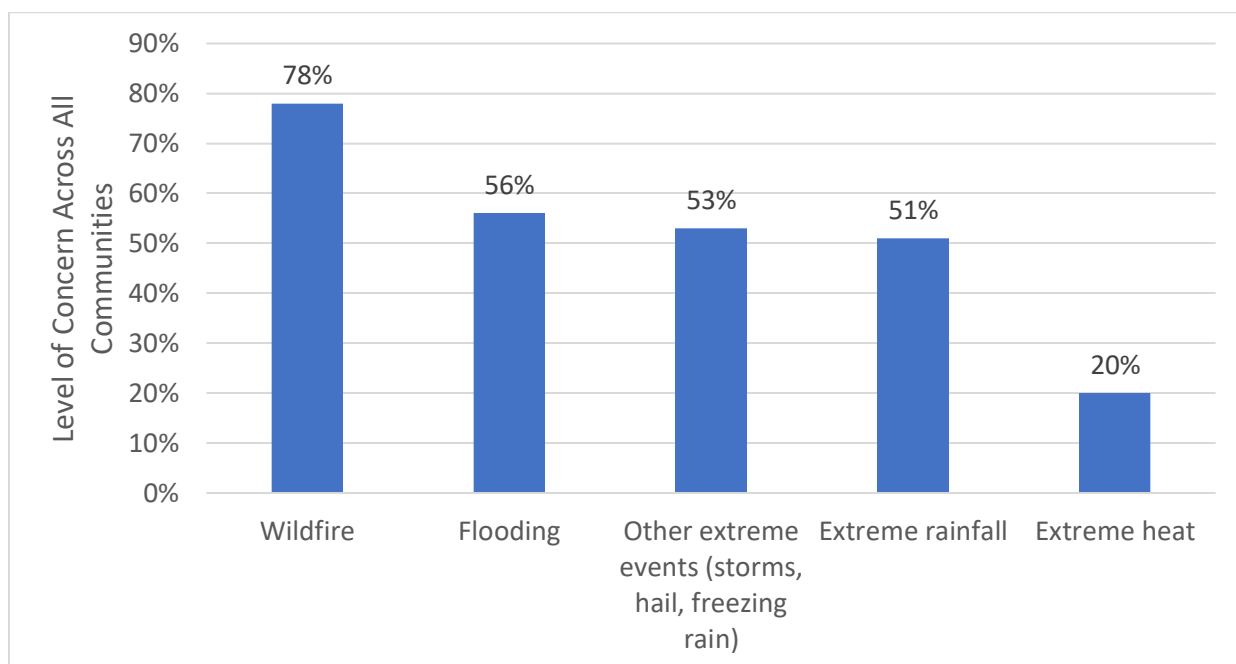


Figure 6. Current levels of concern about climate-related hazards for Northeast communities

In terms of the impact that changing climate conditions could have on municipal service areas, respondents from Northern Rockies Regional Municipality were concerned about a number of municipal services—72% of respondents were concerned about negative impacts to storm drainage and 45.5% were concerned about impacts to water supply, hazard and emergency management and impacts on sanitation and sewer.

An important step in this assessment was to translate knowledge about the projected future changes in climate-related hazards into the impacts of concern to municipal service areas.

Through the gap analysis and Workshop 1, information was gathered to create impact statements that clearly define the impact a changing climate would have on important aspects of community life. Impact statements combine specific climate hazard features (e.g. increasing potential for rain-on-snow events) with specific impacts to community functioning, assets and/or values (e.g. flooding, street closures and mobility issues). An example of an impact statement is:

“Increasing potential for rain-on-snow events (and freezing rain) increases the risk of street flooding, street closures, mobility issues and potential damage to nearby buildings.”


There is a wide range of potential impacts to municipal service areas of the changing climate conditions in the Northeast region – a detailed list is included in Appendix D, which provides additional details relating to each impact statement.




The full list of potential impacts to municipal service areas was prioritized through the vulnerability and risk assessment process, to identify those impacts of greatest concern and where attention should be prioritized in the near term. Those impacts are outlined in Sections 5 and 6 below.

5. What Impacts Are We Most Vulnerable To?

As described above (see Figure 2), vulnerability is a combination of exposure (whether an element is exposed to the climate hazard), sensitivity (how sensitive the element is to its effects) and adaptive capacity (the ways in which the affected systems can anticipate, prepare and adapt to better manage the challenge). Based on the assessment completed in workshop 1, the following impacts (listed in Table 5 below) were identified as those the community is most vulnerable to, given current adaptive capacity.

Table 5. Climate impact statements with highest vulnerability in NRRM

Climate Hazard	Impact Statement
 <p>WARMER WINTERS</p>	<ul style="list-style-type: none"> • Warmer winter temperatures may enable spruce beetle infestations which decreases local forestry incomes and impacts the Community Forest (under application) • Freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs • Increasing potential for rain-on-snow events increases the risk of street flooding, street closures, mobility issues and potential damage to nearby buildings • Less ice cover results in fewer days to use winter roads and ice bridges • Higher winter temperatures may result in the loss of traditional access routes • A combination of hotter temperatures and changing precipitation

	<p>could lead to a lower water table and drier muskeg environment in particular, which has ecological impacts and could affect industry access</p> <ul style="list-style-type: none"> • Warmer temperatures in the winter may have negative impacts on species already under pressure or threatened.
 <p>INCREASED INTENSITY & FREQUENCY OF PRECIPITATION</p>	<ul style="list-style-type: none"> • More frequent flood events increase costs and require more capacity for flood clean-up and restoration • Variability and intensity of precipitation events in winter decreases safety and ease of travel, especially for mobility challenged individuals
 <p>INCREASE IN OTHER EXTREME EVENTS</p> <p>(i.e. storms, hail, extreme heat, wildfires, landslides)</p>	<ul style="list-style-type: none"> • Increase in extreme events cause more frequent power outages, in turn affecting household power and power to critical infrastructure • Increasing intensity of snowfall, ice events and rain-on-snow events stretches the capacity of public works to respond and increases costs • Wildfires and landslides are more common, impacting evacuation routes and transportation in and out of the community. • Major events lead to isolation from health services or other critical services (due to impacted transportation routes within the municipality) • Increasing extreme events decreases the durability of infrastructure generally, leading to earlier replacement and increased maintenance needs • Effects of large-scale wildfires on industrial activity and related infrastructure
 <p>HOTTER SUMMERS</p>	<ul style="list-style-type: none"> • Increasing temperatures and longer growing seasons enhances the ability to grow certain crops • Change in seasonality and increasing temperature leads to introduction of new invasive species (plants, insects, etc) • The combination of hotter and drier conditions increases potential for drought and decreased water supply in late summer • Increasing number or magnitude of wildfires impacts the health of the community due to poor air quality days and mental health impacts • Hotter and drier conditions contribute to increasing wildfire risk in large forested areas (ecosystem, recreation, and forestry industry impacts).

In Summary:

The potential of wildfires due to hotter drier summers and more frequent extreme weather events is a major vulnerability identified in NRRM. In particular, there are concerns related to the impact of wildfires on ecosystems, industry (forestry, oil/gas) and community health and wellbeing (i.e. poor air quality and mental health). In the event of largescale wildfires, there is also vulnerability to access evacuation routes in and out of communities and access to critical services.

Due to hotter drier summers and warmer winters there is also concern related to water supply in the summer, a lower water table, and increased potential for drought. Furthermore, warmer temperatures raise concerns about threatening species and infestations of new invasive species such as the spruce beetle.

Vulnerabilities from warmer winters in NRRM include fewer days available to use winter roads and ice bridges as well as loss of traditional access routes. There was concern about less time available in winters to complete industrial activities in remote areas and the potential for smaller or delayed projects or higher costs to complete work in a shorter period of time.

Overall, an increase in extreme events such as rain-on-snow and ice events stretches the capacity of public works to respond and decreases the durability of infrastructure generally, leading to earlier replacement and increased maintenance needs. More frequent / larger scale emergency and disaster events places an increasing demand on municipal resources and capacity for mitigation, planning, preparedness, response and recovery.

6. Which of These Impacts Pose the Highest Risk?

As Figure 2 depicts, risk is a product of consequence and likelihood. The degree of impact that occurs as a result of the climate hazard (**consequence**), combined with how **likely** this is to happen, provides an indication of the degree of risk due to these changing conditions.

Risk results from the NRRM workshop fall in the medium-low, medium and high categories of risk. None of the impacts were assessed as low risk. To be rated high risk, the impact has a combination of high consequence rating and medium or high likelihood rating, high ratings for both, or a medium consequence rating and high likelihood rating. Table 6, below summarizes the risk assessment results, also indicating which service areas are most affected by each impact statement.







Table 6. Summary of Climate Hazards and Risk Ratings for NRRM

	Economic Development		Natural Environment, Parks, Street Trees		Water Supply		Sewage & Drainage		Building, Planning & Zoning
	Community Development		Energy Systems, Facilities & Grounds		Transportation		Hazard & Emergency Management		Asset & Financial Management

NORTHERN ROCKIES REGIONAL MUNICIPALITY

CLIMATE-RELATED HAZARD	QUALITATIVE RISK	#	IMPACT STATEMENT	SERVICE AREA	CONSEQUENCE	LIKELIHOOD	RISK
 WARMER WINTERS	HIGH	15	Warmer winter temperatures may enable spruce beetle infestations which decreases local forestry incomes		3.33	4.5	15.0
	HIGH	23	Lower water table results in dried out muskeg with impacts to ecosystems and industry		5	3	15.0
	MEDIUM-HIGH	19	Increasing freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs, and safety		2.44	4	9.8
	MEDIUM-HIGH	22	Loss of traditional access routes		2.78	3.5	9.7
	MEDIUM-HIGH	21	Fewer days to use winter roads and ice bridges		2.67	3.5	9.3
	MEDIUM	24	Threatened species impacts		1.89	3.5	6.6

CLIMATE-RELATED HAZARD	QUALITATIVE RISK	#	IMPACT STATEMENT	SERVICE AREA	CONSEQUENCE	LIKELIHOOD	RISK
 INCREASED INTENSITY & FREQUENCY OF PRECIPITATION	MEDIUM-HIGH	32	Variability and intensity of precipitation events in winter decreases safety and ease of travel, especially for mobility challenged individuals	 	2.67	4	10.7
	MEDIUM-HIGH	5	Heavy rainfall events lead to more frequent/intense overland flood events, increasing costs and requiring more capacity for flood clean-up and restoration **	 	2.67	3.5	9.3
CLIMATE-RELATED HAZARD	QUALITATIVE RISK	#	IMPACT STATEMENT	SERVICE AREA	CONSEQUENCE	LIKELIHOOD	RISK
 INCREASE IN OTHER EXTREME EVENTS	HIGH	47	Wildfires and landslides are more common, impacting evacuation routes and transportation in and out of the community		5	3.5	17.5
	HIGH	55	Large scale wildfires		5	3.5	17.5
	MEDIUM-HIGH	46	Increasing intensity of snowfall, ice events and rain-on-snow events stretches the capacity of public works to respond and increases costs	 	3.2	3.5	11.3
	MEDIUM	48	Major events lead to impacted transportation routes within the regional district and municipality making it difficult for residents to access critical services, their employment, and healthcare		3	3	9.0
	MEDIUM	45	Increase in extreme events cause more frequent power outages, in turn affecting power to critical infrastructure **	 	1.56	3.5	5.4
	LOW	51	Increasing extreme events decreases the durability of infrastructure generally (damage), leading to earlier replacement and increased maintenance needs		1.39	3.5	4.9

CLIMATE-RELATED HAZARD	QUALITATIVE RISK	#	IMPACT STATEMENT	SERVICE AREA	CONSEQUENCE	LIKELIHOOD	RISK
 HOTTER SUMMERS	HIGH	66	Hotter and drier conditions contribute to increasing wildfire risk in large forested areas (ecosystem and forestry industry impacts)		5	4	20.0
	HIGH	63	Change in seasonality and increasing temperature leads to introduction of new invasive species (plants, insects, etc)		3.56	4	14.2
	MEDIUM	64	The combination of hotter and drier conditions increases potential for drought and decreased water supply in late summer		2.11	4	8.4
	MEDIUM	65	Increasing number or magnitude of wildfires impacts the health of the community due to poor air quality days and mental health impacts		2	4	8.00
	LOW	62	Increasing temperatures and longer growing seasons enhances the ability to grow certain crops		0.78	4	3.1

** Following assessment the risk rating for impacts #45 and #5 were increased qualitatively by staff. Impact #5 was moved to action planning but #45 was not.

