Integrating Climate Change Measures into Municipal Planning and Decision-Making

A Guide for Northern Communities

Prepared for **Northwest Territories Association of Communities** by Ecology North with support from the Pembina Institute.

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This report provides educational information only. It does not constitute legal or other professional advice. It is essential that local governments and others considering legal measures consult legal professionals for advice.

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About the Northwest Territories Association of Communities

Established in 1966, the NWT Association of Communities (NWTAC) is a non-profit, non-governmental organization that represents the interests of all thirty-three official NWT communities, including all of the larger incorporated communities. Any Municipal Corporation or Community Government in the NWT is eligible to join the NWTAC.

Through the NWTAC, community governments in the NWT can access knowledge, technical expertise or capacity that may not otherwise be available. The NWTAC also regularly distributes information on tools, best practices, and project results to Member Communities through its online resource library, news bulletins, AGM's and training workshops.

About Ecology North

Bringing people and knowledge together for a healthy northern environment.

Ecology North is a non-profit, non-governmental organization established in 1971 in Northwest Territories with integrated programing in climate change mitigation and adaptation, waste reduction, water stewardship and food sustainability. Through research, public education and policy analysis, Ecology North seeks to connect individuals, communities and governments to the information needed for sound environmental decision-making.

Ecology North has been working with communities throughout NWT on climate change adaptation issues for several years. Projects have included direct collaborations with communities on developing climate change adaptation plans and researching and documenting climate change vulnerabilities of water and wastewater systems. Ecology North has also spearheaded a number of youth and public education initiatives to communicate and share northern climate change science.

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About the Pembina Institute

The Pembina Institute is a national non-profit think tank that advances clean energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance.

The Pembina Insitute has been working with communities across the Northern territories since 2002 and established an office in Yellowknife in 2008. The Institute has worked on a variety of issues, from protection of the Mackenzie Basin from upstream risks, to community energy planning, to increasing northerners' resiliency to climate change, to cumulative impacts associated with oil and gas projects.

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Introduction

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Climate change – what does it mean?

Climate is the average pattern of weather in a given location over a period of time — from months to thousands of years. *Climate change* refers to any significant change in temperature, precipitation, and wind patterns occurring over an extended period of time.

Climate change is a natural process, but today's climate change is caused mostly by the increasing amounts of carbon dioxide and other greenhouse gases in the atmosphere.[1] The unprecedented rapid global temperature and climate changes in the past century are primarily the result of burning fossil fuels, as well as the rapid increase in deforestation, industrial processes and some harmful agricultural practices.

Greenhouse gases in the atmosphere act like the glass in a greenhouse (hence the name *greenhouse effect*), allowing heat from the sun in but blocking it from leaving. Some greenhouse effect is essential for human life, but as the amount of carbon dioxide increases in the atmosphere, the changes we are seeing on earth are speeding up — with enormous impacts on the natural environment and people.

The Deh Cho bridge under construction. Photo credit: Kerry Wheler

It is important to distinguish between weather (what you see out your window today) and climate, which refers to long-term average weather patterns in a given area. The most common measure of climate is temperature. While the daily temperatures that we experience vary across seasons, even a small change in *average annual temperatures* can have important impacts on ecosystems, on landscape features such as permafrost, and on infrastructure. Other important climate measures are precipitation (rain and snow), wind, humidity and air pressure. Seasonal changes in precipitation — like more snow in the winter — can have big impacts too.

Documented climate change varies across regions but globally includes warmer average annual temperatures, changes in the frequency and intensity of extreme weather events such as heavy rain or snowstorms with high winds, and changes in the amount of precipitation and the type of precipitation, such as rain instead of snow.

Climate change adaptation

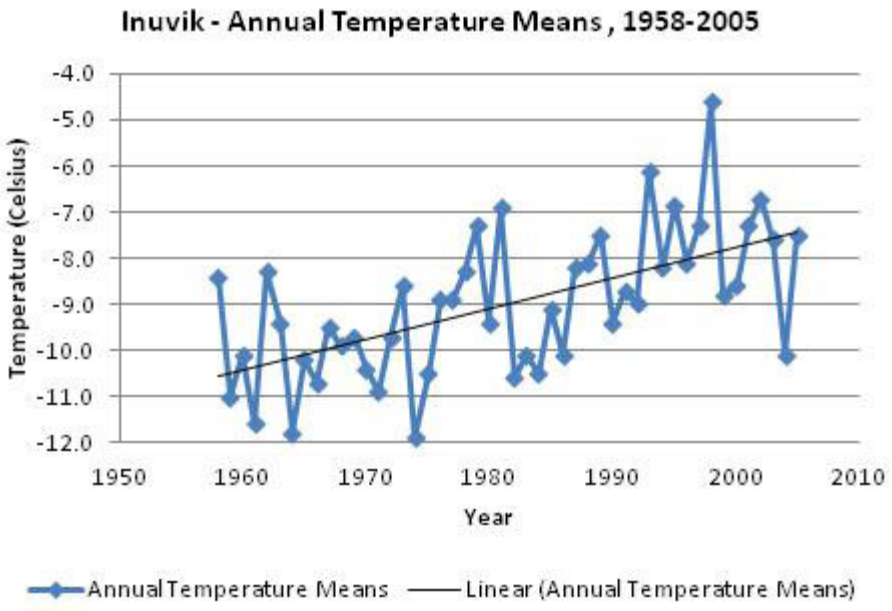
Adaptation is the reaction to the changes being brought about by climate change. There are many definitions of adaptation, but it is important to note the difference between good (proactive) adaptation and less effective (reactive) adaptation.

> …climate change adaptation has been identified as an important mechanism to reduce society's vulnerability to the effects of climate change. Climate change adaptation actions can be reactive, in response to impacts or changes that have already occurred, or proactive, in anticipation of future changes and impacts.
>
> — NWT Climate Change Impacts and Adaptation Report[2]

This guidebook has been developed to help community decision-makers make proactive adaptations as part of all community planning. Adaptation is a process; a single plan is the beginning, not the end. Good adaptation includes adaptive management, where lessons learned, new data and knowledge are re-integrated into planning and operations over time.

Climate change in the Northwest Territories

While global average temperatures have warmed by about 0.5°C over the past 50 years, average NWT temperatures have increased by 2 to 2.7°C.[3] This change is not the same across the NWT, but seems to be faster in the north, and particularly in the Beaufort region.



Annual temperature means in Inuvik, 1958-2005

Source: NWT Environment and Natural Resources[4]

> The NWT, especially the Mackenzie Valley, is a global hot spot for climate change with average annual temperatures increasing about 2°C since the 1940s when records started to be collected. This increase is even more pronounced the further north you travel; for example, annual temperatures in Inuvik, situated at the mouth of the Mackenzie River near the Beaufort Sea, have increased by 3°C.
>
> — NWT Impacts and Adaptation Report[5]

Ice road to Dettah. Photo: Ellen Pond

Like the rest of Canada's north, Northwest Territories communities are already experiencing significant climate change, often at more than double the rate of other parts of Canada. NWT communities are also more vulnerable to climate change for a number of reasons. For example, small populations (as few as 36 people, Kakisa) with little or no tax revenue are restricted in their ability to respond to change. Communities may have limited human resource capacity. As well, costs of transportation and infrastructure are high.

In addition, the climate impacts that NWT communities face are serious. For example, infrastructure is severely affected by permafrost degradation across the NWT. Up to 38% of permafrost has been lost over the past sixty years in southern regions of the NWT.[6] This is leading to dramatic changes in water systems, surface ecology and the built environment (houses, roads and airstrips). The planning implications for communities are enormous.

