BUILDING COMMUNITY RESILIENCE

KEY CONSIDERATIONS AND LESSONS LEARNED FROM TWELVE CANADIAN COMMUNITIES

This Report was prepared as part of the Municipalities and Utilities Partnering for Resilience Project led by QUEST (www.questcanada.org)

QUEST

FUNDED BY:

FCM FEDERATION OF CANADIAN MUNICIPALITIES FÉDÉRATION CANADIENNE DES MUNICIPALITÉS

Natural Resources Canada Ressources naturelles Canada

Canada

Acknowledgments

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The preparation of this report was carried out with assistance from Federation of Canadian Municipalities (FCM) and Natural Resources Canada (NRCAN) in the framework of two separately funded projects. The views expressed are the personal views of the authors, and FCM and NRCAN do not accept responsibility for them.

About QUEST

QUEST is a national non-government organization that works to accelerate the adoption of efficient and integrated community-scale energy systems in Canada by informing, inspiring, and connecting decision-makers. The organization commissions research, communicates best practices, convenes government, utility, and private-sector leaders, and works directly with local authorities to implement on-the-ground solutions. QUEST grounds all its activities in the “Smart Energy Community”– a concept that encapsulates the ideal end state of our work.
Visit us at www.questcanada.org.

Participating Municipalities

As part of the NRCAN-funded initiative, QUEST would like to thank the municipal staff of the Town of Stratford (Prince Edward Island), City of Charlottetown (Prince Edward Island), City of Summerside (Prince Edward Island), Town of Woodstock (New Brunswick), Rural Municipality of Alexander (Manitoba), Town of Dauphin (Manitoba), local stakeholders, and partnering energy utilities for participation in this initiative.

As part of the FCM-funded initiative, QUEST would like to thank the municipal staff of the City of Campbellton (New Brunswick), Town of Cochrane (Alberta), Town of Devon (Alberta), City of Saint John (New Brunswick), Town of Okotoks (Alberta), and Municipalité de Tracadie (New Brunswick), local stakeholders, and partnering energy utilities for participation in this initiative.

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List of Acronyms

CCHIP	Climate Change Hazards Information Portal
CEP	Community Energy Plan
ECCC	Environment and Climate Change Canada
EMO	Emergency Management Organization
EMP	Emergency Management Plan
FCM	Federation of Canadian Municipalities
JIBC	The Justice Institute of British Columbia
NRCAN	Natural Resources Canada

1.0 Executive Summary

Almost 90% of Canadian energy utilities have been significantly impacted by a weather event such as high winds, ice storms, floods, droughts, and forest fires, in the last decade[1]. Climate change will continue to increase the frequency and intensity of these events[2]. Though reliable energy supply is needed to maintain the essential functions of everyday life, there are limited tools and assessment processes to help local governments and utilities to collaborate and plan effectively for risk mitigation and climate adaptation.

The objectives of QUEST's *Municipalities and Utilities Partnering for Community Resilience* initiative were 1) to foster collaboration between municipalities, energy utilities, and other key community stakeholders, 2) to conduct climate risks and vulnerability assessments through innovative tools and endorsed methodologies, and 3) to inform climate adaptation measures and emergency preparedness by identifying each community's areas of vulnerability and strength, and by making tailored recommendations with a focus on energy infrastructure and prolonged power outages.

This two-year initiative, funded by FCM and NRCAN as two separate projects, involved twelve Canadian municipalities in the provinces of New Brunswick, Prince Edward Island, Manitoba, and Alberta. Beyond the unique characteristics of each community and province, QUEST identified common strengths and vulnerabilities among participating municipalities and partnering energy utilities. Despite the diverse energy landscapes across provinces, and how this impacts energy utilities, QUEST noted similar trends in the way they are coping with vulnerable assets, strengthening infrastructure, and improving emergency preparedness and restoration responses in a context of increased frequency and intensity of atmospheric and hydrological hazards.

This report presents lessons learned from participating municipalities and energy utilities and leverages them into a guide for communities interested in starting or reviewing their climate adaptation and climate planning strategy and their emergency responses, with a specific lens on energy infrastructure.

Section 2 highlights the relevance of the initiative and the benefits for participating communities. It confirms that municipal staff and energy utilities need and want to work together, and how the methodology developed by QUEST facilitated more integration and collaboration. **Section 3** presents lessons learned from municipalities and energy utilities. Firstly, it highlights municipalities' most common strengths and vulnerabilities, as well as energy utilities' key emerging practices to cope with climate hazards, and the most common areas of improvement. Secondly, it presents the key recommendations selected by participating communities to advance climate adaptation, strengthen energy systems, and augment emergency preparedness. Finally, it analyzes the key challenges to the development and implementation of climate adaptation measures. **Section 4** builds on the lessons learned to develop a guide for municipalities interested in resilience planning. It highlights eight key considerations and provides additional tips and resources to develop effective public communication and secure financial resources – two major barriers to climate adaptation and planning.

[1] See QUEST's Resilient Pipes and Wires report. 2015

[2] Environment and Climate Change Canada, 2019, Canada's Changing Climate Report, https://changingclimate.ca/CCCR2019/

2.0 Initiative Overview

2.1 Why this Initiative?

Municipalities across Canada are facing extreme climate change impacts, such as high winds, ice storms, floods, droughts, and forest fires. At the same time, almost 90% of Canadian energy utilities have been significantly impacted by a weather event in the last decade[3]. Both municipal systems and energy distribution systems are essential, interconnected, and must work together to maintain the resilience of a community.

Reliable energy supply is needed to maintain the essential functions of everyday life. This includes the operation of municipal infrastructure such as water and wastewater treatment, heating and cooling of buildings, operating vehicle fleets, street lighting, powering emergency shelters, as well as other community infrastructure such as health systems, communications, transportation, food production, financial systems, and the list goes on.

Despite concerns that climate change and weather-related events threaten the reliability and resilience of Canadian energy distribution services, there remains limited tools and assessment processes to help local governments and utilities collaboratively and effectively plan to reduce risks and costs to residents and businesses.

QUEST's *Municipalities and Utilities Partnering for Community Resilience* initiative aimed to foster collaboration between municipalities, energy utilities, and other key community stakeholders to undertake a climate risk and vulnerability assessment using several tools, and to work together to select climate adaptation measures, including: adopting policies and practices, augmenting risk-based decision-making, improving infrastructure, land-use planning, asset planning, energy planning and reliability measures, increasing public education, communication, coordination, and emergency preparedness and response during prolonged power outages.

2.2 A Timely Initiative for Municipalities and Utilities

2.2.1 The Impacts of Climate Change are a Reality for Canadian Communities

The communities QUEST worked with are facing multiple and diverse climate hazards. This aligns with recent reports[4]. Whether located inland or on the coast, the major types of climate hazards participating communities are exposed to and that damage their infrastructure are:

- Hydrological hazards, for example flooding due to changing precipitation patterns, and temperature or due to sea storms and rising sea levels, along with coastal erosion.
- Atmospheric hazards, especially ice storms, wind storms, blizzards, hail, and hurricanes on the east coast, and associated power outages and interruptions to services.

[3] See QUEST's Resilient Pipes and Wires report. 2015

[4] Environment and Climate Change Canada, 2019, Canada's Changing Climate Report, https://changingclimate.ca/CCCR2019/

Other climate hazards that are becoming an increasing concern for municipalities include extended heat waves, water deficits (drought), and forest/bush fires, as well as interruptions to food and medicine supply and hazardous material spills due to inclement weather.

Local vulnerabilities commonly identified include infrastructure located in flood zones, key facilities without back-up power, areas for improved bioretention, areas to improve transportation, and more. Adaptation measures commonly identified include discouraging development in flood prone areas, encouraging development in low risk areas, adopting building codes, protecting natural buffers, increasing bioretention measures, ensuring back-up power for key facilities, planning heating and cooling centres to welcome evacuees, leveraging local energy opportunities, alternate route planning, educating residents, and studying coastal impacts.

Both hydrological and atmospheric hazards pose significant risks to municipal infrastructure (e.g. storm water systems, water and wastewater systems, municipal roads, shelters, communications, etc.), as well as energy distribution systems, continuity of essential services, not to mention impacts to private property, public health and safety, and the local economy.

This initiative took place between 2018 and the end of 2019, during which extreme weather events and other natural disasters - similar to what may be expected with climate change - affected each province. This often resulted in prolonged power outages - testing the robustness of emergency response plans and casting a light on the need to further collaborate with utilities to improve resilience. For example:

- NB: 1 in 100 year flooding along the Saint John River, Spring 2018 and 2019
- PE: Post-Tropical Storm Dorian, Sept 20, 2019
- MB: Major Blizzard, October 2019
- AB: Severe Wildfires in the north of the province, 2019

These events cast light on communities' major vulnerabilities related to land-use planning, back-up power systems for key facilities, communication systems, water systems, and energy infrastructure. In some cases, the events also impacted the availability of emergency management and energy utility staff who were planning to attend our workshop consultations but were deployed in response or recovery operations. However they remained engaged throughout the initiative.

Finally, these events provided useful lessons that were shared across participating communities during monthly calls and during the workshops. They were incorporated into the assessment and recommendation reports prepared by QUEST. It will remain important for each municipality to capture lessons learned after future events to further inform climate adaptation and emergency preparedness.

2.2.2 Communities are Starting to Adapt to Climate Change but Lack Resources

Through this initiative QUEST found that participating municipalities are aware of the importance to adapt to climate change and more willing to act for two reasons. First, being exposed to increased climate hazards, municipalities are aware of the importance of protecting their assets and their population. Second, in the context of polarizing debates on climate change, the challenge of adaptation is more consensual and the notion of a resilient community more accepted within communities as it does not look at root causes. It is therefore easier for staff to show municipal council health and safety benefits and associated positive economic impacts, and to gain public support for adaptation measures.

All participating municipalities have started to develop local initiatives to mitigate risks in order to protect their population and infrastructure. However, the degree of awareness, formalization and integration of climate adaptation into municipal documents and operations vary from one municipality to another. Some municipalities only recently adopted their Climate Adaptation Plan, while others were still in the development phase, or are being required by their Province to develop a Climate Adaptation Plan. Others had not started the process yet, or pursue measures on an ad-hoc or case-by-case basis.

At the same time, QUEST also found that limited human and financial resources, as well as limited access to sound and affordable expertise, were major barriers to the development and implementation of climate adaptation measures for all participating municipalities. There is, therefore, a significant gap between what the municipality is aiming for and is willing to do, and its actual capacity to act.