In NRRM, the eight risks that emerged as the highest risks represent impacts that cut across several anticipated changes to the climate from warmer winters to hotter drier summers and increase in precipitation to more extreme weather events.

The increased risk of wildfires to the area was relatively high in this assessment, including the direct impact to ecosystems and transportation routes as well as the indirect impacts to industry, tourism and human/community health. Hotter drier summers raise the risk of introduction of new invasive species such as spruce beetle, which could impact the forestry industry and thereby economic livelihoods. More variable and intense rainfall events create risk for travel and safety, especially in the winter. And, warmer winters leading to changes in freeze/thaw cycles leads to high risk impacts on the durability of infrastructure as well as costs for replacement and maintenance.

7. Initial Action Ideas

Community-specific

In September 2019, the project team from NRRM put together initial action ideas for addressing the highest risk impacts. For each higher risk impact the team began developing:

- A list of actions,
- A description of the action,
- The status of the action (underway, act now / by X year, monitor or investigate further),
- The range of funding and HR to carry out the action (low, medium or high),
- Next steps, and
- Notes on how well the action addresses evaluation criteria

To view the initial action ideas for NRRM, please visit Appendix G. Detailed Action Plan.


Region-wide




Adapting effectively and building resilience to a changing climate will require action at both a local and regional level. Actions that lend themselves to regional collaboration were discussed with the Northeast Climate Risk Network throughout the course of this project. Broadly across hazards, the Network provides opportunities to:


- share purchasing power for hard goods or common consultancy needs;
- advocate as a united front with stakeholders and other levels of government;
- avoid costly projects if recommendations or best practices from one municipality can be transferred to another;
- share progress and discuss barriers and solutions and;
- partner as a group on common projects and work with the regional governments and other stakeholders.

Hazard-specific opportunities for regional collaboration are summarized in Table 7 below.

Table 7. Potential opportunities for regional collaboration across the Network

Climate Hazard	Impact Statement
 INCREASED RIVERINE FLOOD RISK	<ul style="list-style-type: none">• Chetwynd and Dawson Creek have parallel processes currently including identifying and studying the hazard, mapping flood extents, coming up with mitigation options and including findings in the OCP. While at different steps, this provides an opportunity to learn from each process and pass lessons on across BC.

 <p>WARMER WINTERS</p>	<ul style="list-style-type: none"> • The region has to work together and work with the Province on understanding forest management for pest (and wildfire) resilience • Snow and ice clearing policies and road and bridge closure policies came up frequently as requiring updates and clear communication to the public. Sharing policies and best practices makes sense. • Steaming vs. Heat tracing culverts. A study across municipalities and conditions would provide more fruitful conclusions and recommendations. • PRRD Everbridge Emergency Notification System collaboration <ul style="list-style-type: none"> ○ Freezing rain information and health and social wellness information is shared on this platform already • Could intentionally set up to trial different types of materials to use on various roads during temperature fluctuations. • Invasive species programs provide another opportunity to learn from each other and possibly collectively hire consultants.
 <p>INCREASED INTENSITY & FREQUENCY OF PRECIPITATION</p>	<ul style="list-style-type: none"> • There are several sewage and drainage studies underway in the region. Resultant recommendations could be shared with the network via webinar with consultants on hand. • Understanding how to incorporate new rainfall projections and IDF curves into design could be done by a common consultant or process shared by one municipality to the others. • Several municipalities are further ahead on green infrastructure use (for infiltrating rainfall). Sharing actions and any pamphlets produced for the public is an opportunity for collaboration. • Dawson Creek has significant expertise in watershed and riparian health and may focus more on this area. Best practices could be shared through the Network meetings.
 <p>INCREASE IN OTHER EXTREME EVENTS</p> <p>(i.e. storms, hail, extreme heat, wildfires, landslides)</p>	<ul style="list-style-type: none"> • Set up a more formal contact person and liaison between the Network and the Ministry of Transportation and Infrastructure. They have done significant work on climate change guidelines and the Network municipalities identified flooding, landslides and wildfires to have the potential to limit access to their communities. • Several communities will refresh or initiate landslide and steep slope reviews. This provides an opportunity to share consultants or at least process and best practices. Translating findings into land use controls may also be an area to share ideas. • Asset management becomes an important element of ensuring infrastructure is resilient to climate change. Opportunity: collaborating on a project to apply a climate lens to asset management (in one area or across the board).

 <p>HOTTER SUMMERS</p>	<ul style="list-style-type: none"> • Air quality monitoring is already completed by Oil and Gas industry. Collaboration with industry could add air quality data for rural and urban areas. • Municipalities have Community wildfire plans at different stages of development, update and implementation. Opportunity to learn from each other and also possibly share a consultant from out of town for economies of scale. • Fuel removal communication / education campaign could be shared • Network could partner with the regional health authority to have consistent messaging on wildfire smoke, heat and health • Municipalities all work on water conservation techniques for drought. Many deal with agriculture and/or industry water needs as flow volumes change, and as a result, there are lessons to be shared.
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Key Competencies for Advancing Adaptation

As part of the Gap Analysis at the beginning of this project, the consultant team provided an initial assessment of NRRM's stage of development around climate change adaptation planning, using the Climate Adaptation Maturity Scale developed by the Federation of Canadian Municipalities. The checklist version used to guide the assessment, is included in Appendix H.

The scale has three competency areas: policy, human resources and governance, and technical and risk management capacity. Each competency area has 5 levels through which a municipality can progress.

The competencies are:

- **Policy:** Putting in place policies and objectives related to the development of an environment and vision that supports local climate adaptation.
- **Human resources and governance:** Ensuring staff and council are equipped with the mandate, understanding, skills and knowledge needed to support local climate adaptation.
- **Technical and risk management capacity:** Preparing the tools needed to deliver adaptation initiatives and manage operations in a way that minimizes climate risk (e.g. software, hardware, maps, models, etc.).

At the beginning of this project, NRRM was considered to be at Level 1 for all three competencies (Policy, Human Resources and Governance, and Technical and Risk Management Capacity).

At the end of the action planning process, the assessment using the Maturity Scale was completed again. Based on this assessment, NRRM will have completed level 2 for Policy by the end of the year and is already working on Level 3. NRRM has completed level 1 in the Human

Resources and Governance category with formalization of their cross-disciplinary climate team. Working to engage further champions within the organization will continue movement through the levels in this area. On Technical and Risk Management Capacity, completing this project has moved the dial from level 1 to a mix of Level 2 and Level 3 for NRRM. Staff have been committed to assessing risks, forming a team and brainstorming adaptation responses. Priority climate risks to key infrastructure have been explored and other tools or support data to implement adaptation actions are being investigated.

Next Steps

The **Climate Adaptation Team** is well-positioned – with an overall understanding of the climate projections, potential impacts and priority risks – to continue working across disciplines in the organization and in collaboration with community stakeholders to mitigate risks and build resilience to changes in climatic conditions moving forward. The initial action ideas included above and in Appendix G provide direction and focus in these next phases of the work.

An important aspect of implementation is continual monitoring and review. With climate change, more so than some other things that we plan for, conditions are highly complex and will continue to change and evolve over time. As a result, we need to continue to monitor changes to:

1. Climate projections – particularly any regional and local data;
2. Actual and potential impacts – for example, air quality due to wildfire was not a common concern just a few years ago. New impacts will emerge and existing ones will evolve;
3. Opportunities to mitigate risks and build resilience – windows of opportunity should be constantly in mind to take advantage of sources of funding, partnerships, awareness, and political will, etc.

It is recommended that the Climate Adaptation Team **develop a monitoring and review strategy** to ensure that this function is continually addressed. This may include:

- A review of the climate science every 3-5 years
- A scan of existing and emerging impacts every 1-2 years
- Re-evaluating the top priority impacts and action ideas every 2-3 years

As well, the **NECRN is a valuable resource** for all communities in the region that will require ongoing participation and investment of time and energy by its members to cultivate that value. The Fraser Basin Council will be convening the network in January of 2020, creating an opportunity to identify some initial areas of collaboration and joint projects. Generating some early wins and getting some experience in working together across communities would be a helpful foundation for the work moving forward.

8. Conclusion

The six communities in the Northeast Climate Risk Network have all experienced climate-related shocks (such as a flood or wildfire) or a stress (such as drier conditions, or more rain-on-snow events in the winter) in recent years. These events have impacted city services, community assets and residents. The climate vulnerability assessments have built on the good work started in each community to prepare and respond to a changing climate.

Based on information provided in an initial community-specific Gap Analysis and the climate projections for the region for the time periods of the 2050s and 2080s, staff and stakeholders from the communities and the region identified impacts to a range of service areas. The vulnerability of certain assets or areas was assessed and risk ratings supported prioritization of the impacts to ensure that resources can be directed to where they are most needed.

Throughout the process there were opportunities to learn from and share with others across the network, and to develop capacity within communities to continue with this work. Within each community, cross-disciplinary staff teams considered the top risks for their community as they identified and developed action ideas to mitigate risks, and to prepare and respond to the climate change-related impacts. These teams are well-placed to continue to guide and lead this work forward into implementation and ongoing monitoring and iterations. A range of possible ways to work together, capitalize on resources across communities, and maintain and build capacity as a region were identified.

Together, these assessment results and the initial action ideas developed by the Climate Adaptation Teams reflect the growing capacity of each community and the Northeast Climate Risk network as a whole to form a strong foundation for building resilience across the Northeast Region.

Appendix A. Risk-based Adaptation Planning Tools

Infrastructure or risk-specific assessments, such as an assessment of a sewerage area or a coastal flood risk assessment can rely on damage-curves and specific calculations of consequences to provide quantitative detail where it is needed. **Engineers Canada's [PIEVC protocol](#)** has a specific option to undertake a more detailed engineering study—the need for a more detailed assessment like this is something that may be identified through the more qualitative risk assessment. This higher level risk assessment has a specific purpose of better understanding the range of impacts the community may face, and prioritizing across and between them as a basis for deciding on where to focus their limited resources and time.

The [risk-based land use guide for Canada](#) outlines steps for planning including:

- establish the community needs,
- define hazard potential,
- identify what could be harmed,
- calculate potential losses (consequences),
- recommend safe land-use,
- and monitor decision success.