NWT communities have collectively emphasized the importance of climate change adaptation planning. The NWT Association of Communities passed a resolution in 2011 that:

> "The Federal Government should ensure that adequate funding is available to ensure that Adaptation Plans and Hazard Mapping is completed for all NWT communities including a thorough evaluation of all municipal infrastructure;
>
> And further that the GNWT assist communities to complete their Adaptation Planning and Hazard Mapping and Implementation;
>
> And further that the NWT Association of Communities work with its various partners such as Ecology North and the Pembina Institute to explore opportunities to assist communities through the development of various tools."[7]

Climate change impacts for NWT Communities

The Arctic Climate Impact Assessment, in 2004, concluded that some of the most rapid and severe climate changes are occurring in the Arctic region as a whole. Climate change is expected to accelerate over the coming century, with major ecological, social and economic impacts.

Because the climate is changing so rapidly, it is difficult to keep up to date on trends and severity of impacts. The GNWT is updating and providing information on regional impacts and hazard or vulnerability assessments.

Existing community adaptation plans also include localized impacts assessments. The following table documents direct and secondary impacts relevant to community planning, compiled from several community adaptation plans in the NWT.

Primary and secondary impacts relevant to community governments, based on a review of NWT community adaptation plans

KEY IMPACT	SECONDARY IMPACT
Permafrost degradation	Short-term and long-term damage to buildings
	Short-term and long-term damage to transportation infrastructure such as roads (e.g. potholes, sinking, heaving) and airport runways
	Damage to community infrastructure (e.g. water /wastewater lagoons and facilities)
	Ruptured oil tank fuel lines
	Large-scale landscape changes (e.g. increased size and frequency of thaw slumps)
Warmer air temperatures	Transportation disruptions from shorter ice and winter road seasons (e.g. the Fort Providence ice bridge has been reduced by 30 days in the past 40 years)[7]
	Transportation disruptions through increased risk of landslides on all-season roads
	More difficulty travelling on the land: shorter winter travel season (affecting fur trapping); more dangerous travel on sea ice; more overflow in winter (caused by thinner ice and more snow)
	Decreased heating costs
Rising ocean levels and open water in the Beaufort Sea	Increased shoreline erosion on the Beaufort Sea due to high water levels and less ice cover
Changing weather patterns	More rain on snow events and ice storms
	More extreme weather events
Increased forest fire risk	Greater risk of severe forest fires due to longer, hotter, and drier summer seasons and more lightning strikes

Changes in water	Flooding regimes will change with altered seasons and precipitation patterns
	Lower and warmer summer water levels
	More siltation in rivers due to landslides and permafrost-related shoreline erosion
	Lakes and ponds draining in the Beaufort due to permafrost thaw
Increased precipitation	Increased pressure on current drainage systems/plans
	Increased structural loads (snow, wind) on buildings and infrastructure (e.g. ice build-up on powerlines); higher construction costs
	Increased spring wash-outs
	Increased snowdrifting
	Increased flooding
	Faster effluent movement through lagoons
Food security	Changes in wildlife populations (e.g. fewer caribou, more moose)
	Berries and wild harvested foods are less reliable
	Changes in fish populations as water temperatures, seasonal flow, water chemistry and open water seasons change
	Increased potential for agriculture with longer, warmer growing season

Regional variations of impacts

NWT is a huge area with a variety of geological zones and ecosystems. With mountains in the west, the rocky Canadian shield in the east, a broad flat sedimentary basin in the centre, the Arctic Ocean to the north, the mighty Mackenzie River Valley, and two Great Lakes, the climate varies throughout the NWT — as do the effects of climate change.

Some regional differences in climate change impacts include:

- The Mackenzie Valley is warming faster than the rest of the NWT.
- Permafrost is warming faster in the Beaufort Delta region, leading to localized landslides, erosion and draining of lakes and ponds.
- The Beaufort Sea is increasingly ice free, impacting wildlife, creating access for ship traffic, tourism and oil and gas development, and eroding shorelines with more wave energy behind storms.

Hay River break-up. Photo credit: Doug Lamalice

- Areas in the southern discontinuous permafrost zone are losing permafrost, with localized impacts (particularly around development) where ice lenses are thawing leading to slumping and infrastructure damage.
- Landslides in the mountainous regions are blocking tributary streams and causing siltation of mountain rivers.

Climate change costs to communities

NWT community infrastructure is vulnerable to permafrost degradation as well as damage from extreme and unprecedented weather events. It is now widely accepted that the resources needed for adaptation will be expensive and that planning for climate change and the costs of adaptation must be a priority for all levels of government.

Costs for building foundation upgrades to adapt to thawing permafrost across the NWT are estimated in excess of $420 million for the "worst case" cost and $230 million for the "best guess" adaptation cost, based on an assessment of six representative communities.[9] These costs are just related to permafrost impacts on buildings, and do not include the costs of adapting, maintaining and replacing other infrastructure such as roads, airports, power systems and water and wastewater systems. These costs also do not account for damages to the traditional economy, or from severe weather, flooding or forest fire that may be related to climate change.

This case study of permafrost impacts on NWT buildings is limited in scope, but it is valuable in that it emphasizes the potential costs for which communities may be responsible. With fewer government resources being made available to communities for climate change adaptation, there is going to be a severe infrastructure maintenance gap to fill. This makes it even more important for communities to proactively adapt to climate change before major impacts are felt.

Flooding along the Peel River in 2013. Photo credit: David Cook

Mainstreaming

This guidebook has been developed in order to assist NWT communities to embed climate change adaptation into their existing and future plans. Called *mainstreaming*, this process simply means thinking about climate change and its potential future impacts when developing and implementing any kind of community plan and decision-making.

NWT communities have numerous challenges before adding climate change to the mix. The small size of communities, the remoteness, transportation issues, a harsh physical environment, lack of human capacity, high turnover, and financial constraints are all among the challenges that make running a northern community a difficult task.

When dealing specifically with climate change, one of the largest barriers NWT municipal governments face is the frequent classification of climate change as a special issue, limiting its integration into routine decision-making. The required learning, investment of resources and policy development present an additional burden to local governments already struggling to fulfill a diverse range of existing responsibilities.

This leaves climate change adaptation competing for space on the policy agenda as well as within the budgets of local government.

Yet so substantial and cross-cutting are the implications of northern climate change that the climate change lens must now be applied to all municipal planning and decision-making. And even though the development of Climate Change Adaptation Plans is important to the resilience of NWT communities, communities can begin mainstreaming climate change perspectives even without a completed stand-alone adaptation plan.

Mainstreaming requires a paradigm shift in the considerations that are applied to all planning and decision-making. This guide will assist the community and/or their consultants in identifying their vulnerabilities to climate change relative to each plan, drawing on existing community work in adaption planning, where applicable, and other sources of information.

> **Mainstreaming**
>
> Mainstreaming refers to the incorporation of climate change considerations into established or on-going programs, policies or management strategies.
>
> For NWT communities, this means that climate change should be considered as one of the factors in decision-making in all planning processes.

Two guides provide examples of how to undertake adaptation mainstreaming, where adaptation is integrated into existing planning processes and documents.