Through their participation in QUEST's initiative, participating municipalities were able to overcome the barrier of access to sound expertise that informed the development and preparation of their Climate Adaptation Plans. It also enabled them to identify measures to incorporate into their Emergency Plans, Land-Use Plans, Asset Plans, communications strategies, etc. QUEST helped each municipality adopt a systematic, inclusive, and integrated methodology to develop, improve, or review their Climate Adaptation Plans; to identify and prioritize measures; and to build in-house capacity to implement those measures.

Table 1: State of Climate Adaptation Plan at the beginning of the project

	Climate Adaptation Plan in place	Climate Adaptation Plan in development	No Climate Adaptation Plan
Number of municipalities	2	4	6

2.2.3 A Much-needed Bridge to be Built Between Municipalities and Utilities

QUEST noted that participating energy utilities have already started to implement adaptation and resilience measures. All utilities were actively involved in the workshops in each province. All utilities have an electrical restoration plan but some utilities are more advanced than others in this area. In provinces that experienced repeated severe atmospheric or hydrological hazards over the past decade (especially in PE and NB) utilities have become more proactive, while in other provinces utilities are just starting to address these issues.

The initiative confirmed the need for more collaboration between municipalities and utilities to improve resilience. QUEST was able to have representatives from power and natural gas utilities from every participating province, all of which provided information about their adaptation efforts and indicated support for increased education, collaboration, and engagement with municipalities to improve resilience.

Participating municipalities were interested in obtaining more information about their local energy systems in relation to climate change, including the type of vulnerabilities their energy systems were exposed to, what was being done to strengthen them, and how to prepare for prolonged outages.

Participating municipalities also understand the need to collaborate closely with energy utilities to successfully develop community energy plans and implement local resilient energy projects such as distributed generation.

Energy utilities are also concerned about the impact of climate change as it puts increasing pressure on maintaining the reliability of their assets and increases the costs to operate and maintain them. They were interested in listening to the needs of municipalities and helping them inform their local adaptation and resilience efforts. Participating energy utilities were willing to work with municipal staff on identifying asset vulnerabilities, determining local infrastructure that requires priority restoration, and sharing information about utility adaptation measures and emergency preparedness.

2.3. Key Benefits for Participating Communities

Based on ongoing conversations with participating municipalities and energy utilities, and the evaluation survey, QUEST was able to identify key benefits that communities experienced by being part of the *Municipalities and Utilities Partnering for Community Resilience* initiative.

2.3.1 Inclusivity and Engagement: A Collaborative Approach to Climate Adaptation

Breaking down internal and external siloes. Virtually all workshop participants, including municipal staff, representatives from EMOs, provincial organizations, local businesses, and energy utilities valued the inter-sectoral design of the workshops. It was praised as a powerful tool to raise awareness about community resilience and break down operational silos. In many cases, the workshops were the first opportunity for these stakeholders to get together in order to discuss community resilience with the aim of identifying practices and policies in place, existing gaps, and vulnerabilities[5]. Participation in the project helped each municipality to identify internal and external stakeholders to engage for each recommendation/action.

Building bridges between municipal departments. During the project, municipal staff realised that municipal structure and governance processes are not always conducive to inter-departmental collaboration on climate adaptation. Responsibilities and roles are scattered among different departments and there are few mechanisms for cohesion and integration. Among the more frequent challenges identified during this initiative were:

- A lack of integration between the communications team, asset and energy management staff, planning and infrastructure, emergency management, etc.
- A lack of cohesion and alignment among municipal plans on climate adaptation measures.
- The responsibility of developing and implementing climate adaptation lay within lower divisions (as opposed to director level or CAO levels), with few resources and not enough authority to mobilise staff from other departments. In some cases, municipalities do not have a specific department providing oversight for climate adaptation.

A major outcome of the initiative was the realisation for the need to advance integration and cohesion through inter-departmental collaboration and new governance processes. In each case, the creation of

[5] Based on QUEST evaluation survey distributed to participants at the end of each workshop.

an oversight committee engaging all municipal departments and key community stakeholders was a key recommendation ranked as a high or medium priority.

Engaging energy utilities. While many municipalities have a direct account manager at each utility, there is no established process to collaborate with their energy utilities to understand hazards and reduce risk from prolonged interruptions to power and fuel delivery, or to plan new energy projects. This initiative engaged participating municipalities and their respective energy utilities to better understand and work with each other. Energy utilities provided an overview of their climate adaptation measures, discussed local needs, and contributed knowledge to the reports received by participating municipalities. The most evident findings were the needs to improve communication, collaborate with stakeholders in the community (utility, EMO, municipality, etc.), and to secure funding for adaptation measures.

The ability of municipalities to engage their utilities depends on the utilities' priorities, availability, and understanding of the impact of climate change on energy distribution systems and municipal infrastructure. Utilities also work with constrained capacity and staff. Finding a staff champion within a utility that has the ability to give time and participate in the workshops required a lot of advance relationship building. However, the utilities saw value in participating in the workshops and expressed interest to augment their engagement with all municipalities with respect to climate resilience.

The initiative was particularly helpful in building bridges between utilities and municipal staff, especially as it related to public education, emergency preparedness, mitigating risk to municipal services, disaster response and recovery (management), adapting energy infrastructures through community energy planning and aligned asset management, land-use planning, emergency management planning, and related policies.

2.3.2 Building an Integrated and Systematic Resilience Approach

Leveraging current municipal documents and governance processes. Throughout this initiative, municipalities identified key municipal documents and governance processes that can support improved resilience, including:

- Governance: e.g. task force or committee
- Climate Change Adaptation Plan
- Land Use Planning/Official Plans
- Building Code/Bylaws
- Asset Management Plan
- Energy Management Plan
- Emergency Management and Response Plan
- Communications strategies

Incorporation of low-hanging fruit in municipal plans. Throughout the initiative, QUEST delivered two participatory workshops and two reports for each community: a *Climate Risk and Vulnerability Assessment Report* and a *Recommendation Report*. Thanks to these deliverables, municipalities were able to quickly gain a better understanding of their weaknesses and strengths in becoming a more resilient community. Participating municipalities mentioned that these documents will act as supporting material to develop and update policies, processes, and bylaws.

The mapping of municipal infrastructure, including facilities, helped municipalities identify the most vulnerable assets for various climate hazards and highlighted areas of improvement. In addition, the list of recommendations enabled municipalities to prioritize actions. As a result, by the end of the initiative, most participating municipalities started to incorporate low-hanging fruit to improve existing municipal plans and/or inform their adaptation strategy, including:

- Leveraging climate projections and recommendations to inform the reviews of Municipal Plans. In some cases, a few recommendations had been implemented and others were underway.
- Supporting cases for council approval (e.g. flood zone bylaws, plan review).
- Applying for funding for adaptation measures such as flood risk reduction.
- Driving other initiatives such as community training and education.
- Informing the development and/or implementation of Climate Adaptation Plans, as well as the reviews and updates of Asset Management Plans and Emergency Management Plans. Some recommendations were incorporated into Emergency Management Plans.
- Building connections and synergies with other initiatives. For some municipalities, this initiative was an opportunity to build bridges with other resilience projects in the region (on drought and flooding resilience for instance) or to start new initiatives (on natural asset management for instance).
- Improving energy resilience of critical infrastructure by addressing key weaknesses identified during the workshop. One of the municipalities is currently developing a request for proposals to have generator backup to some of the emergency shelters that were identified. Another is currently looking for options to install back-up power to a water treatment plant.
- Establishing new points of contact with energy utilities. This will prove critical as municipalities further develop resilient strategies with them.
- Bringing resilience and climate adaptation issues to the forefront of Council and administration, making it a priority, and starting processes that incorporate resilience.

2.4. Methodology

2.4.1 Phases

The “Municipalities and Utilities Partnering for Community Resilience” initiative led by QUEST supported twelve municipalities in Alberta, Manitoba, New Brunswick, and Prince Edward Island to develop climate risk and vulnerability assessments using a combination of data gathering, workshop exercises, validated assessment tools, and methods to develop context-appropriate recommendations for climate adaptation and resilience.

The initiative consisted of two separate projects respectively funded by NRCAN and FCM. Each project had three stages:

- **Phase 1: A climate risk and vulnerability assessment stage** resulting in an assessment report for each community. QUEST designed and delivered an interactive and participatory workshop bringing together multiple key stakeholder groups in 2018. The workshop was tailored to the context of each community thanks to data collected through a survey answered by municipal staff. The workshop used interactive tabletop discussions and mapping exercises to tap into participants' knowledge to identify strengths and gaps in their community to climate and industrial hazards. This enabled municipalities to identify hazards, risks, and vulnerabilities while

simultaneously considering opportunities to both reduce risks and enhance community environmental performance. Each participating community received their *Climate Risk and Vulnerability Assessment Report*, which also includes climate change trends, projections, and further analysis of risk and resilience to all climate hazards using JIBC's Disaster Resilience Portal.

- **Phase 2: An action-oriented stage** resulting in a set of specific recommendations to advance resilience. Building on the findings of the survey and the first workshop, QUEST designed and delivered a second interactive and participatory workshop in the second half of 2019 with the same stakeholder groups. The purpose of the workshop was to identify place-specific recommendations that addressed identified weaknesses. The workshop enabled participants to select recommendations based on the type of hazards identified in their community, to prioritize them, and to assign a cost, a timeline, and a department lead. Each participating community received their *Resilience Recommendation Report* at the end of 2019. The report is user-friendly and organizes recommendations by lead department responsible for implementing them, with a tracking table for each recommendation.

- **Phase 3: Networking and knowledge exchange.** For the project duration, participating communities engaged in monthly calls meeting with the project team, and were invited to share their initiatives and questions with the group. In addition, peer-learning sessions were completed by the delivery of three webinars. The first webinar introduced the project, the second webinar presented key lessons from the first workshop, and the third one presented the lessons learned presented in this report.

2.4.2 A Tailored Methodology Adapted to Local Context

The initiative draws on information collected through an initial survey of municipal staff, collection of climate data projections, and workshop exercises which draw on various tools, including the UN ISDR - International Strategy for Disaster Risk Reduction 10 Essentials for Making Cities Resilient, QUEST's Resilience Mapping exercise, and the Rural Disaster Resilience Portal (JIBC). These tools support municipalities to self-assess strengths and weaknesses, and help identify where to target investments to support climate adaptation, asset management, land-use planning, and emergency preparedness, to achieve community wide economic impacts.