The [UKCIP tool \(Adaptation Wizard\)](#) for planning looks at current climate vulnerability and future climate vulnerability (risk included) before brainstorming adaptation options and monitoring and reviewing iteratively.

The [ICLEI BARC tool](#) follows 5 milestones including:

- initiating (taking a first look at impacts and adaptation actions underway;
- researching climate science and completing vulnerability and risk assessments;
- planning (identifying and evaluating actions);
- implementation and;
- monitoring and review.

The ICLEI BARC tool relies on clear impact statements throughout the vulnerability and risk assessments.

The [International Standards Association \(ISO\)](#) published a standard for climate change adaptation (ISO 14090) in June, 2019. The standard provides a framework to help organizations consider climate change adaptation in policies, strategies and plans. A companion standard (ISO 14091) is under development currently and will specify risk and vulnerability assessment steps.

In July, 2019 the provincial government published the Preliminary Strategic Climate Risk Assessment for British Columbia. The publication includes a strategic climate risk assessment framework for B.C that was developed to be scalable to analyze risks at multiple levels and a variety of climate-related risks. The framework has 4 steps:

- Understand the Context (including scope and objectives and audience);
- Identify risk events (they use a scenario approach to risk events);

- Analyze risks (Likelihood and Consequence); and
- Evaluate risks (rate risks and assess the adequacy of existing risk mitigation).

The new [Temperate tool](#) for use in the US, identifies hazards for the specific region populated from National Climate Assessments and other research. Hazards are translated into suggested risks for communities focusing on several priority community systems. Adaptive Need is calculated from a ranking of Impact Magnitude and Adaptive Capacity and is used to prioritize the risks. Actions are pre-populated based on prioritized risks.

The [Infrastructure Canada Climate Lens – Climate Change Resilience Assessment](#) recommends employing the principles of ISO 31000 Risk Management Standard with future climate conditions and impacts. If climate risks to the project in question are identified, an analysis of likelihood, consequence and vulnerability should be summarized and resilience measures taken. Using impact statements is recommended as is assessing risk across a range of domains such as public safety, economy etc. Methodologies listed as consistent with ISO 31000 are Envision, PIEVC and SuRE, not surprisingly all with a focus on Infrastructure.

The most common steps in adaptation methodologies are outlined below in Table 8, with a description of how this project undertook each step. This project will not complete the full cycle of adaptation planning, but will provide each community with an actionable assessment of priority risks and identify key next steps for adaptation and adaptation planning.

Table 8. Steps in Climate Change Adaptation Methodology

	Description / Questions to answer	Methods used
Determine the current and potential hazard	<p>In this step climate-related hazards are identified.</p> <ul style="list-style-type: none"> • What climate-related issues are we concerned about that could cause us harm? • What events have occurred to date and what were the consequences? • With climate projections in hand, what are the hazards and opportunities in climate conditions that we could face by 2050 and/or 2080? 	Regional climate projections report (separate from this project) and Community Scoping Reports.
Impacts: identify what could be harmed and what could benefit from climate-related changes	<p>This step contextualizes the current and anticipated climate-related hazards into how they will impact the community.</p> <ul style="list-style-type: none"> • Impact Statements (ICLEI BARC methodology and Infrastructure Canada Climate Lens). 	Scoping Report, survey and ground-truthing of impact statements in Workshop 1.
Assess Vulnerability	<p>A vulnerability assessment investigates what and who are most vulnerable to the climate-related impacts (and opportunities).</p> <ul style="list-style-type: none"> • Where is the community the most vulnerable? • What is in the way of/exposed to the hazard? • What is very sensitive to the hazard vs. very resilient (sensitivity)? • Where is there high versus low capacity to adapt to the change or hazard (adaptive capacity)? 	<p>Workshop 1:</p> <ul style="list-style-type: none"> • Review and rate impacts for exposure and sensitivity • Identify impacts where there is low versus high adaptive capacity • Provide an assessment rating for overall vulnerability to key impacts
Assess and Prioritize Risks	<p>The assessment of risk further prioritizes where to focus resources for adaptation by identifying where high likelihood of an impact coincides with high consequences.</p> <ul style="list-style-type: none"> • For the impacts identified as having high vulnerability, determine the consequences that will result for people and things exposed to the potential impact 	<p>Initial assessment in Workshop 1:</p> <ul style="list-style-type: none"> • Consequence ratings of high vulnerability impacts <p>Likelihood ratings developed by the project team with expert input.</p> <ul style="list-style-type: none"> • Rank overall community risk from these impacts

	<ul style="list-style-type: none"> Assess risk across a range of consequences – i.e. to safety, to the environment, to the economy, etc. <p>Prioritize where the need is greatest for adaptation action (risk management) in the community</p> <ul style="list-style-type: none"> Completed in many different ways but generally where a community is the most vulnerable and has the highest risk is targeted first for risk management action. 	
Develop and evaluate adaptation options	<p>Once impacts are prioritized, actions and measures can be planned to reduce the risk of the impact and/or reduce the vulnerability of the system.</p> <ul style="list-style-type: none"> Generate strategies and actions to reduce risk and vulnerability to priority impacts. <p>Some actions are going to have a greater effect relative to the investment made, be more easily implemented than others or be more flexible to future climate ranges.</p> <ul style="list-style-type: none"> Develop evaluation criteria and apply to the actions 	<p>Workshop 2</p> <ul style="list-style-type: none"> Brainstorm and discuss actions to reduce risk and vulnerability for prioritized impacts Practice evaluating the actions <i>At this stage this is an introduction to developing and evaluating options – we will not be developing a comprehensive set of actions, but we will consider what options are available and what initial steps can be taken.</i>
Implement	<p>Detail actions including timeline, funding source if needed, responsibility and accountability.</p>	<p>Each community Climate Adaptation Team will be tasked with developing an initial action plan, with guidance from the project team.</p> <p>Final videoconference:</p> <ul style="list-style-type: none"> Communities share their priorities and action plans with other NECRN members Discuss common interests, synergies and opportunities for collaboration
Monitor and Review	<p>A monitoring and review strategy should be included in planning documents and government process planning.</p>	

Appendix B. Regional Results of Pre-Workshop Survey

Background

In total 55 people completed the survey from across five communities (no one from Pouce Coupe completed the survey), see Figure 7. Given the low responses from several communities, this survey cannot be considered statistically representative sample of those that attended Workshop 1.














Chetwynd		12.7%	7
Tumbler Ridge		5.5%	3
Dawson Creek		16.4%	9
Fort St John		34.5%	19
Northern Rockies Regional Municipality		20.0%	11
Other - Write In		10.9%	6

Figure 7. Survey Respondents from Across Communities

Most respondents were from a local government, followed by the private sector.

Table 9. Respondents by Sector

Local or regional government		54.5%	30
Provincial government		10.9%	6
Health care		1.8%	1
Community organization		7.3%	4
Private sector		18.2%	10
Resource industry (Oil & Gas, Forestry, Agriculture)		7.3%	4
Other - Write In		12.7%	7

Understanding of Climate Change

Overall, 60% of respondents self-reported that they had a 'moderate' level of understanding of climate change. Dawson Creek (22%) and Fort St John (16%) had the most respondents with a 'high' level of understanding of climate change.

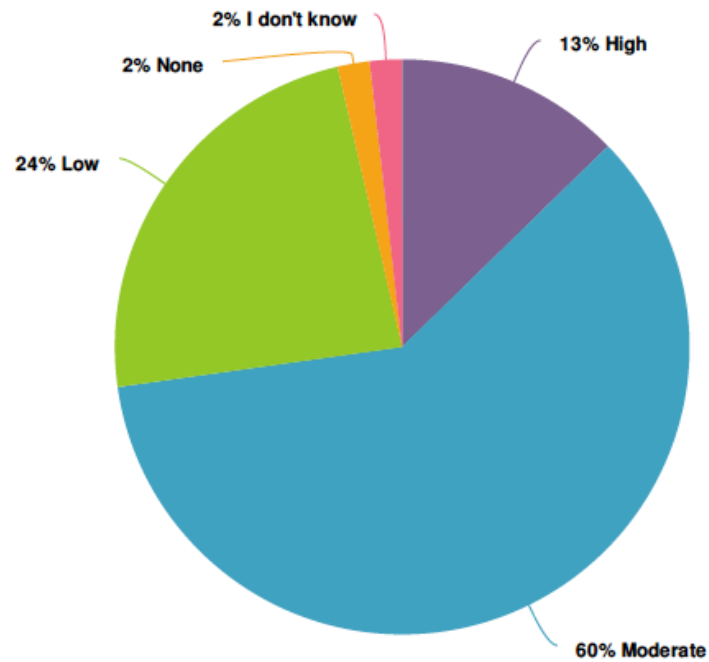


Figure 8. Survey respondents understanding of climate change

Action to Address Climate Change

Overall, 42% of respondents (across all communities) disagreed or strongly disagreed that their community was doing enough to adapt to a changing climate. A significant number of respondents (33%) did not know if their community was doing enough.

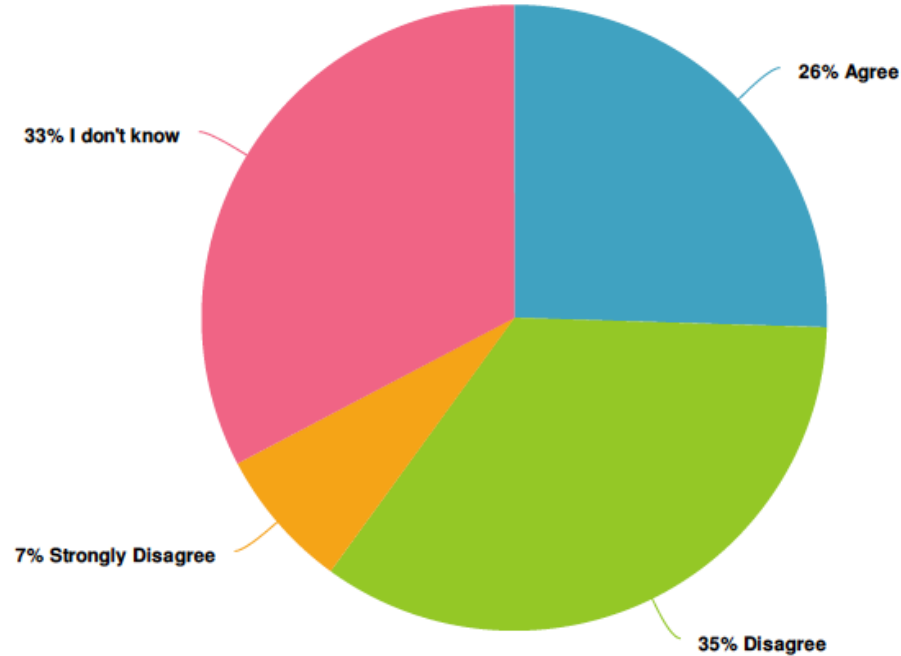


Figure 9. Survey respondents' agreement that their community is doing enough to adapt to climate change.