Natural Resources Canada has just released a guide called land use planning tools for local adaptation to climate change with many examples of land use planning decisions from across Canada, including tools to support decision-making.[10]

In British Columbia there is a new implementation guide to help local governments prepare for climate change that is rich in examples and case studies of adaptation of existing community planning processes.[11]

The BC Guide suggests that mainstreaming requires the following:

a. Climate data and projections need to be in a form that is useable by staff and decision-makers.

b. Staff need to develop knowledge and understanding of impacts as related to their areas of responsibility.

c. Planning and decision-making "triggers" need to be in place, e.g., consideration of climate change impacts must be on the sustainability checklist for new development, or certain levels of infrastructure investment must require risk assessment.

d. Community consultation should be engaged for understanding, action development, and support for implementation.

e. Collaboration with other jurisdictions (e.g., regional, First Nations, provincial/territorial government agencies) is important to access resources and capacity for assessment and implementation.

This guide could be used to help NWT communities mainstream adaptation into all their planning.

"No regrets" adaptation

"No regrets" adaptation is any action that a community takes now that has immediate benefits and also helps reduce climate change vulnerability in the future.

No regrets adaptation actions provide benefits such as reducing a current vulnerability or enhancing a current opportunity, while increasing community resilience for the future.

Dealing with hazardous landfill waste now is a no-regrets action. Community members work to identify and label drum contents in Colville Lake. Photo: Ecology North

Objectives of this guide

This guidebook was developed to address several objectives:

- guide communities in identifying and assessing their vulnerabilities to climate change
- help communities identify gaps in their planning
- share approaches to addressing and managing vulnerabilities through specific tools available to community decision-makers
- help communities to embed climate change adaptation in their municipal plans
- include information on standards and best management practices
- facilitate communities in identifying planning and related capital and human resource gaps
- build adaptation capacity within NWT communities
- suggest which plans to prioritize and tackle first
- communicate a risk management approach

By providing background information plus tools for climate change adaptation, this report enable decision-makers to make informed planning decisions on a broad variety of community planning processes. Routine planning tools and long-term decisions should include reference to climate change impacts and the potential they have to alter the natural and built landscape.

Methodology

The guidebook has been designed using the following principles:

- apply a northern approach informed by NWT community experiences
- strengthen existing municipal planning tools rather than duplicating efforts
- provide summaries and tools and checklists that are clear and accessible

This guidebook was informed by a review of existing NWT adaptation plans, hazard mapping, permafrost mapping and other tools available to communities, as well as broader research into climate change factors that are affecting NWT communities. It was further informed by a review of the templates and tools available to communities through the Northwest Territories Association of Communities and several Government of Northwest Territories Departments such as Municipal and Community Affairs (MACA), Public Works & Services (PWS) and Environment and Natural Resources (ENR).

In order to identify best practices and potential gaps, planning documents were also reviewed from northern communities in other Canadian provinces and territories. Finally, discussions with senior administrative and public works staff from several communities guided much of the approach and content.

Resources

The following are important resources for community decision-makers and planners to become familiar with. Consultants working with communities should have knowledge of climate change and what it means for their communities.

Global Warming 101

This three-minute video offers a good basic overview of climate change

- http://video.nationalgeographic.com/video/player/environment/global-warming-environment/global-warming-101.html
- http://environment.nationalgeographic.com/environment/global-warming/quiz-global-warming/

International Panel on Climate Change (IPCC)

IPCC released its 5th Assessment report with over 1700 expert reviewers from around the world. It includes a nine minute video, and the report associated provides a global view of climate change and it's impacts. The NWT is considered a climate change hotspot.

- http://www.ipcc.ch/report/ar5/wg1/

Environment and Natural Resources GNWT

Environment and Natural Resources GNWT has a page on Climate Change, with reports and information on climate change in the NWT.

- http://www.nwtclimatechange.ca

Department of the Environment and Natural Resources

Department of the Environment and Natural Resources. NWT Climate Change Impacts and Adaptation Report. 2008. 31 pgs.

- http://www.enr.gov.nt.ca/_live/documents/content/NWT_Climate_Change_Impacts_and_Adaptation_Report.pdf

Federation of Canadian Municipalities

Federation of Canadian Municipalities: Quick Action Guide: Municipal Action on Climate Protection

This brochure is more relevant for larger southern communities, but it has an inspiring list of actions that can get your community thinking in the right direction.

- http://www.fcm.ca/Documents/tools/PCP/Quick_Action_Guide_Municipal_Action_on_Climate_Protection_EN.pdf

Federation of Canadian Municipalities

Federation of Canadian Municipalities: Partners for Climate Protection

A valuable resource and tool for mitigation of climate change. The Federation of Canadian Municipalities (FCM) also has financial resources to help with projects.

- http://www.fcm.ca/home/programs/partners-for-climate-protection/program-resources/getting-started.htm

Endnotes

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6 Quinton, W.L., M. Hayashi and L.E. Chasmer, 2011. Permafrost-thaw-induced land-cover change in the Canadian subarctic: implications for water resources. Hydrological Processes, Scientific Briefing, 25, 152–158. Also see Beilman, D.W. and Robinson, S.D. (2003). Peatland permafrost thaw and landform type along a climate gradient. In Proceedings of the 8th International Conference on Permafrost. Zurich, Switzerland, 21-25 July, 2003. Edited by Phillips, M., Springman, S.M. and Arenson, L.U. Swets & Zeitlinger. Lisse, Netherlands. Vol. 1, pp. 61-65.

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10 Government of Canada, Land Use Planning Tools for Local Adaptation to Climate Change (2012). www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/files/landuse-e.pdf

11 West Coast Environmental Law, *Preparing for Climate Change: an Implementation Guide for Local Governments in British Columbia*, prepared for Natural Resources Canada, the Province of British Columbia and the Fraser Basin Council. (2012). wcel.org/sites/default/files/WCEL_climate_change_FINAL.pdf

Climate Change Adaptation Plans

In this chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

When making decisions and planning for your community's future, it is critical to think about what that future will look like. Changes in demographics, the economy, the landscape, and politics will all make your community look much different in the future, but so will the weather, permafrost, and the risks facing your community from a changing climate. It is important to think about the risks your community might face and try to prepare for them proactively. This section outlines how to assess community vulnerability to climate change impacts and how to build a climate change adaptation plan.

Climate Change Adaptation Plans

Many NWT communities have already completed adaptation plans, and it is important as a decision maker to read, understand and refer back to your community's adaptation plan.

Climate change adaptation plans are stand-alone documents, which provide four main tools for the decision-maker:

1. A future climate scenario
2. Impacts of climate change
3. Risk assessment
4. Potential adaptations

These tools help to:

- determine what the future climate will look like
- identify potential impacts of these changes
- explore risks associated with each impact
- and make recommendations for adaptation.

Not every community in NWT has a stand-alone adaptation plan. However, it is possible to do your own scaled-down adaptation planning exercise. This chapter will walk you through a simplified adaptation planning process. Considering future

scenarios, impacts and vulnerabilities will help you and your colleagues to realize the scale of change you need to plan for.

Climate change and its impacts vary from one location to another, and communities vary in their exposure and ability to cope. In addition, communities facing similar risks and opportunities may make different adaptation choices.

Climate science and local climate projections

When making critical decisions about your community's future it is important to understand what the future climate will be like around your community. Planning for the future always involves assessing situations based on the best available data and climate change is no different. However, **because our knowledge about historical baselines continues to develop and because climate is diverging so drastically from historic norms, we cannot rely only on historical data to make decisions.** We need to use:

1. historical trend data;
2. local climate knowledge; and
3. climate models and scenarios.

> Understanding that the past will no longer be a good predictor of the future is a key part of adapting to climate change. Local government staff and elected representatives will need to be aware of the "new normal": the climate of the future will be different than the climate of the past. For example, extreme weather events such as heat waves, drought and storms may become more frequent and more severe. Flooding and wildfires may be more frequent or extensive, or both, than previously experienced. As a consequence, it is important to recognize that what worked in the past to address these types of challenges will not necessarily work for the future.
>
> – Preparing for Climate Change: An Implementation Guide for Local Governments in British Columbia.