The methodology and approach adopted during the initiative proved to be effective at engaging relevant stakeholders and having informed discussion about climate change related hazards, risks, and vulnerability, and to identify adaptation measures suitable to each community.

The initiative involved the following components:

- **Preliminary survey** - Municipal participants answered questions derived from the 10 Essentials, JIBC's Disaster Resilience Portal, and QUEST (focused on energy planning, organization, and communication). This allowed the project team to understand local strengths and vulnerabilities or gaps, and to develop locally-applicable materials and recommendations for adaptation.

- **Climate change data collection** - Historical and projected climate data and maps for this report were extracted from the Climate Change Hazards Information Portal (CCHIP). The climate data

for each community was extracted into spreadsheets and relevant data was used to develop the climate data summaries for each community. CCHIP provided customized climate and climate change outputs based on geographical area, sector, theme and timeframe of interest. The portal draws on data from thousands of locations and multiple sources to provide information such as temperature and precipitation normals and extremes, trends and frequencies of temperature and precipitation at relevant thresholds, key statistics on other extreme weather (e.g., lightning, windstorms, and tornadoes), and climate change projections from international and domestic government sources. The Climate Change weather station data from each location or closest to it and the nearest gridded climate data set from the NRCAN and Environment and climate Change Canada (ECCC) generated CANGRID dataset were used. This data was used to inform each municipality of future potential climate change impacts associated with business-as-usual GHG concentration pathway and to assess potential adaptation measures needed.

- **1st Workshop -** included presentation of survey results and climate data projections; presentations from emergency management, insurance sector, and energy utilities; facilitation of three table-top discussions and exercises, engaging municipal staff, energy utilities, emergency management, provincial staff, insurance providers and other local stakeholders. See exercises described below. Workshops resulted in identification of climate risks and vulnerabilities, and opportunities for improving resilience at the local level.
    - **Overview - 10 Essentials Exercise.** This exercise provided participants with an opportunity to identify and discuss strengths and weaknesses, in terms of local resilience, using the UN ISDR Ten Essentials for Making Cities Resilient (see **Appendix 1** for more information).
    - **Overview - Resilience Mapping Exercise.** Participating community stakeholders were able to share their knowledge and identified local risks, vulnerable and resilient assets, and opportunities to improve resilience using an interactive map of their community, and recording actions in a workbook.
    - **Overview - Action Planning Exercise.** This exercise provided participants with an opportunity to discuss the most significant findings of the day, their ideas for key areas for improvement, related needs, and potential actions.

- **Analysis and Climate Risk and Vulnerability Assessment Report -** Using the data gathered (preliminary survey, climate projections, and workshop 1), the project team assessed each community's strengths and vulnerabilities for key climate hazards of concern (e.g. atmospheric, hydrological, fires), using JIBC's Rural Disaster Resilience Portal, combined with indicators we developed for organization, planning, communication, and energy. This analysis uncovered areas of high risk and low resilience. In addition, we found that even though communities may be highly resilient to certain hazards, there were still specific opportunities for improvement. All of the information collected and analysed was summarized in a Climate Risk and Vulnerability Assessment Report for each municipality. Based on this analysis QUEST refined a set of recommendations for each municipality.

- **2nd Workshop -** This workshop included an overview of all key findings (climate projections, local strengths, areas of improvement) and updates from participating municipalities and their energy utilities. QUEST presented a set of recommendations tailored to the context and needs of each community. Through a table-top exercise, participants selected among the

recommendations, discussed what was needed, assigned timeline, priority, cost, lead department, etc. using a spreadsheet. This process led to very informative discussions and exchange among diverse participants, consensus on key actions to pursue, how to embed the recommendations into existing plans or processes, and opportunities to collaborate.

- **Recommendations report -** based on the results of workshop 2, the project team prepared a report for each municipality, with the selected recommendations organized by lead department and priority.

- **Monthly team calls -** QUEST hosted a monthly webinar call with all participating municipalities, in order to provide the opportunity for sharing knowledge, updating on the project, preparing for workshops, and reviewing outcomes.

3.0 Key Lessons Learned

3.1 Common Strengths and Vulnerabilities in Building Climate Resilience

Beyond unique characteristics resulting from contrasted provincial energy and climate policies, specific geography and climate hazards, and different levels of municipal leadership on climate-related issues, QUEST identified common strengths and vulnerabilities among participating municipalities throughout the initiative.

3.1.1 Participating Municipalities' Common Strengths

Table 2 presents participating municipalities' most common strengths.

Table 2: Key Strengths for Resilience in Participating Municipalities

Category	Description
Emergency Management plan (EMP)	• EMPs are in place and regularly reviewed but they usually need to be updated to respond to new risks related to climate change. • Most communities exercise their plans once a year but they were recommended to conduct more frequent table-top discussions on all climate hazards, and to involve community members. • All communities have several main transportation corridors to enter/exit the community.
Coordination and communi--cation	• Mayor and Council usually understand their roles and responsibilities to communicate with the public before, during, and after an event. New councils need to be briefed every 4 years. • Most communities had informal alliances with neighboring communities (for emergency response) and local suppliers (for resources), while a couple of municipalities had formalized MOUs or Standing Agreements (procurement). • Local governments or other levels of government have some programs in place to regularly assess compliance of schools, hospitals and health facilities maintenance, with building codes, general safety, weather-related risks, etc. • Public alerts networks exist. Municipalities are not always part of it, or can use it better.

	• Most municipalities have a communication plan for promoting emergency preparedness. However, they are not proactive enough in educating and engaging the public and vulnerable populations on climate risks and adaptation measures. Some municipalities require improvements to ensure reliable communication systems.
Energy resilience	• Stationary and mobile back-up power exist for most essential facilities (e.g. EMO, water treatment), but not for all shelters or lift stations. • Most municipalities identified alternate sources of fuel (for generators) in case of supply interruptions. • Risk prevention to conventional hazards is high (e.g. trimming to prevent trees falling on power lines). • All communities have a contact tree, but many need to be updated. • Half of the communities have a Community Energy Plan, and have identified opportunities to improve efficiency, integrate waste heat, renewable energy, etc.
Land-use, planning, and asset management	• Land-use planning documents and Asset Management Plans are increasingly integrating climate hazard considerations, but not a systematic way and without a sound anchor in climate projections . • Awareness of the role of natural assets (e.g. natural buffers, retention ponds/greenspace, to reduce stormwater runoff) exists but is not formalized in policies for new development and improvement is needed to develop a comprehensive strategy. • Climate change is considered in reviews of Land-Use Plans and Bylaws. Municipalities need to be more proactive in discouraging development in high-risk areas (e.g. flood zones, areas abutting forest), and/or requiring minimum elevations (buildings), setbacks, raising electrical equipment, and other flood-proofing measures. • Most municipalities have separated or mostly separated stormwater and sewer systems, however it was unclear if stormwater systems can handle 1 in 100 year flood events. Most communities would benefit from a drainage study to understand how much water their entire network can handle, and make upgrades where needed.
Food security	• Most communities encourage local gardens and markets, but do not have a policy for increasing green roofs, community gardens, etc., nor a food security strategy.

3.1.2 Participating Municipalities' Common Vulnerabilities

Table 3 presents the most common vulnerabilities or areas of improvement of participating municipalities. QUEST noted that rural and small communities (less than 10,000 inhabitants) face additional vulnerabilities due to declining populations, ageing populations, and low-income populations. This situation contributes to a smaller tax base, thus constraining the municipality's capacity to invest in adaptation measures. In turn, this exacerbates exposure to climate hazards. In addition, low-income individuals and seniors require specific social programs and extra planning for extreme events that are not always accessible in the community.

Table 3: Key vulnerabilities and areas of improvement for participating municipalities

Category	Description
Water infrastructure	• Partial separation of storm water and sewer systems requires ongoing prioritization for separation and replacing old pipes. • There is room to improve bioretention practices on municipal property and roads as well as new developments in the community by adopting a comprehensive Natural Asset Management approach. • Exposure of key water facilities and infrastructure to 1 in 100 year flood events and sea rise level. For instance, lift stations, lagoons, and outflow pipes are not always raised above 1 in 100 year flood events; and culverts to be upgraded to prevent flooding. • In some cases, key facilities (e.g. lift stations, water treatment plants) are not equipped with (mobile) back-up power, and reliable communication systems to manage water systems are missing. • Need for study water system reliability based on energy needs.
Energy infrastructure	• Not enough communication between municipalities and their utilities on a prioritization strategy for restoration. • All municipalities rely on the main grid for power, with no alternative local generation sources. Community Energy Plans identify opportunities, but barriers remain (e.g. financial, technical, policy) despite potential opportunities for renewable heat and power to compliment back-up power (generator) on municipal facilities, critical infrastructure, emergency shelters, etc. • Utilities are just starting to consider climate projections (future sea level rise, snowmelts, and rainfall events) and still need to develop asset management plans to strengthen their infrastructure. For instance, distribution and transmission utilities need to increase protection against ice and snow loading on distribution/transmission lines and to better assess flood risk (1 in 100 year events) to electrical/utility infrastructure. In some cases utilities need to relocate substations, transformers, poles, and other equipment. • Utilities are still replying on customers to report outages, and crews to assess amplitude. They need to invest in smart metering and monitoring infrastructure, to enable rapid outage detection and restoration.
Energy supply	• Public education on emergency preparedness is still weak, this includes education on having a 72 to 96 hour emergency kit, prioritization of restoration procedures, knowing where evacuation shelters are located, and the do's and don'ts during power outages. • Back-up power is missing for some key infrastructures and assets (such as lift stations, emergency shelters, schools, animal shelters, grocery, bank). Regional shelters need support for installing back-up sized correctly (expensive). In many instances, there are no official cooling centers (with back-up power) identified for hot days/heat waves. • Many municipalities did not know whether animal shelters, banks, schools, and greenhouses have backup power. • Key suppliers (e.g. fuel stations, grocers) do not always have back-up. Municipalities need formalized MOUs or Standing Agreements, and require back-up as part of permit process. • Municipalities need to work with utilities to understand hazards and reduce risk from prolonged interruptions to power and fuel delivery.