- In Dawson Creek, 33% agreed that their community was doing enough to adapt to climate change (44% of respondents either disagreed or strongly disagreed).
- In Chetwynd, 14% agreed that their community was doing enough to adapt to climate change (57% disagreed or strongly disagreed)
- In Fort St John, 42% agreed that their community was doing enough to adapt to climate change (37% disagreed)
- In NRRM, 9% agreed that their community was doing enough to adapt to climate change (36% disagreed or strongly disagreed and 55% did not know)
- In Tumbler Ridge, an equal amount of respondents (33%) agreed, disagreed and did not know that their community was doing enough to adapt to climate change

Concerns about Effects of a Changing Climate

The top concern across all communities was wildfire (78% of respondents ranked this as something they are most concerned about), followed by flooding (56%), other extreme events such as storms, hail, freezing rain (53%) and extreme rainfall events (51%). The climate impact communities were least concerned about was extreme heat (20%).

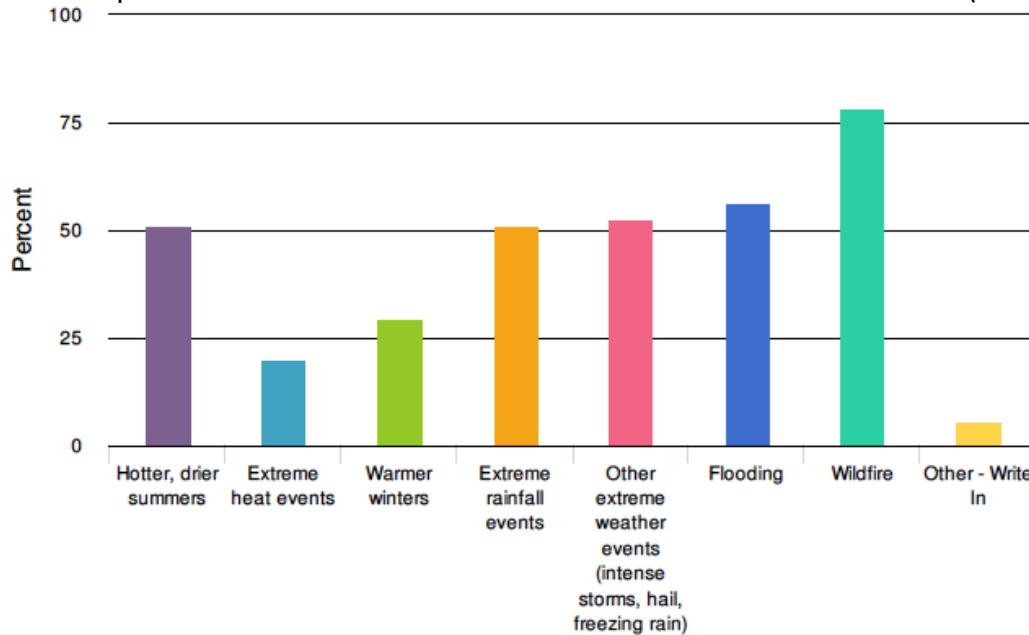


Figure 10. Concerns about effects of climate change

There were some differences across communities related to the top concerns from a changing climate:

- Dawson Creek was the most concerned about flooding and wildfires (both were ranked by 66% of respondents as a top concern)
- Chetwynd was most concerned about flooding (86%);
- NRRM (91%), Tumbler Ridge (100%) and Fort St John (79%) were most concerned about wildfire.

There was a comment/question about whether climate change is having an impact on species (i.e. caribou herds).

Climate Change Impacts on Municipal Services

The top municipal services that communities are concerned will be negatively impacted by climate change:

- Chetwynd: Transportation (86%) and storm drainage (71%)
- Tumbler Ridge: Transportation (100%) and storm drainage (100%)
- Dawson Creek: Relatively equal concern for many municipal services: water supply, storm drainage, transportation, hazard and emergency management (all ranked by 67% of respondents as being negatively impacted)
- Fort St John: Storm drainage (79%) and water supply (63%)
- NRRM: Storm drainage (73%) and relatively equal concern for several other municipal services

About 50% of respondents (across all communities) felt that there are potential positive impacts on parks, green space and economic development (agriculture, industry, tourism).

- There is a sense that the NE will become a more desirable place to live as the winters warm and the population will increase, leading to economic development (Chetwynd)
- Some feel that there will be potential for new crops and agriculture.
- Others see there will be trade-offs and difficult to see this as negative or positive for one region—for example, climate change will have negative impacts for oil and gas (ice roads), but may have positive benefits for agriculture and facilities will require less energy for heating in winter.

Climate Change Adaptation in Your Work

How often to you consider climate change in your work?

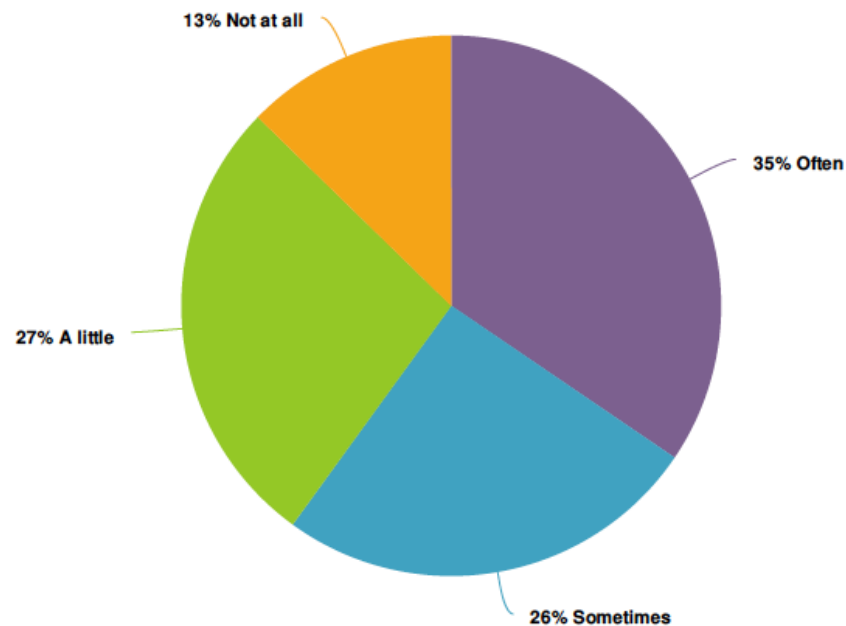


Figure 11. Frequency for considering climate change in one's work.

Differences between communities:

- Dawson Creek reported considering climate change in their work much more often than the rest of the communities (56% often; 11% sometimes; 22% not at all).
- In NRRM several people do not consider climate change in their work at all (36%). (Quote from NRRM: *It is not currently part of regular evaluation or decision-making.*)

Capacity Building

Most respondents said that more information about specific risks and impacts of climate change on their work (67%) would help them to more fully include adaptation in their role. The other top named supports would be 'more data or information about climate change' (60%) and training (60%).

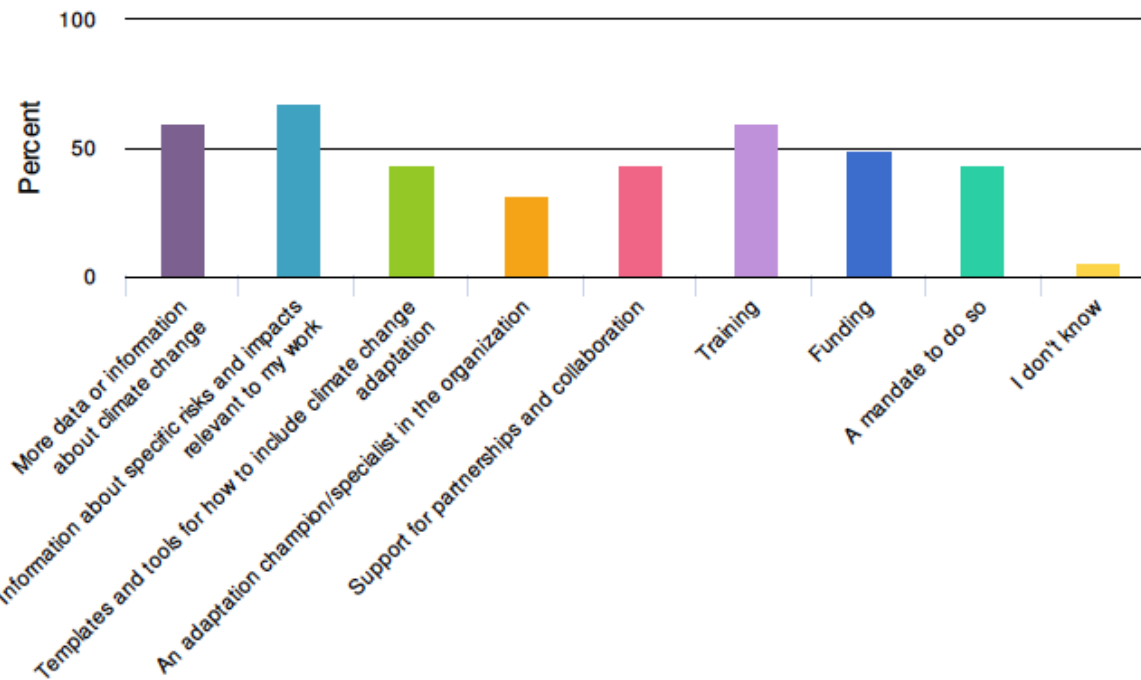


Figure 12. Perception of need for climate change adaptation supports

Barriers to Climate Change Adaptation

The top named barrier to including climate change adaptation in their work across communities was 'insufficient knowledge' (49%) followed by 'insufficient staff time or resources' (47%).

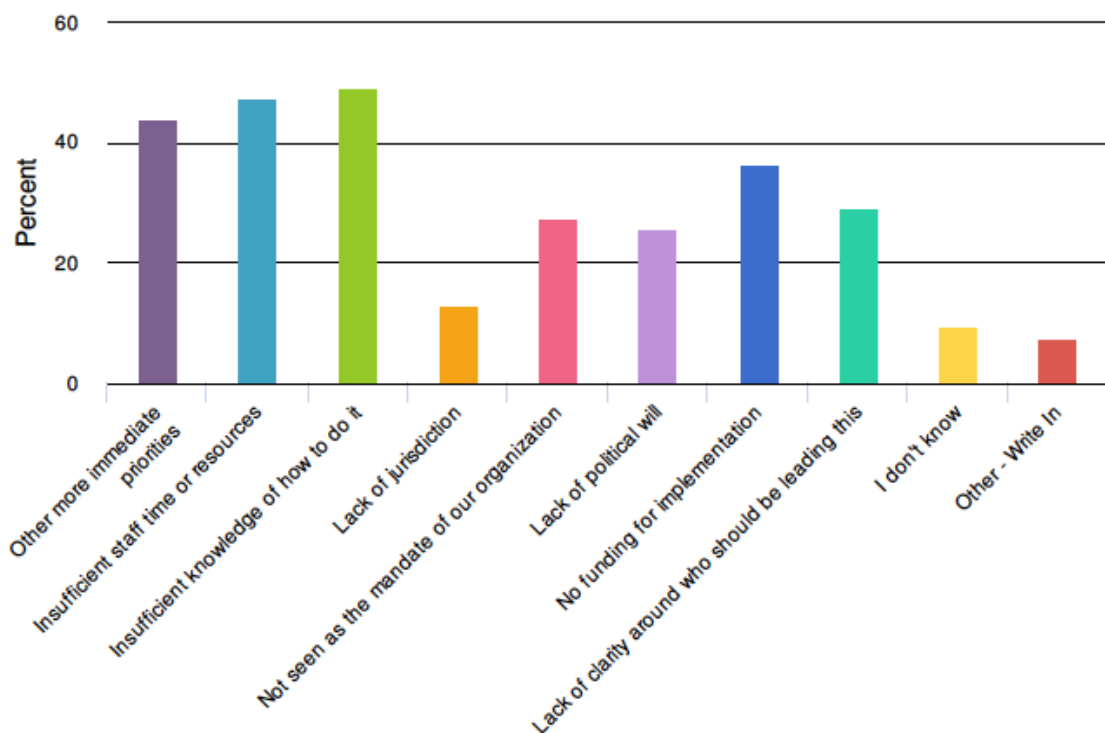


Figure 13. Barriers to climate change adaptation

In some communities, ‘lack of political will’ was a top barrier (Dawson Creek, 67%) and also ‘lack of clarity of who should be leading this’ (NRRM, 46%). In Tumbler Ridge, 100% of respondents (3 people) indicated that climate change adaptation was ‘not seen as the mandate of their organization’.