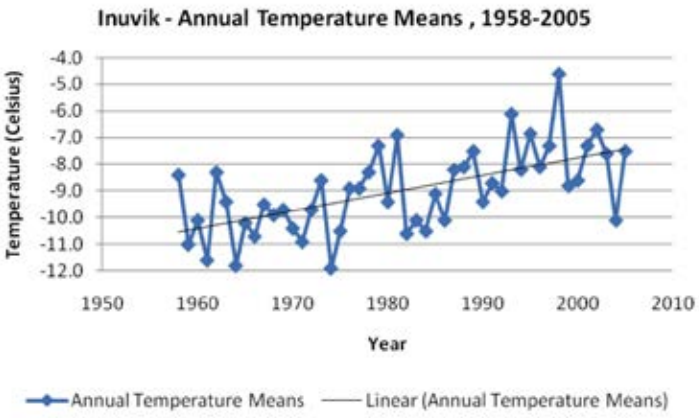
Historical trend data

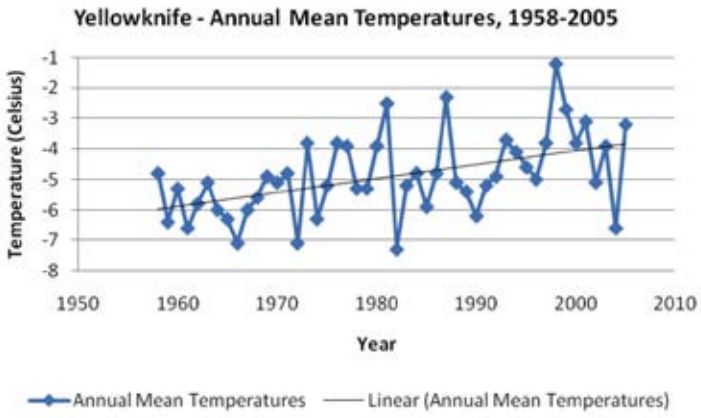
Historical climate data can take many forms; the best hard data comes from Environment Canada's historical climate database.[1] This website allows the user to access data for your community or the closest weather station. One note of caution here, however: due to the size and remoteness of the north there are not many long term data sets, and your community may not have a weather station. There are several communities with charted annual temperature on the Environment Canada database.[2]

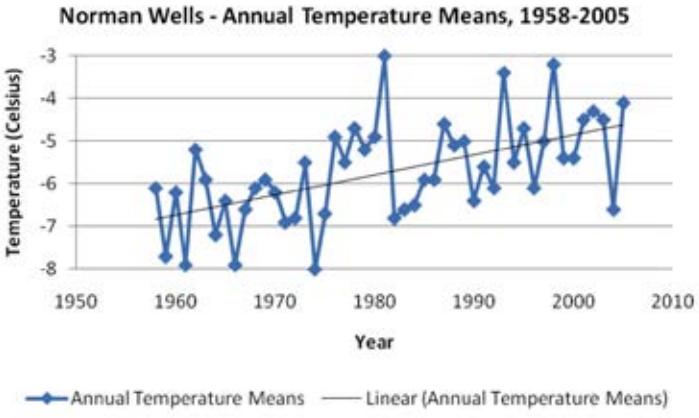
ENR has tracked data from long-term weather stations in four key NWT communities, which could be used for your community in a pinch (see resources at end of this chapter for more information on this resource). Important variables that can be teased out of the historical climate data are annual temperature trends, seasonal temperature trends, annual precipitation trends and seasonal precipitation trends. Wind and extreme weather are important variables but it is hard to gather that information effectively from records.

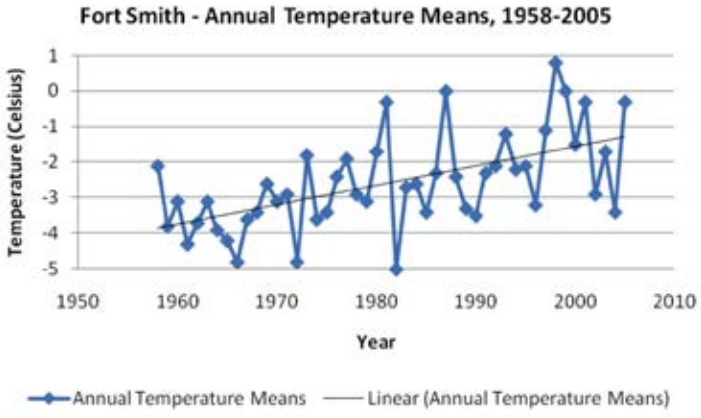
After you have collected and trended this data, it is possible to project into the future what the climate is going to be like. Communities can also work with researchers to help make data available to them and to explain research in plain language.

Annual temperature data for four NWT communities.[2]









Local climate knowledge

There is a great repository of climate knowledge within most communities. Elders are often able to reliably communicate climate trends through the use of stories and narratives, which are often accurate and mirror scientific records. This resource becomes even more important when climate data is not available in your community.

Often, local knowledge is more accurate than recorded historical data. For instance, there is little record of extreme weather events, winds, ice storms, hail, and other unusual weather phenomena; however, elders can often speak to the changes in extreme weather that they and their ancestors have seen over time. Scientists predict that such events are increasing in frequency and severity and this is generally confirmed by local knowledge.[3]

Climate scenarios

Future climate projections are made using global climate models (sometimes called General Circulation Models, and referred to as GCMs), which are computer simulations of the global climate system.

The Climate Models use various future scenarios to look at a range of possible future climates. For example, GCMs use high, moderate or low greenhouse gas emission scenarios. The scenarios are often referred to by common acronyms, with A1, A2, B1 and B2 as the most common global scenarios. A1 and A2 are high emissions scenarios, while B1 and B2 are lower emissions scenarios. A2 assumes the highest emissions and B2 assumes the lowest. Current global greenhouse gas emissions are tracking closest to the A2 (high emissions) scenario.

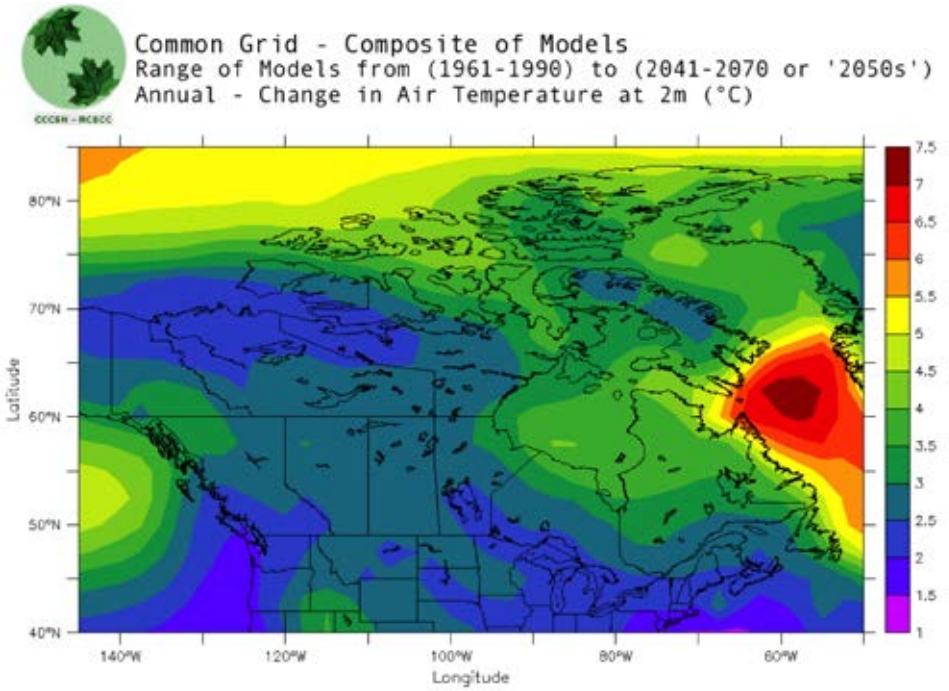
GCM projections tend to be more accurate for temperature than for precipitation, which is harder to model. For example, GCMs are under-predicting rainfall and snowfall in the NWT, compared to actual observations.[4]