Emergency Management (EMP)	• EMPs do not account for climate projections and therefore do not consider increased frequency or severity of flooding, forest fires and/or new climate hazards. • Most municipalities did not have copies of EMPs for local schools, hospitals or nursing homes, and are unaware of expectations. • Most municipalities do not have voluntary registry of vulnerable persons (those that do are maintained by police, fire, or red cross) • No official cooling centers were identified (for hot days and/or heat waves). • Some municipalities lack capacity to respond to major events and will lean on provincial EMO or neighboring communities. • Some municipalities need plans to deal with tourist peaks, and influx of evacuees from other communities. • There are no economic incentives established for investing in disaster risk reduction (e.g. permit fee reimbursement).
Communica-tion	• Municipalities did not have a process in place to report regular updates to Council or update them during events. • All municipalities need to improve public education and communication, especially toward vulnerable groups with a specific focus on 72 to 96 hours emergency-kit preparedness, prioritization of restoration procedures, the dos and don'ts during power outages, emergency plans and shelters, and climate hazards and adaptation. • Training drills/exercises are held annually, but may not be communicated to staff and community stakeholders outside of those involved. Table top discussions could improve communication. • Continue to offer stall opportunities for Incident Command System (ICS) training, climate adaptation and resilience. • Municipalities have vulnerable communication systems that need to be strengthened through back-up and alternate systems (such HAM Radio, Trunk Mobile Radio, Fiber, etc.). • Most communities do not have an inventory of skills and resources in the community, or need to update one.
Planning	• Most communities do not have an established task force or committee to provide coordination and accountability for advancing adaptation measures. • Current asset management plans, land-use plan, EMPs, and other planning documents do not consider climate risks and climate projections, and/or do not incorporate disaster risk assessments. • Reviews and updates of planning process and bylaws need to for future planning consider new practices needed such as "best practice" development rules. Municipalities need to identify zones in which to discourage investment and/or to consider applying minimum building requirements. They also need to encourage new development or 'Build back better' in low-risk areas. In many cases, existing developments are legally allowed to rebuild in the same location and manner, even if the municipality knows there are risks to doing so (e.g. from flooding), and can't afford to buy them out. In some municipalities, there are no minimum elevation building standards/bylaws. • Regulations for housing and development infrastructure do not take current and projected climate risks into account. Municipalities usually adopt building codes and standards set by the Province. Provincial codes do not always align with federal guidance and recommended standards. Municipalities could improve the training to inspectors and use the permit process to enforce compliance to code and to provide incentives (e.g. fee reimbursement for flood proofing measures). • There is limited access to adequate financial resources to protect or relocate key infrastructure in flood risk zones. Adapting infrastructure may require support from other sources (e.g. provincial or federal). Many municipalities do not have the financial resources to dedicate 1 FTE staff to develop, implement, and report on long-term adaptation measures.

Food, Medicine	• All municipalities lack a strategy for interruptions to food supply. • Many local grocers or greenhouses do not have back-up power, or plans for mobile refrigeration. A survey may be needed.
Transpor-tation	• Smaller communities need to obtain or designate vehicles to transport vulnerable persons to shelters. • Shared responsibility for upgrading roads, bridges, culverts: Municipal vs Provincial; and rail crossings (private); can be a challenge for adapting to flooding. • As municipalities increasingly adopt electric vehicles or hybrids, there is a reliance on charging infrastructure that may be impacted by prolonged outages. Need to ensure recharge protocol and back-up system for municipal vehicles.

3.1.3 Initiatives from Energy Utilities to Adapt Energy Infrastructure

When looking at energy utilities it is important to recognize the diverse situation across provinces with respect to energy supply and governance structure. Some communities are connected to natural gas, others are not. In some provinces, such as New Brunswick, 40% of dwellings are equipped with wood heat. Some provinces have large private utilities while others rely on Crown corporations (public utilities). Some communities even have their own local electric utilities or district heating operators.

In addition, there are different policies and programs in each province which may hinder or enable utilities to improve efficiency, integrate local renewable sources, etc. As a result, utilities are taking different measures to adapt to climate change. Finally, vulnerability to atmospheric climate hazards varies from province to province. Some regions, such as Alberta, experience relatively low outage frequency and duration compared to other regions in Canada, such as Atlantic Canada.

Recognizing these regional variations, QUEST also noted similar trends in the way energy utilities are coping with vulnerable assets, strengthening infrastructure, and improving their emergency and restoration responses in a context of increased frequency and intensity of atmospheric and hydrologic hazards.

- **Learning from past extreme weather events.** All energy utilities are developing processes to record lessons learned from past emergency situations and become more resilient to the impacts of climate change. These processes aim both at strengthening communication and relationships with key stakeholder groups, and at strengthening their infrastructure and assets. They have also developed mutual aid agreements and are making improvements to outage detection, response, and recovery. For example, most utilities are modelling three days before an event to determine what crews are needed and to predispatch them.

- **Investing in automated system monitoring in order to gather and analyse real time data**. Transmission and/or distribution utilities are installing new systems on their substations, feeders, and transformers (such as supervisory control and data acquisition (SCADA) devices and for some smart meters) in order to detect, map, and track outages in real time.

- **Adapting business and operations to the demand of municipalities and customers for more local and reliable energy systems.** Under the pressure of both climate change and customers'

demand for more local and renewable energy, utilities are developing programs, tools and other initiatives to help municipalities and/or customers incorporate and/or access distributed energy sources.

- **Adapting Emergency Plans and customer education.** Almost all energy utilities are more active on public education on what to do and not do in case of prolonged power outage. They develop dedicated websites or webpages. They are also shifting to new standards, by encouraging households to have 72-hour emergency kit for example.

Table 4 presents a selection of resilience and climate adaptation efforts they have implemented.

Table 4: Selection of resilience and climate adaptation implemented by participating utilities

Category	Description
New Brunswick	**NB Power** has identified key lessons learned from previous extreme weather events over the past 5 years and is leveraging them to learn and adapt to climate hazards through: • Strengthened communication and relationships with other stakeholders, and • Exceed national standards to strengthen infrastructure and improve tree trimming. **NB Power** has planned to invest $90M from 2018-2020 to:. • Upgrade infrastructure (e.g. steel cross arms for all structures, anchoring and guying, bigger and thicker poles, insulated wires, putting monitoring infrastructure in place at substations, feeders, and transformers, to send info in real time to the utility), and • Conduct a vulnerability assessment using a new software that models weak spots using revised ice loads and wind loads.
Prince Edward Island	**Maritime Electric, Summerside Electric Utility,** and **Charlottetown's district heat operators** are learning & adapting to changing climate, strengthening communication, strengthening infrastructure, improving local resilience, and strengthening relationships. **Maritime Electric** and **Summerside Electric Utility** are making improvements to outage detection, response and recovery, and educating customers on the importance of 72 hour preparedness. **Charlottetown' District Heat System** has cold start ability, to generate both power and heat. The heat can be used by key facilities across the City, which may serve as heating centers or shelters, during prolonged power outages.
Manitoba	**Manitoba Hydro** is responsible for generating power and distributing to customers, as well as distribution of natural gas. Through key lessons learned from previous extreme weather events. **Manitoba Hydro** is making efforts to learn & adapt to a changing climate by strengthening communication and relationships with other stakeholders, and by strengthening infrastructure. **Manitoba Hydro** mitigates hydraulic hazards (including wind setup that can heavily influence the levels of Lake Winnipeg) with the following initiatives: • Winnipeg River Shorelands Permit Program: primarily interested in seeing that development doesn't lead to the degradation of the banks and to detect impacts on the banks; • Winnipeg River Bank Protection Program: dealing with negative impacts to private property; • Public Water Safety Around Dams Program (includes signage, control measures such as booms, visual monitoring and warnings ahead of changes in flow).

	Manitoba Hydro has strengthened dam safety control through visual inspection, training eyes and ears, instrumentation and analysis, emergency preparedness plans, return period reviews. Additionally, spillway back-up power is present at all locations and equipment test runs are carried out under both normal power and emergency back-up. At the transmission level, **Manitoba Hydro** is modernizing the grid and investing in automation through ice monitoring (e.g., cameras and sensors). **Manitoba Hydro** also invests in customers education focusing on backup generation, alternate means of heat (e.g., wood stove), participation in emergency plans and committees, creation of sheltering plans, and 96-hour emergency kit.
Alberta	Based on lessons learned from recent catastrophic climate events, especially the fires in Fort McMurray in 2016, **ATCO Power** has been working on a Dedicated Emergency Website & Utility Restoration Map. These tools are available to customers through their website. **ATCO Gas** is exploring the automation and digitization of the distribution systems. Latest innovative technologies in the sector would give them better visibility into outages and disruptions to gas supply. It will also diminish the need to send remotely resources and people in the field during dangerous or emergency situations. **ATCO Gas** offers Compressed Natural Gas Trailers (CNG) or Virtual Pipelines in situations where the main natural gas lines are temporarily disconnected for safety. They are also able to truck in temporary gas supplies for critical facilities such as hospitals and emergency shelters during prolonged outages. **ATCO Gas** also explores local energy solutions such as Combined Heat and Power (CHP) units which are also being explored for customers to increase generator efficiency and become a backup power option for both electricity and gas in an outage. **Fortis Alberta** is the local power distribution company and provides electricity to communities. Fortis uses supervisory control and data acquisition (SCADA) devices on their feeders to detect, map, and track outages live. Fortis field crews have access to outage maps at all times, and they are also available on their website for customers. This also enables the distribution utility to keep records of the most common causes of unplanned power outages such as weather, the environment, equipment issues. **Fortis Alberta** has a mobile app service for reporting power and street light outages, provides information on their website on how to prepare for and what to do in an outage (https://www.fortisalberta.com/outages). **Fortis Alberta** is looking at other options for electricity reliability including a battery storage facility. **Fortis Alberta** has a publicly available interactive hosting capacity map for its distribution systems to help municipalities design and integrate local energy projects. (https://www.fortisalberta.com/customer-service/get-connected/generation/hosting-capacity-map). This tool facilitates the development of Community Energy Plan.