Respondents indicated that the key stakeholders that should be involved in developing climate change adaptation measures include local or regional governments, provincial government, health sector, resource and industry, and the private sector (Figure 14). Nearly 75% of indicated all of these sectors needed to be involved in developing adaptation plans and 72% of respondents indicated that all of these sectors should be involved in implementing adaptation plans.

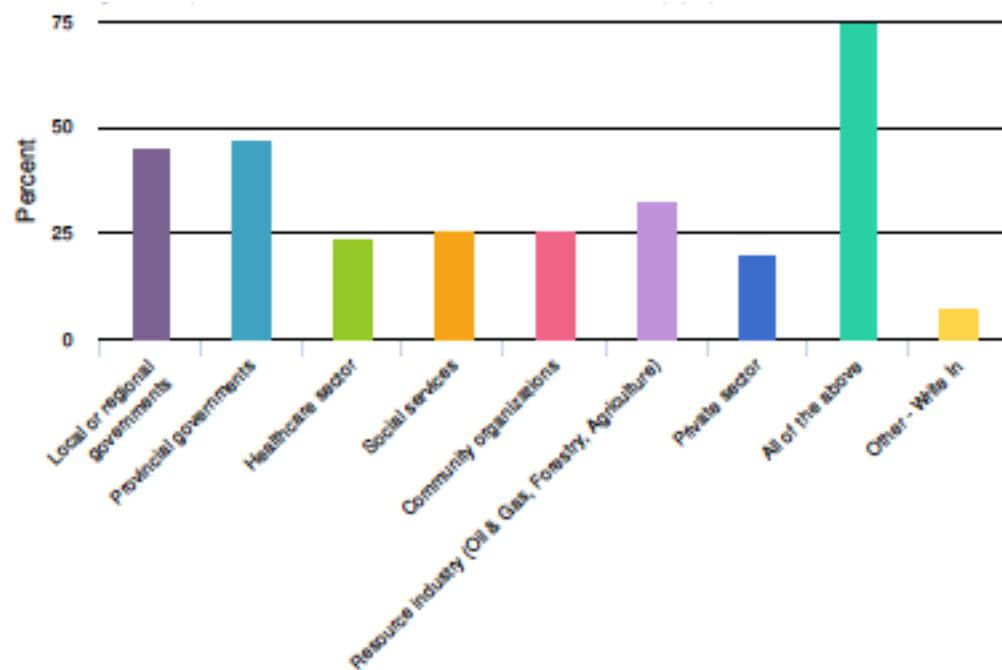


Figure 14. Perception of key stakeholders that should be involved in developing climate change adaptation measures

Other organizations that were named as important to include are:

- NEAT (Northern Environmental Action Team)
- Resource industry and private sector
- Emergency Management BC
- Fire Departments
- Health Authority

Appendix C. Qualitative Vulnerability and Risk Assessment Process

Step 1: Generate Impact Statements

Based on the regional climate projections summarized above, five overall changes to climate conditions were used as a basis for grouping types of impacts that communities in the Northeast are likely to face:

1. Warmer winters
 - a. Average and low temperatures in winter will warm
 - b. Shorter winter season
 - c. Fewer Heating Degree Days
 - d. Less ice days
 - e. More precipitation falls as rain, and less as snow
 - f. Peak flows and snowmelt in spring occur earlier
2. Hotter, drier summers
 - a. Number of summer days increases
 - b. Average and high temperatures (daytime and night) get hotter
 - c. Very hot days are hotter, and occur more frequently
 - d. A combination of hotter temperatures and changing precipitation & hydrology patterns leads to greater likelihood of dry periods and drought conditions in summer and fall
 - e. Longer potential growing season
3. Increasing frequency and intensity of precipitation
 - a. Annual and seasonal precipitation increases, especially in spring and fall
 - b. Large precipitation events occur more often
 - c. More precipitation falls during large precipitation events
 - d. Rain-on-snow events are more likely
4. Increase in extreme weather events (windstorms, hail, extreme heat, forest fires)
 - a. Due to a combination of changing conditions, unusual events such as large windstorms and hail events may occur more frequently

- b. Due to increasing temperatures and drier periods in summer and fall, extreme heat events and forest fires may occur more frequently

5. Increased riverine flood risk

- a. A changing snowpack, snowmelt timing and increased intensity and frequency of precipitation lead to greater risk of riverine flooding

Within each of these categories, a set of “impact statements” was generated based on information compiled in the Gap Analysis⁹. In the first part of the workshop, participants were asked to “groundtruth” these impact statements, providing any additional information to describe the specific way this would affect their community. In addition, participants were asked to remove any that did not apply to their community, add any that were not already included, and make changes as appropriate. The full list of impact statements and the additional detail provided, is included as Appendix D.

Step 2: Assessing Vulnerability

Vulnerability is a combination of “Sensitivity” and “Adaptive Capacity,” as described in Figure 2. In Step 2, participants individually provided ratings for both Sensitivity and Adaptive Capacity, for each impact statement that they felt confident rating. Where there were large discrepancies among group members’ ratings for an impact statement, discussion ensued to land on a common rating. Ratings were on a scale of 1 to 5 (see **Error! Reference source not found.** for details). These overall ratings were then used to place the impact statement on a “vulnerability matrix” to sort and identify those that were higher vulnerability. **Error! Reference source not found.** shows the section of the matrix identified as “higher vulnerability” (marked with an asterisk). Those that were categorized as higher vulnerability were then checked with participants in the workshop, with the opportunity to drop any that didn’t make sense, and/or make a case to add back in others rated slightly lower. Through this process, an overall list of around 50 impact statements was cut to about half.

⁹ In January 2019 a community scoping report was developed for each community that presented an overview of themes and findings from a literature review; a summary of contextual information from regional climate projections reports, priority impacts, identification of gaps and opportunities for adaptation planning and implementation (based on the literature review and interviews), and an assessment rating using the “Climate Adaptation Maturity Scale”.

Instructions: Use these rating scales to assess each impact statement at your table

1. Think about: “Is the system / asset / group of people represented in the impact statement subject to existing or anticipated future stress? How will the impact exacerbate existing stress?”

Sensitivity Rating:

2. If the impact occurs, will it affect functionality (the ability of the system / asset / group of people to serve its purpose or provide the use it is designed for)?

1 No: Functionality <u>will</u> <u>stay the same</u>	2 Unlikely: Functionality <u>will</u> <u>likely stay the same</u>	3 Possibly: Functionality is <u>likely to</u> <u>get worse</u>	4 Likely: Functionality <u>will get</u> <u>worse</u>	5 Yes: Functionality <u>will</u> <u>become unmanageable</u>
--	---	--	--	---

Adaptive Capacity Rating:

3. Can the system / asset / group of people adjust to the projected impact with minimal cost and disruption?

1 No: will require <u>substantial costs</u> <u>and intervention</u>	2 Unlikely: Will require <u>significant</u> <u>costs and intervention</u>	3 Possibly: Will require <u>some costs</u> <u>and intervention</u>	4 Likely: But will require some <u>slight costs and</u> <u>intervention</u>	5 Yes: <u>Little to no costs or</u> <u>intervention will be</u> <u>necessary</u>
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Figure 15. Sensitivity and adaptive capacity rating scales Used in workshop 1 assessment process

SENSITIVITY		No	Unlikely	Possibly	Likely	Yes
		S1	S2	S3	S4	S5
ADAPTIVE CAPACITY	No			*	*	*
	Unlikely				*	*
	Possibly				*	*
	Likely					
	Yes					
	AC1					
	AC2					
	AC3					
	AC4					
	AC5					

Figure 16. Vulnerability assessment matrix, based on BARC-ICLEI

Step 3: Assessing Risk

Risk is a combination of “Consequence” and “Likelihood,” as described above. In Step 3, participants assigned consequence ratings together as a small group. Each of the highest vulnerability impact statements included in Step 2 was assigned a rating from low to high in five categories (affected people, economy, critical infrastructure, environmental, and cultural). These overall consequence ratings were then combined with ratings of likelihood for each of these types of events, provided by expert reviewers (see Appendix E. Heat Map

Risk results from the NRRM workshop fall in the medium-low, medium and high categories of risk. None of the impacts were assessed as low risk. To be rated high risk, the impact has a combination of high consequence rating and medium or high likelihood rating, high ratings for both, or a medium consequence rating and high likelihood rating as per the heat map below (Figure 17). (Note: Each impact statement is indicated by a number, corresponding to Table 10 below.)

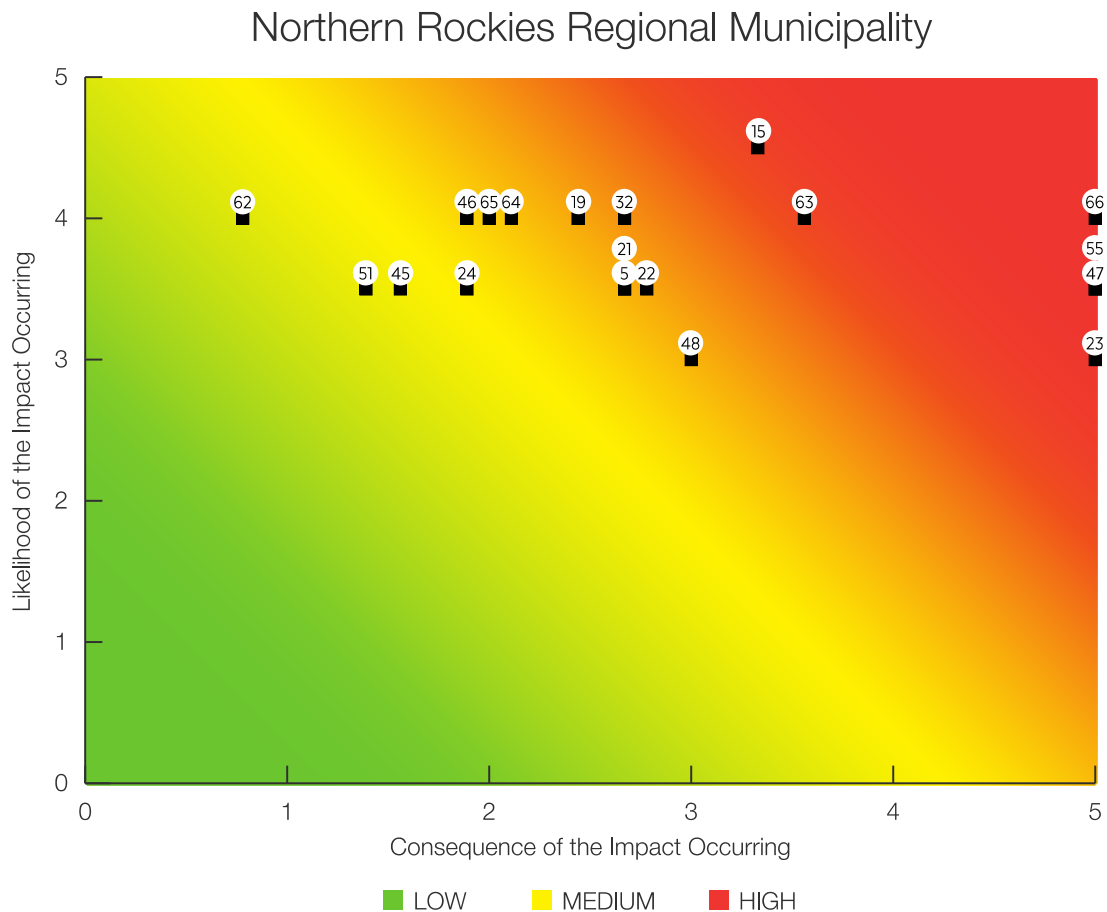








Figure 17. Heat Map characterization of risk ratings for highest vulnerability impact statements



For the reference of staff as they work with this prioritized set of risks in their planning, the following comments were provided in workshop 2, to modify the placement of top risks based on their professional judgment:

- Move #5: Likelihood impact occurring and consequence related and merging to #34
- Move #48: Less consequence; areas impacted are not sensitive locations

- Move #45: More consequence; no backup system in place.