The GCMs do show that climate change in the Arctic is going to be greater than elsewhere in the world and will continue to intensify over time. Even with only moderate greenhouse gas emissions over the next 100 years, average annual Arctic temperatures are projected to increase by an average of 5°C over land. Winter temperatures will increase the most.[5]

Climate scientists have developed complex models that predict the future of global climates. Environment Canada is one of the leading global agencies in climate modeling, and has developed a tool for Canadians to project the climate in their

region in the future. The Canadian Climate Change Scenarios Network (CCCSN) has created a series of ensemble maps that show the change in temperature and precipitation annually and in all four seasons for the period of 2041 to 2070. The layperson can develop these scenarios relatively easily on their website. (See CCCSN in the resources section of this chapter.)

CCCSN ensemble maps are created from Global Climate Models (GCMs) from around the world, averaging out the different models to create a best guess scenario for the future. The CCCSN website allows a planner to make projections of future climate, including annual and seasonal temperature and precipitation. These maps are relatively easy to make, they illustrate the change well and are a good tool for community decision makers. They can be downsized to a region around your community, but the spatial scale is still 2.5km. Here is an example of a Canada-Wide Scenario for Air Temperature in the 2050s.[6]



Climate Scenario:

After collecting information from Environment Canada, from local elders, and from available global and regional climate scenarios, you should be able to develop a basic climate scenario for your community. This could be just a simple best guess description of future climate at a set future date, or it may include maps and trend charts. This scenario will help to develop the next section of the plan — impacts of climate change.

Here is an excerpt from the Fort McPherson Climate Change Adaption Plan outlining their future climate scenario in 2050.

> The scenarios predict annual temperatures increasing between 3 and 4 °C by 2050. The greatest temperature change will be in the winter with changes of 4 to 6 °C, Autumn will warm by 3 to 4°C, while spring and summer the change will warm less by around 1.5 to 3 °C.
>
> Precipitation is more difficult to predict, but the scenarios indicate that Fort McPherson will get wetter by 12 to 20% annually. Most of this will come as snow in the fall and winter, with predictions of up to 40% more snow.
>
> Other factors that are predicted by climate scientists for this area of the world are more cloud cover as a result of greater evaporation, and more open water in the Beaufort Sea, and freshwater lakes. There is expected to be more extreme weather events such as strong winds, floods and droughts. It is also likely there will be more thunderstorms with the hotter, wetter weather in the summer.[7]
>
> – Fort McPherson Climate Change Adaption Plan

Other scenario models

Few tools are available to NWT communities to integrate available knowledge (such as permafrost temperatures and thaw rates, snow loads and other parameters) into predictive models at the local level. Although we know that such changes can dramatically impact water stores and flows in and around communities, it is difficult to predict the magnitude, seasonality and spatial extent of such changes.

Researchers at Wilfrid Laurier University have partnered with Environment and Natural Resources to bring local information about factors that could impact water resources into the hands of decision-makers.

In its early stages at the time of publication of this guide, the project will be a source of additional tools for community planners that will help in scenario planning and in identifying appropriate municipal responses to changes in water storage and flow patterns. For an update on this project, you can contact the Environment and Natural Resources Climate Change Adaptation Specialist or Dr. Bill Quinton at Wilfrid Laurier University. For contact information see: www.taigaplains.ca/members/quinton/

Identifying impacts on your community

After you have figured out what the climate will look like in your community in the future, it is important to figure out what climate change impacts are likely to affect your community. The first thing to do is set limits on what impacts you will, or, more importantly, will not look at. This will depend on how you want to use the information, but for community decision makers, limiting your view to within the municipal boundaries and focusing on infrastructure will simplify matters and produce the most relevant information.

The next step is to do some research into climate change impacts. There are a variety of resources available on climate change impacts on NWT communities, which can give you some initial ideas as to what the impacts might be on your community. When discussing potential, consider:

- Current issues affecting communities (there is a good chance these will still be around in the future, and may be worse)
- Talking with elders
- Adaptation plans from other communities
- Academic research
- Government reports

Once you have an idea of what some of the impacts may be, do some brainstorming with a small diverse group (including community public works staff, elders, and youth) within the community. Develop a list of potential impacts within the area of interest (for example, impacts on infrastructure), based on a climate scenario for your community. When doing this, ensure you record all the impacts that are discussed.

Risk assessment

The next step is to **prioritize the impacts** that your research and brainstorming determined may affect the community. Based on a review of existing adaptation plans, this guide for local government has prioritized three key areas of impacts:

1. Permafrost degradation – stability of buildings and infrastructure
2. Increased wildfire risk
3. Increased risk of flooding.

Other impacts that can affect communities include: shoreline erosion, changes to the land around the community, safety on the land, human health impacts, impacts on wildlife, water quality, transportation, and even industry. These are all important, but a focus on things a community has some control over is important to keep from being sidetracked.

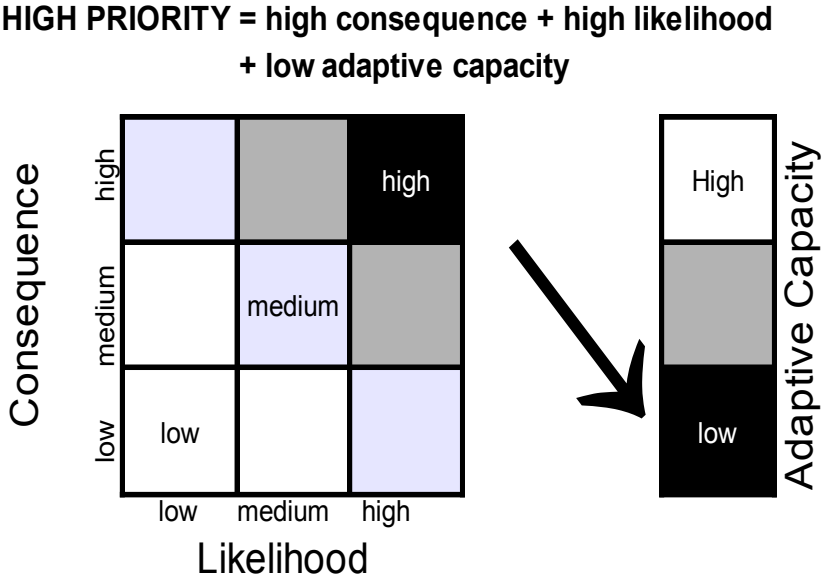
Attempt to prioritize your list of impacts based on potential risk to the community using a risk assessment tool such as the one below. Rate each impact based on these three variables from low to high:

Probability (or likelihood) - how likely is this secondary impact to happen and how often?

Consequence (or severity) - how seriously is the impact going to affect our community?

Adaptive capacity - How resilient are we to the impact and consequence?

After doing this for your impacts it will start to become clear which impacts have the highest future risk.