3.1.4 Common Areas for Improvement for Energy Utilities

While energy utilities are taking measures to adapt to climate change, there remain common areas for improvement and similar challenges:

- **Being more proactive in working with municipalities.** Non-municipally owned energy utilities understand the need to work with municipalities to develop more resilient infrastructure and respond to new demands and expectations. The collaboration is just starting and therefore

there is still room for improvement, especially to adopt proactive climate adaptation planning. This includes:

- **Identifying local risk and assisting with resilience planning to align asset management plans and emergency management response** - including how to prepare for outages, how to ensure critical services remain operational, how to improve communications, etc. Utilities should also ensure that key municipal facilities and services (e.g. water) should be prioritized for restoration, in advance of any major events.
- **Supporting community energy projects** such as energy efficiency improvement, integrating local renewable energy sources, waste energy sources, etc, that may provide complementary power and heat for key facilities (such as shelters). There are opportunities to combine renewable energy upgrades in schools with emergency shelter options in all communities.
- **Involve municipalities in restoration and preparedness plans**. Utilities have electrical service restoration plans, but they may not be exercised with municipal staff at a local scale. In order to improve communication and preparedness, utilities could work closer with municipalities (e.g. through exercises or table-top discussions) to identify needs, clarify roles and responsibilities, and align efforts for restoration.
- **Improving flood response** by performing constant monitoring, pre-positioning equipment (trucks) and floating crews to locations, conducting door-to-door surveys, and letting customers know of the situation/when it would be time to make decisions (e.g. to leave). After the flood, speaking with each affected customer to encourage raising electrical panels/equipment.

- **Conducting vulnerability assessments and integrating them in planning strategy**. Most utilities have only undertaken a partial assessment of flood risk (1 in 100 year and 200 year events) to electrical/utility infrastructure, and in some cases have identified a need to relocate substations, transformers, poles, and other equipment. In some cases, they also need to consider future sea level rise, snowmelts, and rainfall events. Some utilities could improve flood response by using a mapping approach to identify what pieces of equipment are possibly affected and what customer service points might be affected by flooding, to make decisions about where to cut power.

To overcome these challenges, QUEST noted that some participants suggested introducing changes to provincial or federal legislation to include essential warming centers in emergency and electricity acts (so that cost can be shared to equip key shelters with backup) as municipalities lack the resources (on their own) to ensure back-up systems for all facilities.

3.2 Key Recommendations to Advance Resilient Communities

During the second phase of the project QUEST helped participating municipalities select recommendations tailored to climate hazards faced by the community as well as initiatives and policies already in place. QUEST noted that despite different local contexts, participating municipalities selected common recommendations that address vulnerabilities/areas of improvement presented in **Section 3.1.2.**

3.2.1 Securing Budget and Funding

Access to financial resources is crucial to the viability of many climate adaptation and emergency management measures. Participants in the first and second workshops noted that municipal financial capacities are limited, and that investment from the federal and provincial levels of government is needed to support some local projects and initiatives.

QUEST noted that small communities face additional vulnerabilities due to declining populations, ageing populations, and low-income populations. This situation contributes to a smaller tax base, thus constraining the municipality's capacity to invest in adaptation measures. In turn, this exacerbates exposure to climate hazards. **Section 4.3** below provides more specific options for municipalities to secure stable financial resources.

3.2.2 Developing Integrated Municipal Climate Governance

Climate adaptation is a relatively new area of governance for municipalities. It is challenging for them to incorporate these new responsibilities into existing practices, planning documents, and organizational structure. **Table 5** presents key recommendations selected by participating municipalities to incorporate climate risks, climate projections and resilience in governance process and policies.

Table 5: Key recommendations related to municipal governance

Create a task force to oversee progress and advance climate adaptation measures; to engage community stakeholders, enable collaboration, knowledge exchange, and accountability. Designate a lead who will report to Council.	Creating a task force (or appointing this to an existing committee) is a critical first step to keep these plans moving forward in a cohesive way. This will increase the ability of each municipality to develop, implement and monitor a Climate Adaptation Plan; coordinate with other departments; and integrate the plan into existing plans and initiatives. The creation of a task force can help in applying a cohesive and systemic approach to incorporate climate risks and adaptation measures into municipal policies and plans. This should involve a range of community stakeholders (industry, power utilities, community associations, local government, emergency management, reps from school and care facility, insurance provider, etc.).
Ensure that hazard/risk assessment, climate change plan, emergency plan, asset plan, etc reference and leverage each other	Align existing municipal processes and documents (emergency response plan, planning documents, communication plans, asset management plans, etc.) with identified climate hazards. Reviews and updates of municipal documents are a great opportunity to integrate recommendations and new climate knowledge. Here are some options to consider: • Update Land Use Plan to consider all climate hazards (zoning) • Update Asset Management Plan to consider climate risk, and consider the cumulative impacts of failure/interruption on providing essential municipal services to the community. • Incorporate recommendations from this report and disaster risk assessments into relevant local development plans on a consistent basis • Prepare a Climate Change Adaptation Plan, incorporate recommendations from this assessment The update of the EMO Plan should include the following gaps identified by participants: • Deliver regular community-based exercises or table top discussions for different hazard types, working with local and provincial EMO • Obtain copies of EM Plans, discuss expectations, with local industry • Have plans to deal with tourist peaks, and influx of evacuees • Ensure fueling stations and grocers have back-up power • Ensure bylaws and measures to reduce the risk of fires • Ensure shelters have back-up power • Allow more municipal staff to have access to ICS training • Other measures associated with ice storms, blizzards, flooding etc
Establish annual or quarterly updates to Council, all Staff	Needs to be done quarterly or annually by collecting updates from each Department, on progress toward implementing adaptation measures; scheduling annual/quarterly updates for Council.
Develop Climate Change Adaptation Plan, incorporate recommendations from this assessment	Most communities are developing a Climate Adaptation Plan, and incorporating recommendations from this project. A Climate Adaptation Plan provides a local focus for understanding climate risk and potential adaptation measures, where to make investments, who to partner with, and helps align municipal priorities, planning decisions, policies and processes, to consider future climate impacts.

3.2.3 Strengthening Public Education and Communication

Municipalities selected a series of recommendations to strengthen their public communication strategies on disaster preparedness (before an event) and emergency response (during an event) presented in **Table 6**. Most of these recommendations highlight the need to better engage community stakeholders, and develop specific messages and training for each type of climate hazards.

Section 4.2 provides additional resources for municipalities to develop sound communications plans.

Table 6: Key recommendation related to public communication for emergency preparedness

Develop an integrated communication strategy focused on key hazards faced by the community	To improve community resilience to the impact of climate change, it is important to develop a sound communication strategy across all municipal departments and emergency services, external stakeholders, the public, and vulnerable groups. • Develop an ongoing public education and outreach strategy to increase resilience to climate hazards. • Deliver regular community-based emergency training/exercise for different hazard types.
Develop an ongoing public education and outreach strategy specific to vulnerable populations by working with partner organisations	• Ensure insurance coverage is available/affordable. • Create a voluntary registry of vulnerable persons. • Update contact tree to include groups that currently serve, or could help, reach vulnerable citizens. • Engage low income neighborhoods, people with disabilities, senior centers, nursing homes to prepare for future hazards; and communicate future potential hazards/climate risk in the community, and your planned measures or adaptations (short term, medium priority). • Ensure vulnerable populations are informed of plans/what to do during a hazard by working with healthcare facilities and social services providers.
Work with current property owners in flood prone areas. Ensure flooded properties only rebuild with the necessary flood mitigation measures	Examine options for: • Protecting structures, raising structures, relocating structures. • Ensuring every dwelling and business has back-water valves and sump pumps installed with back-up power. Encourage measures such as elevating structures, waterproofing, anchoring buildings, raising electrical panel/equipment, relocating or set-backs to reduce future risks to previously impacted properties.
Develop regular community-based exercises for each hazard type	Training exercises beyond fire drills need to be developed and focus on identified climate hazards in the community. Exercise once annually (minimum) for different hazard types. Ensure community-based exercises have taken place in the community at large (e.g., table-top or full-scale exercises) for each hazard type. Exercises could have info sessions about each hazard and then rotating hazards to incorporate these factors. The municipality needs to assess the costs of these exercises and assign a budget.
Strengthen collaboration with industry, local businesses, care facilities and schools	Ensure formal alliances with local industry and businesses, obtain copies of EMPs from local schools, nursing homes and from local industry, and engage relevant industry and businesses to task force or committee.

3.2.4 Incorporating Climate Risks and Adaptation Measures into Land-use Planning, Bylaws, and Asset Management

Municipalities also identified several recommendations related to the review and/or updates of key strategic planning and capital investment documents in order to incorporate climate risks, climate projections, and adaptation measures. **Table 7** presents selected recommendations. Municipalities selected recommendations that leverage both their regulative powers (bylaws, zoning) and allocative powers (investment decisions).

Table 7: Key recommendation related to land-use planning and asset management

Update Asset Management Plan to consider climate hazards and risk, and how to respond. Incorporate recommendations from this assessment.	Most communities are creating or updating their asset management plans. May need to update with climate change considerations. This update should use Canada's Changing Climate Report/Climate data portal to stay up to date with climate projections and hazards.
Update Land Use Plan to consider all climate hazards and ensure disaster risk assessments are incorporated into all relevant local development planning on a consistent basis	Leverage the review of Official Plans, Land Use or Municipal Development Plans, to incorporate climate risk. This includes discouraging development in flood prone areas, bylaw amendments, etc. This update should use Canada's Changing Climate Report/Climate data portal to stay up to date with climate projections and hazards, as well as local flood risk maps. Encourage Council to adopt policy that all capital investment decisions and development decisions consider future climate risk.
Ensure the community has suitable bylaws or regulations to limit or prohibit development within flood hazard areas	Risk sensitive land-use regulations, building and health and safety codes need to support disaster risk reduction. Limit land use, or require specific building codes for developments, such as elevating structures above maximum flood levels (e.g., 100 to 200 year flood level), requiring waterproof materials and anchoring buildings to prevent floatation, requiring set-backs from flood prone areas, raising electrical equipment
Invest in green infrastructure (bio-retention, green spaces) / Take a Natural Asset Management approach, to reduce risks of flooding and reduce stormwater intrusion in sewer systems	Investment in green infrastructure enhances resilience strategies and Climate Adaptation Plans. Green infrastructure may include bio-retention and a greater number of green spaces. By using a Natural Asset Management approach, municipalities reduce risk of: • Flooding and reduce stormwater intrusion in sewer systems • Soil erosion and landslide Potential improvements were identified for bioretention (e.g. green spaces, reservoirs, permeable pavement, trees, etc) on municipal and private land, as well as flood protection in low lying areas near rivers (e.g. bylaws to restrict new developments), adapting existing infrastructure e.g. roads, culverts, and implementing bioretention measures. Retaining or re-establishing natural ecosystems in floodplains provides flood control. Here are some strategies for erosion: • Re-vegetation of eroded areas with trees, shrubs or grasses

	• Stabilization of ravines and slopes with branches or other materials pushed into a grid pattern • Establishment of wind breaks to control wind erosion; stabilizing slopes on rivers where necessary; limiting development on slopes with significant erosion • Relocate property vulnerable to erosion Here are some strategies for floodplains to provide flood control • Vegetation cover which provides soil stability and absorption, which assists with water retention and absorption • Natural stream flows and riparian areas (areas situated on the bank of a river or other body of water) which slow water runoff velocity, reduce bank erosion and reduce the introduction of sediment and debris in watercourses • Protection of ecosystem services (e.g. restrictions, land-use planning, permit process)

3.2.5 Building Resilient Energy Infrastructure

Communities selected recommendations to augment their energy resilience and the resilience of their energy systems. Most recommendations require close collaboration with energy utilities. They are presented in **Table 8**.