Table 10. Highest risks identified for NRRM

Climate Hazard	Impact statement #	High Risk Impact Statements in descending risk score order (Likelihood X Consequence)
 HOTTER SUMMERS	66	Hotter and drier conditions contribute to increasing wildfire risk in large forested areas (ecosystem, recreation, and forestry industry impacts).
 INCREASE IN OTHER EXTREME EVENTS	47	Wildfires and landslides are more common, impacting evacuation routes and transportation in and out of the community.
 INCREASE IN OTHER EXTREME EVENTS	55	Effects of large-scale wildfires on industrial activity and related infrastructure.
 WARMER WINTERS	15	Warmer winter temperatures may enable spruce beetle infestations which decreases local forestry incomes and impacts the Community Forest (under application)
 WARMER WINTERS	23	A combination of hotter temperatures and changing precipitation could lead to a lower water table and drier muskeg environment in particular, which has ecological impacts and could affect industry access.
 HOTTER SUMMERS	63	Change in seasonality and increasing temperature leads to introduction of new invasive species (plants, insects, etc.)

 <p>INCREASED INTENSITY & FREQUENCY OF PRECIPITATION</p>	32	<p>Variability and intensity of precipitation events in winter decreases safety and ease of travel, especially for mobility challenged individuals</p>
 <p>WARMER WINTERS</p>	19	<p>Freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs</p>

for full list of consequence and likelihood scores).

Appendix D: Impact Statements with Additional Detail

This table includes all impacts generated throughout the adaptation planning process with NRRM with additional notes added from participants in the workshops.

Climate – related hazard (shock): Hotter Drier Summers and Longer Growing Season		
#	Impact Statement	Vulnerability Detail
66	Hotter and drier conditions contribute to increasing wildfire risk in large forested areas (ecosystem, recreation, and forestry industry impacts).	Destruction of forestry plantations -> increased costs to replant (increased cost to nurseries) -Negative impact to tourism, ability to travel to and from Fort Nelson -Hunting outfitters regularly impacted (smoke/vulnerability)
63	Change in seasonality and increasing temperature leads to introduction of new invasive species (plants, insects, etc.)	Leads to higher costs to industry and public to maintain native ecosystems and compliance with legislation -Longer growing season - more costs to municipality
62	Increasing temperatures and longer growing seasons enhances the ability to grow certain crops	Increase in locally grown fruits and vegetables -Expanded agriculture (crops and livestock) -Opportunity for new business/expansion into non-traditional areas
64	The combination of hotter and drier conditions increases potential for drought and decreased water supply in late summer	Suspension of industrial water licenses + Permits, affects business continuity + Profitability - NRRM ability to meet residents water needs -Impacts on agriculture/crops and livestock
65	Increasing number or magnitude of	Impacts to those with respiratory issues

	wildfires impacts the health of the community due to poor air quality days and mental health impacts	<ul style="list-style-type: none"> -Impacts to family members associated with stress -Education to public may reduce generalized anxiety -Impacts on health are workers responding to increased number of people having hospital visits (increasing ambulance/emergency services, etc.) -Impacts on patients/families/caregivers increased stress
60	With increasing wildfires, regional forest fire evacuees increase in number and frequency which increases stress on the community's emergency response and emergency social services	
61	Increasing temperatures and variable weather conditions reduces the ability to grow certain crops	
69	Prescribed burning	Public may ease up on smoke concerns if prescribed burns reduces wildfire smoke later

Climate – related hazard (shock): Increase in other extreme events (storms, hail, extreme heat, wildfires, etc.)		
#	Impact Statement	Vulnerability Detail
47	Wildfires and landslides are more common, impacting evacuation routes and transportation in and out of the community.	<ul style="list-style-type: none"> Air quality/smoke -Evacuation route -Tourism -Damage/infrastructure -Alert system -Jurisdictional issues (declaring an emergency) -Lack of knowledge regarding emergency response plan
55	Large scale wildfires	<ul style="list-style-type: none"> -Closure/shutdown of industrial activity (oil and gas/forestry/mining); puts infrastructure at risk, costs in delayed processing/manufacturing -Although Fort Nelson has not experienced wildfire within the community in recent history, the fire danger ratings have reached levels of concern in the last ten years.

45	Increase in extreme events cause more frequent power outages, in turn affecting power to critical infrastructure	Business -School -Critical infrastructure (airport)/ needed back-up generators
46	Increasing intensity of snowfall, ice events and rain-on-snow events stretches the capacity of public works to respond and increases costs	\$\$ - Sand, people/resources, overtime -Liability/injury (winter rain)
48	Major events lead to impacted transportation routes within the regional district and municipality making it difficult for residents to access critical services, their employment, and healthcare.	
51	Increasing extreme events decreases the durability of infrastructure generally (damage), leading to earlier replacement and increased maintenance needs	Storm sewer vulnerability - increased \$ spending on critical infrastructure
49	Unusual weather events such as hail and tornados may increase with damaging effect for buildings, infrastructure and other assets	Increased insurance costs -Landscape refurbishment - municipally owned -Crop vulnerability in future
50	Increasing frequency and intensity of extreme events puts pressure on the physical and emotional capacity of community volunteers including ESS and volunteer fire fighters	Volunteer burnout -Stress could cause staff to quit
52	More frequent / larger scale emergency and disaster events place increasing demands on municipal resources and capacity for mitigation, planning, preparedness, response and recovery	Increased costs (see #47)

54	Family Supports	Need for education on emergency preparedness for families to cope with extreme events -Stress on families in those situations
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Climate – related hazard (shock): Warmer Winter Conditions		
#	Impact Statement	Vulnerability Detail
15	Warmer winter temperatures may enable spruce beetle infestations which decreases local forestry incomes	2018 forest health survey results Without harvest of dead timber, increases fuel loading = fire hazard
23	Lower water table	Dried out muskeg Impacts to industry access - permitting Access to water for wildlife Fish breeding
19	Increasing freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs, and safety	- Increased flood risk and operations and maintenance costs resulting from freeze-thaw conditions (during the spring thaw season, NRRM experiences freeze-thaw cycles that result in snowmelt during the day, which then freezes and plugs drainage systems during the night); -Culvert ice plugs (\$) -NRRM is also responsible for maintaining rural roads in the region. Road infrastructure may be degraded more quickly and require more maintenance with increasing freeze/thaw cycles and heavy rain or hail.
21	Fewer days to use winter roads and ice bridges	Less time available to complete industrial activity in remote areas; leads to smaller projects, delayed projects or higher costs to complete work in a shorter time
22	Loss of traditional access routes	Ice thickness changing - making access not always safe, decrease in amount of ice days = less winter days on trapline
24	Threatened species impacts	Early spring results in early insect hatches (i.e. black flies) which can kill birds - chicks that aren't in optimum condition (i.e. goshawk chicks killed by black flies) Insect hatches earlier no feed source for other species

		Conservation foundations
2	Increased river flow and flood events cause increased avulsions (changes to the river's path) and bank erosion, impacting aquatic habitat.	<ul style="list-style-type: none"> Erosion of river banks/sediment has negative effect on fish, wildlife Creating deadfall from eroding banks, leading to log jams on bridge structures (P-3 bridge, Muskwa)
16	Increasing pest infestations due to warmer weather would negatively impact agriculture and forestry	Bugs adapt quicker than slow moving plants
17	More rapid snow melt leads to increasing localized flooding from backed up culverts	Loss of permafrost leading to Hepving Road, building structures Increased flooding impacts infrastructure, need to deal with increased water. Flooding also impacts provision of fresh water
18	Warmer winters and summers lead to decreasing heating requirements and possibly increasing cooling needs, which impact energy bills and building design	Cost potential to add A/C
20	Increasing potential for rain-on-snow events (and ice storms) increases the risk of street flooding, street closures, mobility issues and potential damage to nearby buildings	Poor highway conditions lead to accidents School bus cancellations Rail system Emergency services

Climate – related hazard (shock): Increased Intensity and Frequency of Precipitation

#	Impact Statement	Vulnerability Detail
32	Variability and intensity of precipitation events in winter decreases safety and ease of travel,	Increased number of residents leaving community to access many services (increased need to travel to access services and uncertainty of travel) -Very little options for travel

	especially for mobility challenged individuals	-Increased number of people travelling because no other option - taking bigger risks
5	Heavy rainfall events lead to more frequent/intense overland flood events, increasing costs and requiring more capacity for flood clean-up and restoration	-Staff noted that they are experiencing 1:50 year and 1:100 year events more frequently during the summer. These storms overwhelm the drainage system. -Recently, a 25-year return period storm flooded the wastewater treatment plant, which resulted in moderate damage to one of the buildings and a costly insurance claim. -Surcharging & backup -In a recent event one subdivision in Fort Nelson experienced over 100 mm of precipitation in an hour, resulting in flooding.
30	Situations of increased turbidity due to larger or more frequent precipitation events decrease the number of days that pumping can occur from the river to water supply reservoirs	
31	Heavy rainfall events cause more sewer back-up, which damage buildings and can cause health impacts	
33	Increasing surface run-off during the rainy season and decreasing recharge during the longer dry spells will impact groundwater and base flows	Groundwater -> (water table) - Roads/accesses - Drainage/sewer surcharge - study data lacking
34	Increasing intensity of rainfall causes more frequent localized flooding and sewer surcharge in parts of the community	Impacts to housing, schools, roadways, storm sewers Back-ups in aging infrastructure Doesn't apply to rural septic systems (not near lakes) Increased demand placed on storm sewer infrastructure, ditches/culverts. Potential need to upsize
35	Increasing intensity of rainfall makes crop planting and harvest more	Increased intensity could damage/kill crops

	difficult for farmers. Crop failures and hot/dry summers	
36	Increasing run-off carrying more salt (from roads) in the winter, and other contaminants year-round, negatively affects water quality leading to environmental impacts	Warmer winter would require less salt on roads Increase in winter abrasive used on highways to combat constant road conditions Impact on water and fish
37	Increased surface runoff can lead to increased nutrient concentrations in the water and increased sediment load thereby impacting operation of water supply infrastructure	Areas of concern: -Flooding airport bypass (syd) -MOTI - not all in our jurisdiction
38	Increasing intensity of rainfall will increase erosion at sewer outfalls if not properly placed	
41	Rainfall in winter	Increased costs to tax payers (airport) - Mobility issues - Liability (claims) - Heritage, South industrial

Appendix E. Heat Map

Risk results from the NRRM workshop fall in the medium-low, medium and high categories of risk. None of the impacts were assessed as low risk. To be rated high risk, the impact has a combination of high consequence rating and medium or high likelihood rating, high ratings for both, or a medium consequence rating and high likelihood rating as per the heat map below (Figure 17). (Note: Each impact statement is indicated by a number, corresponding to Table 10 below.)