Potential adaptations

The next step is to prioritize the **high-risk impacts** and try to determine how the community can adapt to meet these challenges. Although all impacts should eventually be examined, the high risk ones will be the most important. Determining the best course of action to develop potential adaptations (solutions) to these impacts is a challenging process. Use your staff and community and do some brainstorming around these impacts looking for solutions or adaptations. Research what other communities are doing and use the resources at the end of this chapter.

Potential adaptations may:

- Reduce exposure
- Reduce sensitivity
- Increase adaptive capacity

For example, a low-lying coastal area might have a high probability of experiencing flooding due to sea level rise; however, the risk also depends on what the consequences of such a flood would be. If there is a great deal of infrastructure and residences in the area, the consequences of flooding are much higher than if there is a recreational park. With the same probability, the overall risk would be higher in the first case than in the second: land use planning can therefore increase or reduce risk.

SENSITIVITY	Will the system / community be affected?
EXPOSURE	Are we exposed to the climate impacts?
CONSEQUENCES	Vulnerability x Exposure – How seriously might the climate change stress affect our community?
PROBABILITY	How likely and how often will the climate stress occur?
RISK	Consequence X Probability – what to pay attention to first

Assessing risks is an important first step in the planning process as it will allow communities to prioritize **actions**.

ADAPTIVE CAPACITY	Can we easily do something about it?
VULNERABILITY	Risk x Adaptive Capacity – Identify the weak spots

Adaptive capacity is critical to adaptation planning. It captures the human dimension in terms of our ability to cope with severe events. A community's response to climate impacts need not only involve technical solutions, but should also consider the management, political, and social capacity within the community.

Vulnerability can be reduced by increasing the community's capacity to respond. For example, emergency preparedness can lessen the impact of a particular event. As well, having strong, highly connected social networks in a community can increase adaptive capacity.

It is important to remember that vulnerability can apply to a single piece of infrastructure, all the way up to the community as a whole. Engineers Canada (PIEVC) notes a distinction between "vulnerability" and "engineering vulnerability":

- **Vulnerability** includes a wide range of factors, from engineering considerations to political decision-making and socio-economic factors; it also must deal with the risk tolerances of stakeholders

- **Engineering vulnerability** addresses the question of whether the infrastructure *"would continue to perform to design function given the climate change stresses being considered."* Engineering vulnerability does not address alternate means to deal with a loss of infrastructure function (i.e., it does not deal with social adaptive capacity).

Here are two examples of adaptations:

1. **Developing and practicing emergency response plans.** This will help your community respond to emergencies that might happen in the near future. Emergency plans will also help in the long-term with climate-related emergencies, especially if you have practiced the plan. Having and practicing an emergency plan is a "no regrets" action that increases adaptive capacity.
2. **Implementing your Community Wildfire Protection Plan (CWPP).** Maintaining firebreaks and following FireSmart guidelines around homes and businesses helps to protect your community from wildfire risk now. These actions will also help to reduce the wildfire risk associated with climate change in the future. This is a "no regrets" action that reduces sensitivity.

Adaptation Plan Checklist

- ❑ Our community has an adaptation plan
- ❑ It has been reviewed and integrated into other planning processes

OR

- ❑ Our community does not have an adaptation plan but we have followed the process below to:
  - ❑ Determine a future climate scenario
  - ❑ Determine the impacts of climate change on the community
  - ❑ Completed a risk assessment on those impacts
  - ❑ Developed potential adaptations for those impacts
- ❑ Our community has started mainstreaming climate change in all our planning

Resources

Centre for Indigenous Environmental Resources

Centre for Indigenous Environmental Resources, Managing the Risks of Climate Change: A Guide for Arctic and Northern Communities

The Centre for Indigenous Resources (CIER) has a variety of excellent tools for climate change adaptation planning. This particular guide provides an outline for small indigenous communities to follow to effectively adapt to climate change. While visiting their website, look around at some of the other resources they have.

- http://ccrm-cier.redrockconsulting.com/index.php

Environment Canada: Canadian Climate Data Scenarios Network (CCCSN)

This website has a variety of tools to develop climate change scenarios for a community or region. The site uses global climate models to determine future climate conditions.

- http://www.cccsn.ec.gc.ca/?page=download-intro

Environment Canada: Meteorological Data

This site has data from weather stations throughout Canada and the NWT. Find your community and see how far back the data goes. Some communities do not have weather stations, and for these you may have to use neighbouring communities.

- http://climate.weather.gc.ca

Natural Resources Canada

Climate Change Adaptation Planning: A Handbook for Small Canadian Communities.

This is an excellent reference for small communities, has a great of information on how to prepare an adaptation plan in a 6 step process.

- http://www.cip-icu.ca/Files/Resources/RURAL-HANDBOOK-FINAL-COPY

Communities Adapting to Climate Change: A Tale of Two Communities

This is an informative 10 minute video outlining two BC communities and their experience participating in the Columbia Basin Councils Communities Adapting to Climate Initiative

- http://www.cbt.org/Initiatives/Climate_Change/action_video.asp

Endnotes

1 Environment Canada's Historical weather Data http://climate.weather.gc.ca/index_e.html#access Accessed April 4, 2014.

2 Environment and Natural Resources. 2010. Climate Observations in the Northwest Territories. www.nwtclimatechange.ca/content/climate-trends Accessed April 4, 2014.

3 Arctic Borderlands Society. Arctic Borderlands Ecological Knowledge Co-op Community Reports 1996 – 2009. www.taiga.net/coop/ (Accessed March 20, 2014)

4 Arenson, L. 2013. Department of Transportation Highway 3 Vulnerability Assessment, p19. Presentation at *Pan-Territorial Permafrost Workshop*, November 7, 2013. Available on-line at http://www.northernadaptation.ca/sites/default/files/6_nwt_highway_3_vulnerability_assessment_-_arenson_0.pdf. Accessed MArch 28, 2014.

5 Climate change projections taken from Chapter 5 in the CSA Technical Guide on Infrastructure in Permafrost.

6 Canadian Climate Change Scenario Network. www.cccsn.ec.gc.ca/?page=ensemblescenarios-2050s Accessed April 4, 2014.

7 CS Environmental. Tetl'it Zheh Draft Climate Change Adaptation Plan. 2012.

Hazard Mapping

In this chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

Hazard maps and their use in planning

Community plans require a map or series of maps, including a Land Use Map. The Land Use Map shows the current community and lays out future plans, including areas set aside for future development and areas that should be protected from development because of landscape hazards.

Climate change can affect the size of hazard areas and the risk associated with them, so including landscape hazards in the development of a land use plan is very important.

Landscape hazards are natural features that could present risks to buildings and infrastructure. Risks are determined by the probability of an event occurring, multiplied by the consequences of that event.

> Consequences "might be expected to impair personal safety, quality of life, the surrounding environment, social well being, or financial affairs within a community."
>
> – CSA Technical Guide[2]

Landscape features that could present risks to buildings and infrastructure can be mapped in order to determine the level of hazard. Important landscape features could include: coastal erosion, standing water bodies, drainage channels or floodplains, steep slopes, and permafrost conditions. In this chapter we focus on permafrost hazards as an example of integrating hazards into community planning.

Slumping from permafrost thaw. Photo credit: Jamie Bastedo

Small slump on the Dempster Highway. Photo: Craig Scott

Hazard mapping can help to make informed decisions about:

1. Where and how to build new development
2. What existing buildings and infrastructure might be at risk now and in the future
3. What kinds of emergencies to plan for

This section covers 1 and 2, using permafrost as an example. Emergency plans are covered in another chapter. If landscape systems and landscape hazards are well understood, **communities can build in the most suitable place, with suitable requirements**, to minimize service costs, reduce risk, and ensure resilient communities over the long-term.