Table 8: Key recommendations related to energy planning and infrastructure

Strengthen collaboration with utilities	Strengthen collaboration and knowledge sharing with natural gas and power utilities through regular contact, through exercises, and communications. Work with utilities when considering new energy or infrastructure projects and developments. Identify key municipal facilities that should be prioritized for restoration. Formally incorporate information shared by utilities in municipal plans and strategies.
Ensure all critical municipal facilities and services have stationary back-up power and multiple energy sources	Some municipal facilities do not have back-up power, for example lift stations, shelters, public works, communications, etc. There is not enough back up for everything municipally owned, and transportation in weather may be a challenge (for moving generators or fuel). Municipalities need to identify key facilities, study load requirements to size back-up systems correctly, estimate cost, prioritize and implement stationary or mobile backup systems, where feasible, combined with innovative solar/storage and other local energy options.
Explore energy monitoring systems and local energy resources (CEP) and storage for local renewable power and heat options at municipal facilities and shelters	Municipalities have potential sources of renewable heat and power for back-up, for use in key facilities to improve their resilience. Participants identified opportunities to develop renewable projects in the community, such as community solar farms, district heat, etc. as well as energy efficiency and peak demand reduction.

	Several communities have Community Energy Plans which prioritize these projects, as part of achieving their 10 year targets for energy and GHG emissions reduction.

3.3. Key Challenges

3.3.1 Lack of Financial Resources for Proactive Action

Participating municipalities faced four major challenges to develop, execute, and monitor an integrated community plan on resilience:

- **Limited municipal financial resources.** Most municipalities do not currently have the budget and financial resources and capacity to invest new resilient infrastructure and/or upgraded existing ones. As a result, many measures identified in Climate Adaptation Plans and other municipal plans (e.g. climate adaptation, flood risk reduction, back-up power) are partially implemented, delayed, or not followed up upon.

- **"Who pays for what? "** was one of the most recurring questions asked in relation to securing funding resilience infrastructure projects, such as back-up power. Such projects typically spread over a region and involve multiple stakeholders (e.g. provincial and municipal governments, utilities, infrastructure managers). As a result, there is a lack of clarity on responsibilities and funding sources, which hampers the implementation of required investment.

- **Limited and insufficient federal and provincial funding sources for proactive adaptive measures.** The systems and processes currently in place for all stakeholders mainly adopt a reactive approach to addressing climate events and risks (e..g emergency response, outage management, etc.), and lack proactive approaches and actions (systems strengthening, adapting infrastructure). This is in part due to a lack of funding, resources, education, expersize, and understanding the need. In most cases, large funding programs are reactive and support post-disaster recovery. Participating municipalities felt that it was difficult to access the level of funding needed to strengthen existing infrastructure and invest in public communication.

- **A saturated funding landscape.** Given the multiple federal and provincial agencies offering funding related to resilience and climate adaptation, it is challenging for municipalities to stay on top of what they are eligible for, and to comply with timeline due to capacity issues. Participating municipalities explained that a one-window approach hosting all available provincial and federal funding programs as well as streamlined processes around eligible criteria and funding requirements will be helpful.

3.3.2 Lack of Human Resources and Organizational Challenges

Municipalities also have to cope with limited human resources and challenges in building in-house capacity. They also need to rethink their organizational structure to incorporate the issue of climate and adaptation. Key challenges noted by QUEST include:

- **Integrating climate adaptation in existing municipal structure and processes.** Climate change, and climate adaptation in particular, are a relatively new area of governance for municipalities.

They need to incorporate new responsibilities, practices, and considerations into their existing documents and organizational structure. In a few municipalities, there is no department in charge of climate action, thereby lead staff lack internal support and credibility. In most cases lead staff in charge of climate adaptation are not located high in the organizational structure – i.e. not at the CAO or director level. Making it difficult to find internal resources and building momentum. During the duration of the initiative, a few municipalities undertook an internal restructuring, leading to a reorganization of services. It is too early to tell whether these changes will foster better integration of climate issues into corporate activities and processes.

- **Staff capacity and retention.** The development, implementation, integration, and reporting of adaptation measures and climate resilience plan over the long term require a full-time equivalent, permanent staff. It is sometimes difficult for municipalities to recruit and retain staff preventing their capacity to build institutional memory and expertise on community resilience. For instance, during the two year duration of the initiative, three out of twelve municipal staff involved in this initiative left and were replaced by colleagues. When there is staff, there is not always a dedicated person in charge of adaptation. Rather, it is often pursued ad-hoc across departments or rests on one person in charge of climate adaptation and mitigation, environment and sustainability measures. Finally, there is also little capacity for communications team to work with climate staff on public education and awareness campaigns.

- **Alignment and integration**. Participating municipalities were aware of the double challenges of integrating climate projection and climate hazards into existing plans (emergency response plan, planning documents, communication plans, asset management plans, etc.) on the one hand, and to align existing municipal processes and documents so that they mention and leverage one another, on the other hand.

3.3.3 Lack of Alignment Between Levels of Government

Clarify responsibilities among levels of governments. Regulative and policy powers of municipalities are limited. For instance, municipalities do not have the power to require residents and business owners to take mitigation measures, or change building codes. Those are not under the control of municipalities. In some cases, they are not allowed to own or operate energy plants, and/or generate revenues from energy sales. As a result, there is a need for better coordination and communication between the three levels of government to integrate climate adaptation plans and strategies. For example, municipalities do not have a clear understanding to what extent local schools provide training or education on disaster risk reduction within the curriculum (including climate related risks) beyond regular fire and emergency drills.

Then what? Supporting business and land-owners. Some participants raised the issue of liability once flood zones or hazard areas have been identified. What does it mean for homeowners who are informed they are in a flood zone? What are the implications for property values and insurance premiums? What is the role of the municipality and of other levels of government in supporting changes to new land-use patterns?

3.3.4 Key Challenges for Energy Utilities

Despite the contrasted energy and policy systems they evolve in, and their different sizes and activities, energy utilities are facing two major challenges:

- **Dealing with uncertainty and increasing costs.** It is difficult to anticipate the number of storms that will impact energy infrastructure and the damage they will create impacts on infrastructure. It is therefore difficult to effectively budget for costs associated with restoration and set aside a reserve fund. Past events help, but they are not accurately capturing future climate projections. In addition, transmission and distribution utilities are usually non-profit or regulated corporations, meaning that most of them have limited funding mechanisms, or no funding mechanism at all, for preventive adaptation measures and restoration after major events. Costs have to be passed on to customers through rate raise, or mitigated through cut costs somewhere. This is the role of the province (or municipalities in the case of municipally-owned utilities) to ensure the regulatory system enables utilities to be proactive to adapt to climate change, and that utilities are investing in adaptation measures.

- **Significant investments to improve real time grid management.** Despite starting investing in devices to obtain real time data, energy utilities operating at the provincial level still rely on customers to report outages and dispatch crews to determine its size and impacts. Upgrading the transmission and distribution systems requires large investments that are not always aligned with asset management plans and capital investment priorities.

4.0 Mini Guide for Municipalities Interested in Resilience Planning

4.1 Eight Tips to Develop a Resilience Strategy

1. Know where you stand before you start

Set the context with an inter-departmental survey. QUEST developed a survey that was sent to municipal staff representing different departments. The purpose was to identify policies, practices, and infrastructure in place, identify gaps, and collect other relevant information to get a better understanding of the community context and prepare next steps.

2. Know your enemy

Obtain climate change projections (e.g. using Canada's Changing Climate Report and Climate Data for a Resilient Canada) and determine implications for the community in terms of hazards. Discuss the probability and consequence of various types of direct and indirect climate hazards, and potential local impacts. In addition, use JIBC's Rural Disaster Resilience Portal to identify level of risk and current level of resilience, for each hazard type e.g. flooding, ice storms, fires, etc.

3. Be broad, be open, be rigorous

Adopt a robust, systematic, and inclusive methodology. The approach adopted by QUEST is based on on-the-ground collection of data and information and robust and participatory methodology structured around a survey and two interactive and participatory workshops.

QUEST designed the workshop exercises to be inclusive and bring multiple stakeholder groups that do not usually discuss together around the same table. Participants included municipal staff from all departments both at the management level and in the field. Representatives from energy utilities, emergency measures, the business community, and community leaders also participated in the workshop. The diversity of participants in the room informed the conversation and captured more complete and accurate information.

The methodology (as outlined in **Section 2.4**) adopted during the project proved to be effective at engaging key stakeholders, assessing climate risk and local vulnerabilities, and identifying potential adaptation measures best suited to each community's context. Based on this we provide the following key considerations for municipalities interested in resilience planning.

Based on the results of this initiative QUEST recommends other Canadian municipalities use a flexible approach that includes:

- Gathering data about the municipality (e.g. infrastructure, policies and practices), and obtaining climate projections using Canada's Changing Climate Report and Climate Data for a Resilient Canada
- Conducting two in-person workshops engaging all stakeholders (including staff, council members, energy utilities, EMO, local businesses, and community organizations)
- Undertaking a self-assessment using the 10 Essentials for Disaster Risk Reduction, to identify organizations strengths and opportunities for improving resilience
- Facilitating table-top mapping exercise to identify strengths, vulnerabilities and opportunities for improving resilience

- Analysing level of risk and resilience (for each hazard type) using JIBC's Disaster Resilience Portal
- Preparing recommendations (based on the results of the above steps)
- Discussing and selecting potential adaptation measures, assigning priority, cost, and Lead Department, identifying associated challenges or needs, and any existing plans or processes in which to embed the selected measures

4. Identify your strengths and weaknesses

Understand your organizational strengths and weaknesses. QUEST conducted an exercise using the 10 Essentials for Disaster Risk Reduction approach (also known as *Making Cities Resilient*). Developed by the UN ISDR (International Strategy for Disaster Reduction), this methodology is endorsed by the Government of Canada. It enables participants to identify community strengths and where improvements may be needed in a range of areas, including organization, budgeting, training, etc. It provides a high-level framework to determine the strengths and weaknesses in a community, to be able to better target efforts at improving resilience.