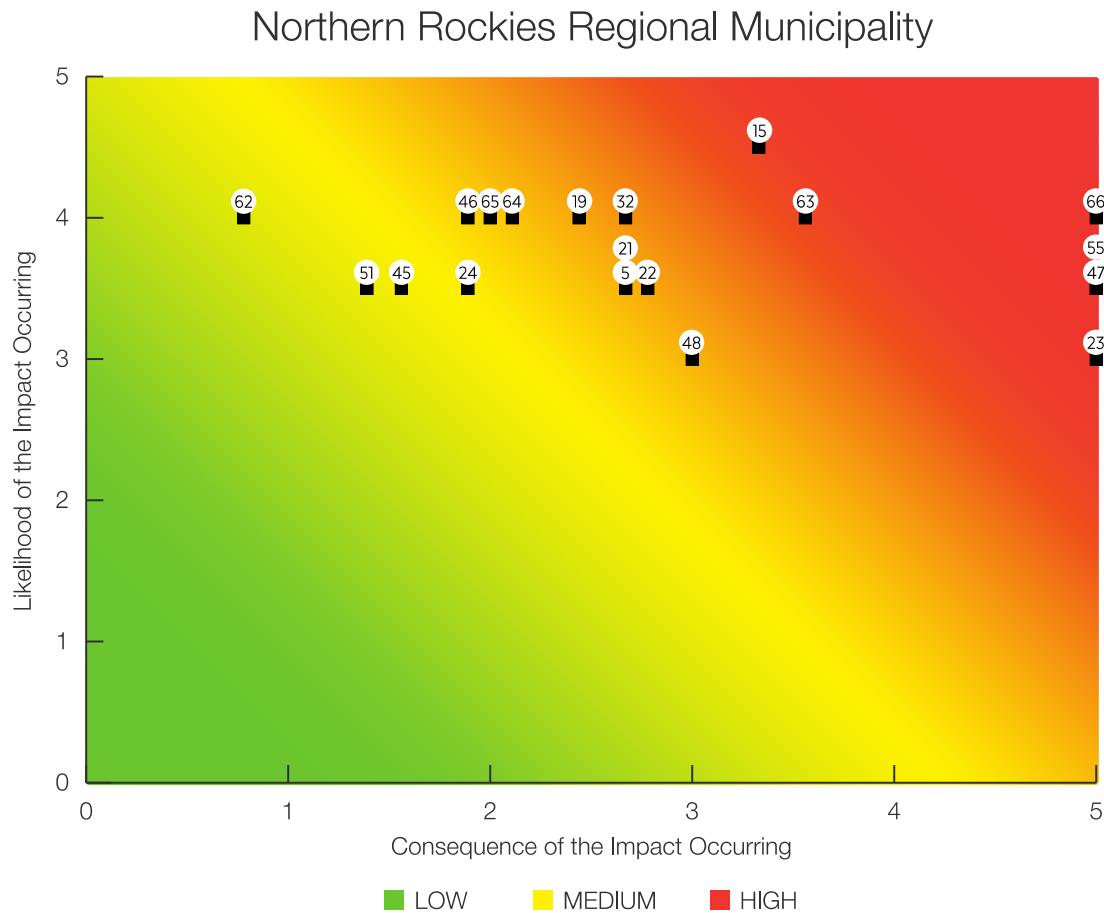










Figure 17. Heat Map characterization of risk ratings for highest vulnerability impact statements

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 WARMER WINTERS	19	Freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs

Appendix E. Climate Adaptation Teams, Terms of Reference

Purpose

- To build internal capacity for assessing and planning for changing climate conditions
- To build in redundancy to this capacity (i.e. multiple people with understanding, skills, and institutional memory)
- To raise awareness of vulnerabilities and risks due to a changing climate and build buy-in within the organization and community for this knowledge to become more mainstreamed into and across organizational processes
- To maintain momentum by providing mutual support

Consider a balance of these characteristics in choosing who to invite to your team:

- Internal champions and/or those who have some degree of understanding and interest in the impacts of a changing climate for the work of the local government (this could include those who attended workshop 1)
- A range of functions within the local government (e.g. drawn from different departments, and/or responsible for different aspects of this work – for example: a CAO, an engineer, a planner, an EOC operator or Fire Chief, someone from finance/asset management, an elected official)
- Those who are responsible for key climate risks
- Positional authority – a combination of higher-level decision-makers with others who get things done on the ground
- At this time we are suggesting that this be an internal team; however, in the smaller communities you may want to include an external stakeholder for the extra capacity or strategic role they may play in supporting the work moving forward.

Function:

- This team will be tasked with providing guidance and leadership to your climate adaptation effort in this next phase of the work.
- For the time being, this is likely to be an informal working group. As this advances, becomes more understood, and/or is established as a priority within your organizations, you may decide to establish a steering committee and/or formalize the role of this group (or your organization may be ready to make this formal already!)
- The scope of this group's work will depend on capacity and need. In the next two steps of the Climate Vulnerability Assessment we will be exploring what actions you may want to pursue in the near term. This will inform the "terms of reference" you may want to set for this group. For the duration of this project, this will include:
 - Participating in workshop 2 on June 11th, in Chetwynd (all day)
 - Participating in drafting an action plan, with support from SHIFT (early fall, 2019) (up to 2 coaching calls with SHIFT; 2-4 hours to draft your action plan)

- Meeting with the NECRN in the fall to share your action plan, learn from others, and coordinate regionally around areas of shared interest and priority. (3 hours)
- Meeting monthly or bi-weekly as a team to provide leadership on implementing your action plan, from fall of 2019 (at this stage you may want to reconsider membership in the Climate Adaptation Team, and/or establishing a broader steering committee)

Appendix G. Detailed Action Plan

1.0 Hotter Summers:							
High Risk Impacts: #63: Change in seasonality and increasing temperature leads to introduction of new invasive species (plants, insects, etc.) #66: Hotter and drier conditions contribute to increasing wildfire risk in large forested areas (ecosystem, recreation, and forestry industry impacts).							
Action #	Action	Action Description	Status: Underway, Act Now/by X year, Monitor, Investigate further	Lead Department	Effort: Range of funding / HR from low to high	Next Step	Evaluation Notes: How well this action addresses evaluation criteria
1.1	Statement 66: Education	Community engagement about safety and preparation for fires	underway	Admin	Low effort	Review and refresh	
1.2	Statement 66: Emergency Management	Readiness to activate emergency centre, voyent alert system	underway	Admin	Low effort		
1.3	Statement 66: Land management	Implementation of wildfire protection plan	Underway	Doug/ RDP	Medium effort		
1.4	Statement 63: Education	Education on invasive weeds with NRRM staff & schools.	Active	PW	Medium effort	Continue to update and refresh education with new information on invasive sp.	
1.5	Statement 63:	Identification and	Active	PW	Medium effort		

	Treatment	treatment of areas of invasive weeds					
1.6	Statement 63: Education	Education directed to property owners on high risk, and what can be done to mitigate impacts of a forest fire (ensuring no gaps in siding, cleaning gutters regularly, etc)	Short Term	PW/RDP/Admin	Medium effort		

2.0 Increased Intensity and Frequency of Precipitation

High Risk Impacts:

#32: Variability and intensity of precipitation events in winter decreases safety and ease of travel, especially for mobility challenged individuals

#5: Heavy rainfall events leading to more frequent/intense overland flooding events, increasing costs and requiring more capacity for flood clean-up and restoration

Action #	Action	Action Description	Status: Underway, Act Now/by X year, Monitor, Investigate further	Lead Department	Effort: Range of funding / HR from low to high	Next Step	Evaluation Notes: How well this action addresses evaluation criteria
2.1		Priority ranking and procedures for both roads and sidewalks owned by the NRRM. Continuing to update.	On-going	PW	Low	Continue to update	
2.2	Communicatio	Communication with the	Short Term	CS/Admin/R	Medium	Develop	

	n & Education	public on risk areas, safety procedures, limiting risk,		DP		communication on how best to limit risk during the winter	
2.3	Research	Complete Sewerage and Drainage Climate Change Vulnerability and Adaptation Assessment	Underway	PW			
2.4	Asset management	Make upgrades to infrastructure based on the above noted assessment as part of scheduled replacement.	On-going	PW	High	Wait for recommendations of study	
2.5	Research and develop programming for residents	Provide examples and develop material to encourage residents to employ green infrastructure (earth works catchment systems, rain & fusion gardens)	Medium Term	Pw/rdp	Medium	Research existing programs at other municipalities.	

3.0 Warmer Winters

High Risk Impacts:

#15: Warmer winter temperatures may enable spruce beetle infestations which decreases local forestry incomes and impacts the Community Forest (under application)

#23: A combination of hotter temperatures and changing precipitation could lead to a lower water table and drier muskeg environment in particular, which has ecological impacts and could affect industry access.

#19: Freeze/thaw cycles decrease the durability of infrastructure (such as roads and trails) and increase maintenance needs

Action #	Action	Action Description	Status: Underway, Act Now/by X year, Monitor, Investigate further	Lead Department	Effort: Range of funding / HR from low to high	Next Step	Evaluation Notes: How well this action addresses evaluation criteria
3.1	Research	Review pine/spruce beetle reports already available and identify risk areas and actions	Future	Rdp	Low	Compile reports, review, recommend any actions	
3.2	Maintaining roads	Removal of snow effectively from roads to prevent amount available to melting/freezing	An improvement potentially	Pw			
3.3	Maintenance	Steam culverts in the spring to prevent damage from freeze thaw	On-going	PW			

4.0: Increase in other extreme events (storms, hail, extreme heat, wildfires)

High Risk Impacts:

#68: Wildfires, overland flooding and landslides are more common, impacting evacuation routes and transportation in and out of the community.