Integrating hazard mapping into land use planning

Hazard maps can highlight a number of potential hazards including, slope, permafrost, drainage, flooding, fire, or shoreline erosion. These maps are often combined into one landscape hazard map, or they can each be separate stand alone maps. In any case they are essential when a community is developing Land Use Planning, or proceeding with community developments. These maps can be used to identify high hazard/high sensitivity areas, help define suitable land uses depending on the hazards or risk level, and delineate areas with low, medium, and high suitability for development.

These maps can also provide information to municipal operations about where to watch for on-going and additional damage to infrastructure (e.g. roads, powerlines).

In addition to scientific maps, local knowledge from elders or from those involved in maintenance and operations of community infrastructure could also be included in the hazard maps. This local knowledge can often provide detailed information that can be missed by other mapping. For example, the Paulatuk landscape hazards report notes that *"Recently, a large hole formed in the road by the cemetery and an ATV fell in, highlighting the importance of proper road maintenance"* (pg 5). Mapping these maintenance issues may also provide clues to localized landscape hazards.

An example of incorporating landscape hazards into land use planning can be found in the Fort Simpson General Plan (see box below). In Fort Simpson, active erosion zones along the river have been identified, and excluded from future development through the land use designation *Environmental Reserve*. As additional information and data are gathered about future climate projections and changing landscape conditions, they can be included in Community Plan revisions, particularly in terms of land use designations, permafrost protection, and designating Open Space areas and areas suitable for development.

Fort Simpson on the Mackenzie River. Photo credit: Teresa Chilkowich

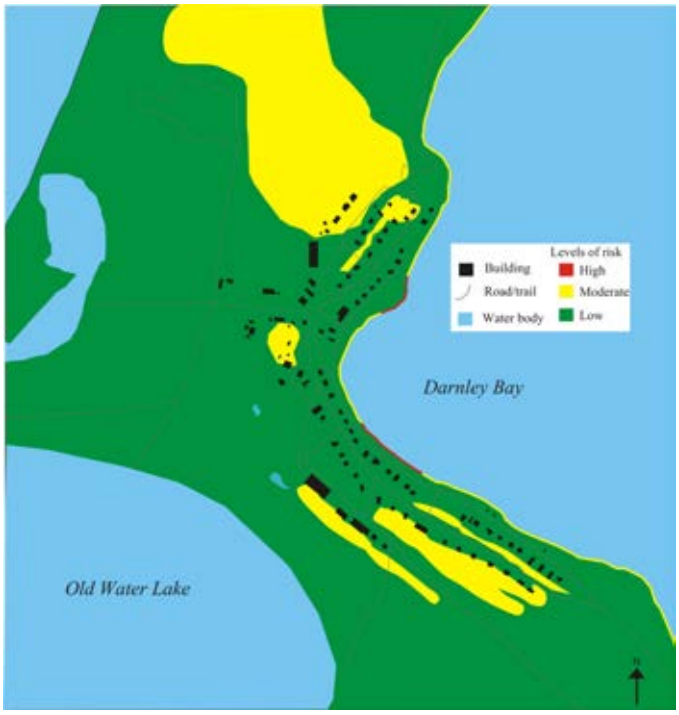
Fort Simpson General Plan - Environmental Reserve

The Land Use Concept Map shows Environmental Reserve areas adjacent to the Mackenzie River. This Environmental Reserve includes areas where there is evidence of active erosion and the potential for riverbank failure has been identified by engineers and soils scientists (pg 13).

Fort Simpson's General Plan suggests developing an Environmental Reserve Management plan to:

- Restore eroding parts of the riverbank with native vegetation
- Protect parts of the riverbank from future erosion
- Understand long term changes to the river, river bank and flood zone arising from climate change
- Augment the value of the natural open space

The *Landscape Risks, Climate Change, and Infrastructure* report prepared for Paulatuk demonstrates a hazard mapping process.[1] A series of current landscape hazards were mapped for the community, and assessed for low, medium and high risk. The maps included: coastal erosion, snow drifting, water ponding, and permafrost. All the landscape risk maps were combined into a final composite landscape hazard map showing low, moderate, and high risk areas for infrastructure.



Paulatuk composite landscape risk map. Credit: Melanie Irvine

Once mapped and assessed, landscape hazard maps can then be incorporated into land use planning to understand the implications for communities.

Specifically, this section illustrates a process to take the information in hazard maps, and use it for planning purposes to:

1. Determine suitable land uses
2. Decide conditions for development
3. Support existing infrastructure and buildings

Permafrost affects bearing capacity and differential settlement as starkly illustrated in one of Dawson City, Yukon's iconic buildings.. Photo: Craig Scott

Permafrost hazard mapping as a land use planning tool

Permafrost has been used as the main example in this section because permafrost degradation will have impacts across the NWT. In addition, permafrost affects bearing capacity, differential settlement and frost heave at the site scale, as well as land stability at larger scales (e.g. thaw slumping). Permafrost is a critical component in the foundation systems of many buildings, transportation infrastructure, and other infrastructure in the NWT.

Please note that each community will need to assess their approach to permafrost depending on the nature and extent of their permafrost – the approach in an area with discontinuous, warm, thin permafrost will be different than the approach in an area of continuous, cold, deep permafrost. Approaches to permafrost may need to adapt and change over time, as permafrost conditions continue to alter. In addition, some communities may map their localized permafrost and find that the community does not have permafrost underlying any buildings or infrastructure (e.g. Jean-Marie River), although permafrost degradation may still impact the surrounding landscape.

Landscape hazard mapping could be used to assist in determining suitable land uses for a Community Plan. The following steps lay out a process to include hazard and permafrost mapping into land use planning. The same process can be used for other hazards as well.

Step One – mapping

Landscape hazards should be mapped with the most up-to-date data available, and include future projections with climate change when possible.

For example, permafrost mapping and data could include

- detailed data on permafrost composition, such as percent of ground ice content, soil composition including organics such as peat, known ice formations such as ice lenses, salinity if applicable
- active layer depth, permafrost depth, depth to bedrock
- known ground temperatures or ground temperature profiles.[2]