Map your vulnerable and resilient assets. The second exercise is a participatory mapping exercise[6] that provided workshop participants with a hands-on resilience-building mapping experience and enabled them to share knowledge, discuss localized resilience, apply basic techniques for identifying risks and vulnerabilities in a spatial context, as well as planning local adaptation and resilience measures. Participants then drew and noted hazards, risks and opportunities to improve resilience on a large map of their community. Dot stickers, markers, and a colour-coded legend enabled participants to note these opportunities, and discuss various aspects/viewpoints. The QUEST team collected and presented key findings in a Climate Risk and Resilience Assessment Report. This report lists facilities and assets located in hazard-prone areas, potential shelters for heat waves or power outages, vulnerable neighbourhoods, areas to encourage or discourage development, and more.

5. Consider your options

Identify key areas of improvement and possible adaptation measures. The results of the previous exercises reveal important areas of improvement and point toward possible adaptation measures. Just like in this project, a second workshop helps municipalities to identify, select, and prioritize recommendations for adapting to climate change. Don't forget to assign tasks and responsibilities!

Build your library. As adaptation to climate change is an increasing and pressing issue, provincial, federal, and international agencies are developing resources, tools and recommendations to assist municipalities in becoming more resilient. **Appendix 2** provides additional resources to guide you in the development and implementation of a Climate Adaptation Plan.

6. Don't reinvent the wheel, just enhance how it spins

Integrate recommendations into existing municipal plans and processes as much as possible. For example, QUEST produced a *Recommendation Report* building on recommendations selected by participants in workshop 2. For each recommendation, we identify a Department Lead, timeline, urgency, cost, challenges, and next steps, as well as how to embed within existing plans (e.g. EM Plan, Land Use Plan, Asset Plan, etc.).

[6] Originally developed by Spatial Quest to support NB Municipalities's work on resilience, the exercise has been adapted by QUEST for the Municipalities and Utilities Partnering for Resilience initiative.

Improve existing public education into a sound communication strategy. With relevant staff, assess your existing public communication strategy on disaster preparedness (before an event) and emergency response (during an event). Map community stakeholders who are already included and are missing. Develop specific messages and training exercises for each type of climate hazards for different audiences (public and business). **Section 4.2** below presents some tips for an efficient communication strategy.

Look at what other municipalities are doing. When developing your own climate measures or reviewing them, check what other municipalities have been doing and identify similarities and differences. This may help you identify strengths and gaps.

7. Secure stable financial resources.

Estimate costs and look for internal and external funding sources. Securing funding and a budget is crucial to the viability of some climate adaptation and emergency management measures. It may be challenging to secure funding, especially when competing with other municipal priorities. There are different strategies to secure financial sources. They are presented in **Section 4.3** below. This is why it is important to estimate the cost of each action and to engage both the Chief Administrator office and the Finance office when developing an action plan.

8. Repeat

Review on a regular basis climate projections and monitor and report on your progress. Reassess priorities at least once every 5 years. Continue engaging all staff and external community members.

4.2 Tips for an Efficient Communication Strategy

Based on most frequently selected recommendations, **Table 9** presents some tips to develop an effective education communications plan. It can be tailored to the needs of any community.

Table 9: Tips for an effective public education communications plan

Activities	• Plan annual resilience day activity or exercise (this is essential) • Engage other community organizations to educate employees, customers, participate in resilience day activity • Ensure local schools provide some training within the curriculum, on climate change, emergency preparedness, or organize a resilience awareness day • Ensure communication plan for promoting preparedness (72 to 96 hours) and alerting the public of hazards, how to prepare, where to shelter or when to evacuate, as well as how you will keep them informed • Provide seasonal updates and guidance (e.g. mail pamphlet, social media, news release) • Communicate/Alert public in advance of impending storms, floods, etc. • Provide clear, simple, or tailored messaging for different audiences (e.g. residents, businesses), by neighborhood, or by local risk and vulnerabilities and adaptive measures
Messaging	• Provide clear, simple, or tailored messaging for different audiences (e.g. residents, businesses) or by neighborhood • Ensure public knows where to get town's information • Incorporate specific messaging based on hazards in your community (see table below)
Channels / medium	Explore the use of various channels to communicate with the public:

	• website • media (radio, paper, tv) • notices • social media • brochures/pamphlets • workshops, events • bill inserts (e.g. water bills)

Table 10 suggests key messages for different types of climate hazards. The messaging recommendations were partly informed through JIBC's Rural Disaster Resilience Portal.

Table 10: Examples of key messages by hazard type

Blizzards, Snow/Ice Storms, and Cold Weather	Encourage residents to have heating sources that do not require power and/or have alternate power sources (e.g., generator).
	Encourage homeowners to have back-up generation for any private and shared wells.
	Communicate a list of community heating locations/drop in zones.
	Encourage most residents have winter tires and winter emergency kits (including rock salt, shovels, blankets, food and water) in their vehicles.
	Encourage residents to help with breaking up ice and snow near drainage.
Hailstorms	Educate residents about storm safety e.g. to stay indoors and away from windows, skylights and glass doors during hail and avoid contact with plumbing, corded electrical equipment, concrete floors and walls if there is lightning along with the hail, as well as to store vehicles under cover.
	Encourage businesses and residents to store vehicles under cover.
Heat Waves	Educate residents about heat waves and how to know the warning symptoms of heat exhaustion and how best to keep cool (short term). Use Health Canada guidelines (Heat Alert Response System).
	Encourage businesses and residents to conserve water during the summer months (when there is a water deficit), and notify residents, businesses, farmers etc., of water shortages or drought conditions.
	Encourage businesses to self identify as potential cooling centres.
Windstorm or Hurricane	Encourage most residents have designated areas of refuge in their homes.
	Encourage businesses and residents to prepare for high winds by: covering windows with storm shutters or plywood, reinforcing garage doors, securing boats to land or storing them on land, and removing potential windborne missiles such as barbecues and patio furniture. Ensure residents are educated about storm safety and know to stay indoors and away from windows, skylights and glass doors during hail and avoid contact with plumbing, corded electrical equipment, concrete floors and walls if there is lightning along with the storm.
	Communicate evacuation routes and designated shelters, on an event by event basis.

Hydrological Hazards, including floods	Encourage businesses and residents to have back-water valves and sump pumps installed with back-up power.
	Encourage community organizations and watershed organizations to participate in tree planting, restoration, and protection of ecosystems (wetlands, watercourses, etc.). Encourage developers to consider bioretention practices.
	When flooding affects the town's wastewater system, ensure businesses and residents: limit their water use Less flushing and less use of appliances with pressurized drainage, such as dishwashers and washing machines, means less pressure on the system.
	Communicate location of shelters, closed roads and evacuation routes.
Hazardous Material Spills	Consider a public education program for the community on railway safety. Work with rail companies and local industry, as well as Fire Departments.
	Use signage to limit the amount of trucks carrying hazardous materials through core neighborhoods. Reduce speed limits, install roundabouts, and educate drivers.
	Educate residents about risks associated with driving during extreme weather events, such as ice storms, snow storms, wind storms, and flooding, and to drive with caution.
Power Outage / Interruption to Energy Supply	Educate residents on what to do (e.g. turn off all appliances) and not to do (e.g. avoid using propane, bbq inside) during restoration/cold start of grid. Educate residents on generator installation and use.
	Inform residents that 72 to 96 hours preparedness (especially in rural and remote areas) is better for prolonged outages.
	Educate residents on restoration procedure, priority level of customers.
	If outage occurs in winter, communicate a list of community heating locations/drop in zones, and charging centers, that have back-up power.
	Educate residents and businesses know how to handle or dispose of food items after power is restored.
	Encourage residents to have heating sources that do not require power and/or have alternate power sources (e.g., generator).
	Encourage homeowners to have back-up generation for private and shared wells, or for medical needs.
	Encourage businesses (including grocers, convenience stores, fueling stations, and key employers) to have back-up generators in place and ready to be used.
	Survey how many grocers, stores, fueling stations have back-up power.
Brush, Bush Grass Fires; Wildland / Urban Interface Fires	Recommend to residents to have home fire evacuation plans and have tested them.
	Promote and recommend FireSmart principles to residents.
	Encourage vegetation management (pruning trees, removing flammable brush, etc) to limit risk of forest-urban interface fires.

Food Security	Encourage residents to participate in community gardens, household gardens, rooftop gardens.
	Encourage and support locally grown food (e.g., community gardens in the summer, year-round greenhouse with back-up, container aquaculture/agriculture, local markets, etc).
	Encourage all farmers who have essential power needs (e.g., greenhouses, dairy operations) have back-up power supplies.
	Encourage residents to have non-perishable food stored as part of their 72 hour preparedness kit.

Note: Messaging recommendations were partly informed through JIBC Rural Disaster Resilience Portal.

4.3 Budget and Funding Considerations

Participating municipalities noted that municipal financial capacities are limited, and that investment from the federal and provincial levels of government is needed to support local projects and initiatives.

It may be challenging to secure funding, especially when competing with other municipal priorities. The table below presents different strategies to secure financial resources for municipalities. These funding sources are usually available for plans, studies, pilot projects and/or capital projects. They may require matching funding.

FCM and the Local Governments for Sustainability (ICLEI) recently published a toolkit called On the money: Financing tools for local climate action, that explains how your municipality can leverage private and community investors to help you take action on climate change in your community. This toolkit includes tips on how to harness people power through group purchasing and community owned renewable power, break capital barriers with local improvements and energy performance contracts, and create a funding cycle with green revolving funds and green bonds.

The two following handbooks provide helpful, on-the-ground solutions to secure funding for energy resilient infrastructure that may be relevant to your community:

- Bridgewater Financing Mechanism Scoping Study (2019)
- Community Energy Investment Strategy for Waterloo Region (2018)

Table 11 presents some possible funding strategies to secure financial resources for the development and implementation of Climate Adaptation Plan.