#69: Effects of large scale wildfires on industrial activity and related infrastructure

Action #	Action	Action Description	Status: Underway, Act Now/by X year, Monitor, Investigate further	Lead Department	Effort: Range of funding / HR from low to	Next Step	Evaluation Notes: How well this action addresses evaluation criteria
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					high		
4.1	Community engagement/ education & emergency planning	See all statement 2 items in Hotter Summers					
4.2	Asset management	Make upgrades to infrastructure based on sdccva assessment as part of scheduled replacement.	On-going	PW			

Appendix H. Climate Adaptation Maturity Scale

The following pages are the checklist portion of the “Climate Adaptation Maturity Scale” published by the Federation of Canadian Municipalities’ “Municipalities for Climate Innovation Program.” The full document is available at:

<https://fcm.ca/home/programs/municipalities-for-climate-innovation-program/climate-adaptation-maturity-scale.htm>

Competency: Policy <i>Putting in place policy and objectives related to the development of an environment and vision that supports local climate adaptation.</i>										
Maturity level →	1		2		3		4		5	
	Concept Level		Preliminary Level		Implementation Level		Operational Level		Continuous Improvement Level	
	Working on Level 1 <input type="checkbox"/>	Completed on Level 1 <input type="checkbox"/>	Working on Level 2 <input type="checkbox"/>	Completed on Level 2 <input type="checkbox"/>	Working on Level 3 <input type="checkbox"/>	Completed on Level 3 <input type="checkbox"/>	Working on Level 4 <input type="checkbox"/>	Completed on Level 4 <input type="checkbox"/>	Working on Level 5 <input type="checkbox"/>	Completed on Level 5 <input type="checkbox"/>
	We have set expectations for our work on climate adaptation. We have the support we need to begin preparing a policy.		We have drafted a climate adaptation policy and have prepared strategic guidelines that will inform the development of an adaptation plan and other adaptation initiatives.		We have adopted our climate adaptation policy and are using it to guide our actions, and have drafted an adaptation plan. We have established performance measures to monitor progress.		We have a climate adaptation plan in place and are managing climate risks. We are using performance measures to track the progress and outcomes of our climate adaptation initiatives.		We are continually improving our understanding of climate risks and our approach to managing these risks.	
Outcomes	You have achieved a specific maturity level when you can demonstrate evidence of the outcomes below.									
Policy and objectives	<input type="checkbox"/> We have looked into policy issues and constraints surrounding climate change adaptation within our community.		<input type="checkbox"/> We have developed a policy that details our organizational commitment to climate adaptation. <input type="checkbox"/> Senior management and council have endorsed the policy.		<input type="checkbox"/> We are starting to use the policy objectives to guide our broader corporate plans and actions. <input type="checkbox"/> We have drafted an adaptation plan detailing specific initiatives and processes.		<input type="checkbox"/> Senior management and council have endorsed the adaptation plan. <input type="checkbox"/> Climate risks are managed in terms of levels of service, operations, and maintenance, in accordance with the policy.		<input type="checkbox"/> We are validating and refining corporate, service and adaptation objectives based on the evolving needs of our community.	
Strategy and framework	<input type="checkbox"/> We have defined objectives and committed to taking a concerted approach to managing climate risks.		<input type="checkbox"/> We have engaged senior leadership in identifying strategic-level climate risk categories across the municipality.		<input type="checkbox"/> We are beginning to integrate climate risk considerations into our asset management practices.		<input type="checkbox"/> There are clear links between the climate adaptation plan, asset management practices, and other strategic corporate efforts.		<input type="checkbox"/> We are continually improving our understanding and management of strategic-level climate risks.	
Measurement and monitoring	<input type="checkbox"/> We have articulated the expected benefits and outcomes of climate adaptation to council and internal stakeholders.		<input type="checkbox"/> We have developed guidelines and criteria for local or regional adaptation initiatives.		<input type="checkbox"/> We have established performance measures to monitor progress on climate adaptation, outcomes, and community benefits.		<input type="checkbox"/> We monitor progress on the climate adaptation plan and the implementation of adaptation initiatives.		<input type="checkbox"/> We are monitoring performance and using the feedback to prioritize and make ongoing refinements and improvements.	

Competency: Human resources and governance

Ensuring staff and council are equipped with the mandate, understanding, skills and knowledge needed to support local climate adaptation.

Maturity level →	1		2		3		4		5	
	Concept Level		Preliminary Level		Implementation Level		Operational Level		Continuous Improvement Level	
	Working on Level 1 <input type="checkbox"/>	Completed on Level 1 <input type="checkbox"/>	Working on Level 2 <input type="checkbox"/>	Completed on Level 2 <input type="checkbox"/>	Working on Level 3 <input type="checkbox"/>	Completed on Level 3 <input type="checkbox"/>	Working on Level 4 <input type="checkbox"/>	Completed on Level 4 <input type="checkbox"/>	Working on Level 5 <input type="checkbox"/>	Completed on Level 5 <input type="checkbox"/>
	We have council support ¹ to establish a cross-functional climate adaptation team. ²		We have established a clear mandate for our climate adaptation steering committee. ² Council has approved use of funding for internal or external awareness raising regarding climate risks and potential adaptation initiatives.		Our climate adaptation steering committee and team ² have clear responsibility and the support needed for preparing a draft climate adaptation plan.		Our climate adaptation plan is in place. Our climate adaptation team ² is guiding and supporting climate adaptation on an ongoing basis, and has ongoing council support. Adaptation-related roles and responsibilities are operationalized.		Our staff and council are continually improving our understanding of climate risks and our approach to managing them.	
Outcomes	You have achieved a specific maturity level when you can demonstrate evidence of the outcomes below.									
Cross-functional groups	<input type="checkbox"/> We have appointed a climate adaptation team to examine current and future climate change risks and to identify potential adaptation opportunities or initiatives.		<input type="checkbox"/> We have appointed a cross-functional climate adaptation steering committee ² to oversee planning and deployment of climate adaptation initiatives by the climate adaptation team.		<input type="checkbox"/> The climate adaptation team, with oversight from the steering committee, is developing and will manage a climate adaptation plan.		<input type="checkbox"/> Our climate adaptation team has been made permanent to provide ongoing communication, support and guidance on adaptation across the organization.		<input type="checkbox"/> Our climate adaptation team and steering committee support the continuous improvement of our climate adaptation initiatives.	
Aligned culture	<input type="checkbox"/> Staff/council have a basic understanding of risks posed by climate change to infrastructure, natural assets and operations.		<input type="checkbox"/> Our climate adaptation team raises awareness of local climate risks and builds buy-in for potential adaptation initiatives.		<input type="checkbox"/> Climate-adaptation-related roles and responsibilities are clearly identified and communicated for staff in key departments.		<input type="checkbox"/> Climate risks are managed in terms of levels of service across our organisation.		<input type="checkbox"/> Climate change considerations are influencing how we optimise decisions on assets and service delivery.	
Stakeholder engagement	<input type="checkbox"/> We have identified climate change and adaptation stakeholders within the community.		<input type="checkbox"/> We have completed some community consultation on our climate change vulnerability assessment and potential adaptation initiatives (see Level 2 of the Technical and Risk Management Capacity competency).		<input type="checkbox"/> We have completed community consultation on the climate change vulnerability assessment, potential adaptation initiatives, and climate impacts on levels of service.		<input type="checkbox"/> We communicate regarding climate change adaptation initiatives and progress on climate adaptation plan implementation, internally and externally.		<input type="checkbox"/> Staff or council members are recognized by peers and external stakeholders as adaptation resources, and engage with them to exchange knowledge. <input type="checkbox"/> There are ongoing mechanisms through which the community can be engaged in discussions or activities relating to local climate adaptation.	

¹ Council support is defined as a formal council resolution or adoption of bylaws, studies, master plans or policies that confirm formal support from elected officials.

² Members of the climate adaptation team or steering committee may wear many hats within their organization, and may also hold responsibility for other initiatives (e.g. asset management). It is also recognized that in smaller municipalities, members may sit on both the climate adaptation team and climate adaptation steering committee. Some municipalities may choose to engage external stakeholders in their climate adaptation team or climate adaptation steering committee, or in both groups, but it is recommended that there be a strong level of internal representation.

Competency: Technical and risk management capacity

Preparing the tools needed to deliver adaptation initiatives and manage operations in a way that minimizes climate risk (e.g. software, hardware, maps, models, etc.).

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	Concept Level		Preliminary Level		Implementation Level		Operational Level		Continuous Improvement Level	
	Working on Level 1 <input type="checkbox"/>	Completed on Level 1 <input type="checkbox"/>	Working on Level 2 <input type="checkbox"/>	Completed on Level 2 <input type="checkbox"/>	Working on Level 3 <input type="checkbox"/>	Completed on Level 3 <input type="checkbox"/>	Working on Level 4 <input type="checkbox"/>	Completed on Level 4 <input type="checkbox"/>	Working on Level 5 <input type="checkbox"/>	Completed on Level 5 <input type="checkbox"/>
Maturity level →	We are exploring our technical needs and data gaps so that we can take steps to better manage our assets and reduce their vulnerability to climate change.		We have defined our technical gaps and are acquiring the necessary data and tools to conduct a vulnerability assessment of our infrastructure-based services.		We understand the priority climate risks to key infrastructure systems and are planning our monitoring and management approach for addressing them.		We understand ongoing climate risks to our assets and levels of service, and are planning adaptation initiatives to address them. We have data collection and analysis processes in place to support risk management and adaptation initiatives.		We continually improve our approach to strategic adaptation planning and reducing climate risk over the longer term.	
Outcomes	You have achieved a specific maturity level when you can demonstrate evidence of the outcomes below.									
Data and performance management	<input type="checkbox"/> We are compiling available data and identifying gaps related to asset performance, as well as observed and expected local climate change impacts. <input type="checkbox"/> We are conducting a needs assessment for an information system to manage and track asset and climate data.		<input type="checkbox"/> We are filling data gaps related to asset performance and local climate change impacts. <input type="checkbox"/> We have established appropriate operational and customer levels of service for priority assets. <input type="checkbox"/> We have completed the needs assessment for our information system, and are exploring suitable options.		<input type="checkbox"/> We have identified our priority assets for risk management, and are establishing processes for ongoing data collection on asset performance and climate change impacts. <input type="checkbox"/> We have acquired an information system for managing and tracking data, and are currently implementing it and training relevant staff.		<input type="checkbox"/> We have implemented our information system, trained relevant staff, and established processes for ongoing data collection related to asset performance. <input type="checkbox"/> Our approach to climate change risk management and ensuring levels of service is well-documented.		<input type="checkbox"/> We continually improve our approach to data collection and management; and practices and tools are in place to manage the quality and consistency of data. <input type="checkbox"/> Flexibility is built into the processes and tools to make it easy to adapt them to a changing reality or changing conditions.	
Technical tools	<input type="checkbox"/> N/A		<input type="checkbox"/> We are conducting a needs assessment for other technical tools (e.g. models, software, maps, etc.) to support analysis of climate change impacts on established levels of service.		<input type="checkbox"/> We have acquired or developed other technical tools and have completed a vulnerability assessment of our assets. <input type="checkbox"/> We are identifying measures to address climate risks to levels of service, operations and maintenance, and capital projects as needed.		<input type="checkbox"/> We are using our tools to monitor the effectiveness of our risk management practices and adaptation measures.		<input type="checkbox"/> We continually improve our tools for analyzing climate impacts on established levels of service and managing climate risk.	
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Economic considerations	<input type="checkbox"/> We are exploring costs for accessing relevant data sources or acquiring necessary technical tools and systems for conducting a climate risk assessment of our assets.	<input type="checkbox"/> We have allocated funding for acquiring relevant data, technical tools and systems, and/or training needed to conduct a detailed vulnerability assessment of our assets.	<input type="checkbox"/> We are assessing costs related to adaptation initiatives that address immediate risks to our assets or levels of service.	<input type="checkbox"/> We have allocated annual funding to implement priority adaptation initiatives and to manage operations in a way that reduces climate risks to our assets and service levels.	<input type="checkbox"/> Our climate adaptation initiatives are fully funded and our operations are managed in a way that minimizes climate risk to our assets and service levels over the longer term.
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