Table 11: Strategies to secure financial resources

Sources	Description
Budget	Create budget item/fund for adaptation to support adaptation measures
Internal financing sources	• Property taxes, tax levies • Tax Increment Financing, Local Improvement Charges • User fees (on water, power and natural gas distribution system, waste, etc.) • Development Cost Charges (DCCs) • Green bonds
Local Incentives and Rebates	• Development Cost Charge reductions • Local Improvement Charge financing (LIC) or Property Assessed Clean Energy (PACE) programs • Fee rebates/credits (on water and energy bills); local economic incentives for investing in disaster risk reduction for households and businesses, and new developments (e.g. tax holidays for businesses, faster permitting for developments meeting certain adaptation criteria)
New accounting/ decision-making tools	• Consider natural asset management approach - full cost accounting and valuation of natural assets • Estimate avoided cost when presenting business case for adaptation measures • Combine funding with Gas Tax revenue • Reinvest efficiency savings into low cost adaptation measures, community engagement, etc. • Update the long term financial plan to include considerations of climate change mitigation and adaptation

Institutional grants and external sources of funding	Scan and submit funding applications to
	• Federal agencies and governments
	  ○ NRCAN
	  ○ Environment and Climate Change Canada (ECCC)
	  ○ Infrastructure Canada programs
	• FCM programs, including:
	  ○ Green Municipal Fund
	  ○ Municipalities for Climate Innovations Program
	  ○ Municipal Asset Management Programs
	• Provincial programs and agencies

Loans	• FCM low-interest loan (GMF) • Municipal green bonds
Leverage private investments	• Engage private sector, to partner and financially support adaptation measures for infrastructure that supports their operations and/or immediate community • Ensure local Chamber of Commerce or others support efforts of small enterprises for business continuity during and after disasters
Economy of scales and synergies at the local level	• Leverage existing initiatives or project by expanding/adapting their scope and collaborating with other departments (thinking beyond silos) • Collaborate with neighbouring municipalities • When a measure involves several communities, cost-share (e.g. procurement of generators, building sea walls, etc.)

Conclusion

This Lessons Learned Report presented key challenges Canadian communities and utilities are facing when building a resilient community and adapting energy infrastructure to a changing climate. It emphasized observed good practice and opportunities and synthesized them into a Mini Guide for municipalities interested in resilience planning.

QUEST's *Municipalities and Utilities Partnering for Community Resilience* initiative confirms that Canadian municipalities and their utilities are aware of the impacts of climate change and are increasingly starting to integrate climate hazards and projections in their governance structure, plans, and practices. Yet, local governments face four major barriers that are slowing down the development and implementation of Climate Adaptation Plans:

- Limited financial resources to invest in adaptation measures and resilient infrastructure
- Limited human resources and expertise to develop, monitor, and implement these measures
- Lack of alignment among the policies and priorities developed by the three levels of governments
- Lack of internal and external integration and inter-sectoral collaboration, especially between utilities and municipalities

This initiative was instrumental in overcoming most of these barriers by fostering collaboration among community stakeholders and providing sound expertise to municipalities. By the end of the project most participating municipalities started to incorporate low-hanging fruit to improve existing municipal plans and/or inform their adaptation strategy.

QUEST hopes that NRCAN and FCM will continue providing funding for similar capacity building projects. In conjunction with large adaptative capital funding, capacity building projects such as QUEST's *Municipalities and Utilities Partnering for Community Resilience* initiative enable municipalities to access and retain sound expertise, identify and prioritize actions and measures, and adopt new planning and governance practices.

The energy lens of this initiative also highlights the need to foster collaboration between energy utilities and municipalities, as well as the necessity to adapt energy infrastructure in order to mitigate the impacts of climate change on communities and increase their resilience. The lessons learned suggest the need to:

- **Continue developing and refining specific methodology and tools focused on local energy systems.** For this initiative, and as presented in **Section 2.4**, QUEST developed an innovative methodology focused on energy resilience and energy infrastructure. Working with various municipalities and utilities from different provinces, QUEST's tools proved efficient in informing energy resilience planning and strategy by engaging utilities and making recommendations to strengthen energy supply and infrastructure. It also highlighted a series of potential avenues for future projects and programs that intend to increase energy resilience:
    - Developing and/or refining energy resilient tool and methodologies to consider the specific energy and policy landscape of each province

    - Understanding of the cost benefit/analysis of energy resilience by assessing the costs of damages of climate hazards on energy infrastructure, the social and economic cost of energy outages on communities, as well as expected economic benefits of investing in resilience energy infrastructure
    - Assessing the costs of adaptive and preventive measures and investigating funding sources and mechanisms to cover upfront capital costs

- **Integrate mitigation and adaptation through a Smart Energy Community approach.** Developing and adopting a Community Energy Plan (CEP) and conducting community energy mapping were a key recommendation selected by participating municipalities. CEP is recognized across Canada as an effective pathway to Smart Energy Communities. It provides a platform for multiple stakeholder groups to convene, coordinate, and implement innovative community energy projects and programs, resulting in more energy efficient, resilient and vibrant communities. In the context of the quick uptake of distributed energy resources and new energy technologies, CEP offers new opportunities to rethink local energy systems in relation to the main grid, and to enhance energy resilience.

QUEST has appreciated working with all participating municipalities, local stakeholders, and energy utilities. The QUEST team would like to thank each of the workshop participants for their time and valuable insights. QUEST hopes they found the workshops informative and impactful to incorporate resilience in their day-to-day activities.

Appendix 1 - The 10 Essentials

Developed by the UN ISDR (International Strategy for Disaster Reduction), this methodology is endorsed by the Government of Canada. It enables participants to identify community strengths and where improvements may be needed in a range of areas, including organization, budgeting, training, etc. It provides a high-level framework to determine the strengths and weaknesses in a community, to be able to better target efforts at improving resilience.

The 10 Essentials are:

1. Put in place organization and coordination, clarify everyone's roles and responsibilities
2. Assign a budget and provide incentives for homeowners, low-income families and the private sector to invest in risk reduction
3. Update data on hazards and vulnerabilities, prepare and share risk assessments
4. Invest in and maintain risk reducing infrastructure, such as storm drainage
5. Assess the safety of all schools and health facilities and upgrade these as necessary
6. Enforce risk-compliant building regulations and land-use planning, identify safe land for low income citizens
7. Ensure education programmes and training on disaster risk reduction are in place in schools and communities
8. Protect ecosystems and natural buffers to mitigate hazards, adapt to climate change
9. Install early warning systems and emergency management capacities
10. Ensure that the needs and participation of the affected population are at the centre of reconstruction

Appendix 2 - Additional Resources

Generic resources

Natural Resources Canada's Impact and Adaptation Platform: https://www.nrcan.gc.ca/climate-change/impacts-adaptations/10761

Adaptation to Climate Change Team, Faculty of Environment, Pacific Water Research Centre, Resources page: https://act-adapt.org/community/commuity-books/

Climate change data

ECCC Climate Change Data portal: http://www.canadaccdp.ca/

Climate Data for a Resilient Canada: https://climatedata.ca/

Infrastructure and asset management planning

Combatting Canada's Rising Flood Costs: Natural infrastructure is an underutilized option Insurance Bureau of Canada, 2018. This report provides guidance to those considering or opting for a natural infrastructure solution. The natural infrastructure implementation framework that is being introduced provides such a structure, and it is consistent with the natural infrastructure preservation commitments Canada has made under the Paris Agreement, the United Nations' Sendai Framework for Disaster Risk Reduction and the Pan-Canadian Framework on Clean Growth and Climate Change.

Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol, Engineers Canada. The Protocol systematically reviews historical climate information and projects the nature, severity and probability of future climate changes and events. It also establishes the adaptive capacity of an individual infrastructure as determined by its design, operation and maintenance. It includes an estimate of the severity of climate impacts on the components of the infrastructure (i.e. deterioration, damage or destruction) to enable the identification of higher risk components and the nature of the threat from climate change impact. This information can be used to make informed engineering judgments on what components require adaptation as well as how to adapt them e.g. design adjustments, changes to operational or maintenance procedures.

The Municipal Natural Asset Initiative's latest research report, Opportunities to Fund Municipal Natural Asset Management Projects, reviews six of Canada's major infrastructure funding programs from the perspective of a manager wanting to fund a municipal natural asset project. It identifies key considerations in determining project eligibility and funding terms and offers an easy-to-use program overview chart

Building Community Resilience Through Asset Management. A handbook and toolkit for Alberta Municipalities. (2015). The purpose of this handbook is to introduce asset management concepts with a focus on implementation to small and mid-sized communities. This handbook:

1) provides an overview of the process of asset management, the objectives, and the benefits; 2) Identifies the mindsets and key elements of asset management that enable success; 3) Describes information management for asset management and good decision making; 4) Shows how staff throughout a municipality contribute to successful asset management; and 5) Suggests ways of implementing asset management through existing municipal processes.

Land-use planning

Risk-based Land-use Guide: Safe use of land based on hazard risk assessment, NRCAN, 2015. This guide explains three key actions intended to assist municipal staff determine whether land-use proposals will be safe for their intended use. It explains: 1) how to integrate hazard risk management into existing land-use management instruments; 2) how to determine if the hazard risk of a land-use proposal is acceptable; 3) how to consider reducing the risk to tolerable and acceptable levels.

Emergency response

Institute for Catastrophic Loss Reduction: https://www.iclr.org/

Heat Alert and Response Systems to Protect Health: Best Practices Guidebook. Government of Canada. The guidebook provides an overview of health risks from extreme heat and offers evidence-based strategies for alerting health authorities and the public when hazardous conditions arise. It is intended for use by policymakers, planners and service providers involved in protecting citizens from extreme heat events. The Guidebook is designed to help develop interventions tailored to the needs of a specific community.

Building codes and standards

Infrastructure Canada's Climate-Resilient Buildings and Core Public Infrastructure Initiative. With $42.5 million in financial support from Infrastructure Canada, and in support of the Pan-Canadian Framework on Clean Growth and Climate Change, the National Research Council Canada (NRC) is undertaking ground-breaking work to integrate climate resilience into building and infrastructure design, guides, and codes. This initiative is intended to develop capacity in Canada's construction industries to adapt to the increasing demands on our built infrastructure attributed to climate change. The work undertaken by the NRC will contribute to an infrastructure landscape that can keep Canadian communities safer from extreme weather and the effects of climate change.

Building for climate changeA quick guide for homeowners and builders.Southwest New Brunswick Service Commission. This handbook will focus on building and landscaping approaches to address four key threats: wildfire, flood, extreme precipitation, extreme wind.

Funding and budget

On the money: Financing tools for local climate action,FCM and ICLEI (2018). The report explains how your municipality can leverage private and community investors to help you take action on climate change in your community. This toolkit includes tips on how to harness people power through group purchasing and community owned renewable power, break capital barriers with

local improvements and energy performance contracts, and create a funding cycle with green revolving funds and green bonds.

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