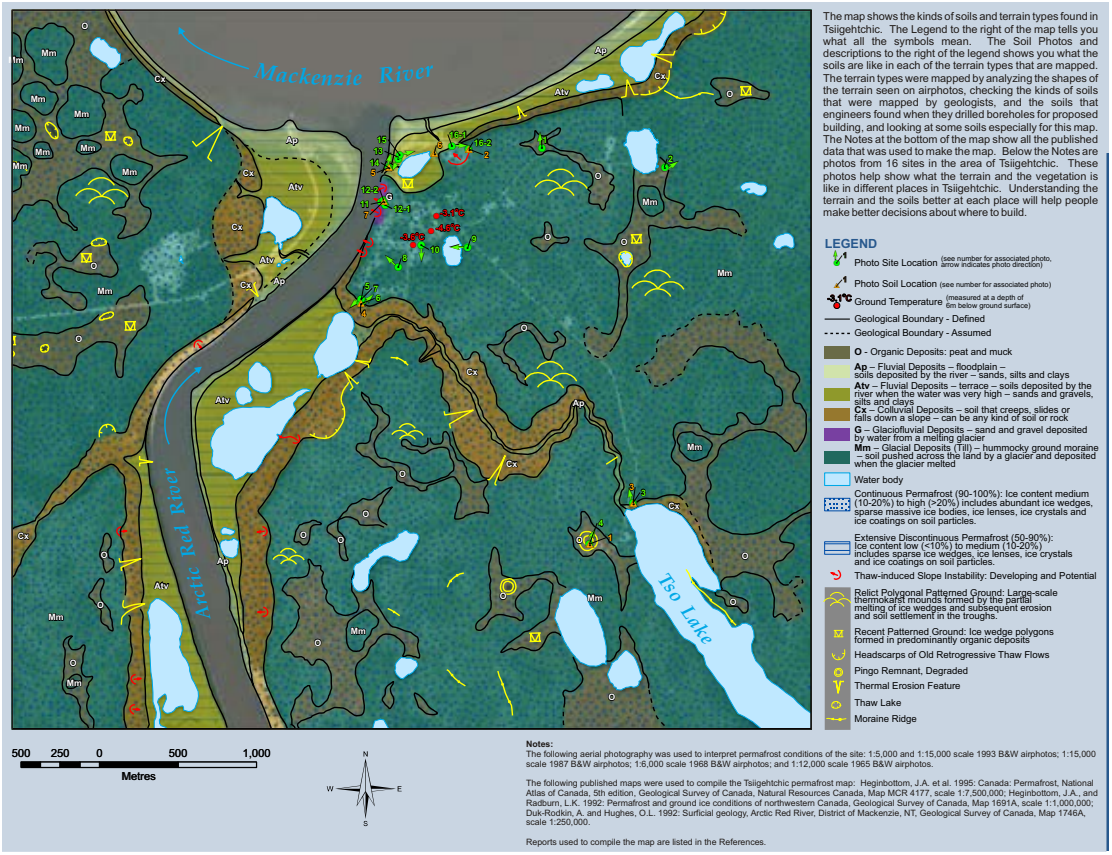
If available, use detailed permafrost GIS maps based on aerial photo assessments, LiDAR analysis, GPR (ground penetrating radar) or resistivity surveys.[2] ENR has mapped permafrost for four NWT communities, and has plans to expand this mapping work to other communities. Soil maps may also provide information for permafrost mapping, and contour maps are also helpful.

Consider working with community members and elders to ground-truth the scientific information on permafrost and terrain conditions. For example, ice wedges, visible depressions, slumping, vegetation types, soil types and drunken forests provide clues about local landscape permafrost conditions and hazards.

Field observations can also provide indications of conditions. The photo below, with standing water beside the highway, provides a clue in the tipped black and white marker that shows where the ground has moved and where the original surface was. (Source: NWT Department of Transportation, *Highway 3 - Climate Change Vulnerability Assessment Final Report, Appendix B*, 2011.)

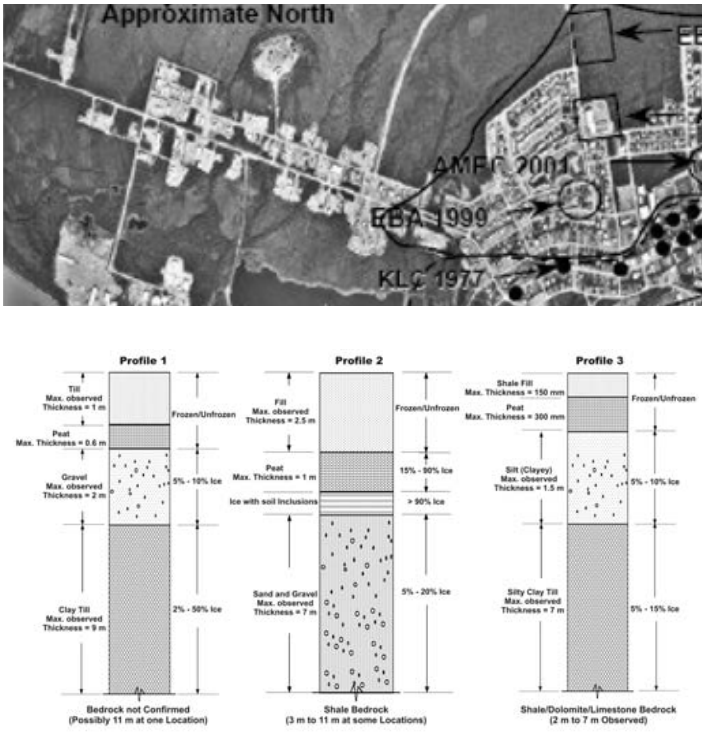
Elevated road surface on Highway 3. GNWT Department of Transportation. *Highway 3 Climate Change Vulnerability Assessment.* 2011.

An example of permafrost mapping that combined soil maps with field observations can be found in the Tsiigehtchic Community Permafrost Map.



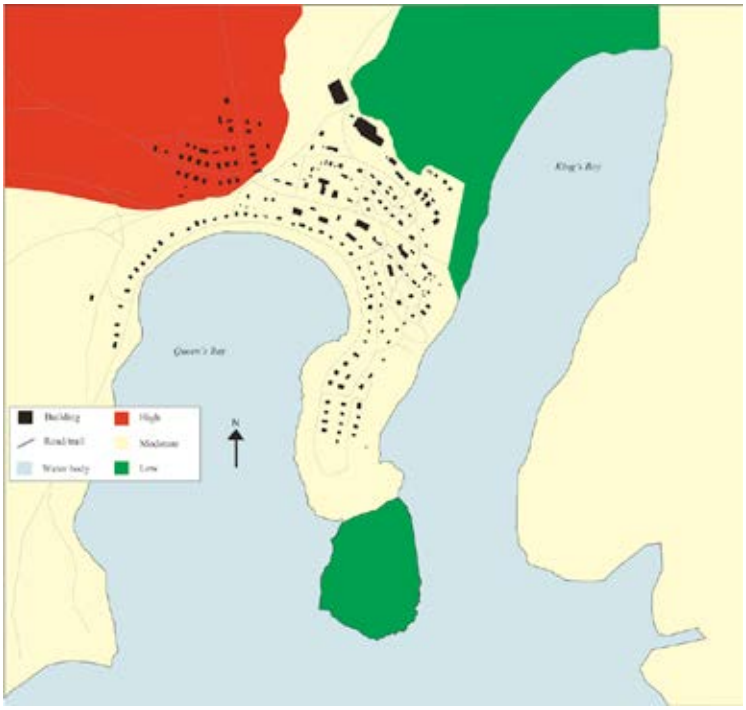
Tsiigehtchic Community Permafrost Map: EBA Engineering

Data may also be buried in research reports. Geotechnical reports on existing buildings are often available within the community or from Public Works and Services. Aboriginal Affairs and Northern Development Canada (AANDC) has a series of permafrost monitoring stations across the Beaufort Region with some stations right in communities. Previous reports and work on permafrost may be available in some communities. For example, work by Zhou and others to model impacts to buildings from permafrost degradation included some assessments of local conditions. Mapping for the Town of Inuvik outlined two sub-areas with different profiles and different modeled impacts on buildings. In one sub-area, modeling results show that nearly 100% of the buildings will be affected under all future climate scenarios, while the second sub-area will have far fewer impacts under future climate scenarios.[3] This suggests that two hazard levels could be assigned in Inuvik, based on soil and permafrost conditions – this should be checked with other available data and experts with local knowledge.



Inuvik permafrost zones with soil profiles.

In another example, local mapping for Ulukhaktok identifies high and low risk areas, related to the presence of bedrock under some of the permafrost. The conditions are described as: *Ice wedge polygons and thermokarst are visible in the west side of the community. There is bedrock near the ground surface in parts of the community. In these areas, the piles of building foundations have been grouted directly into the rock, which reduces the risk that the foundation will move with changes in permafrost.*[4]



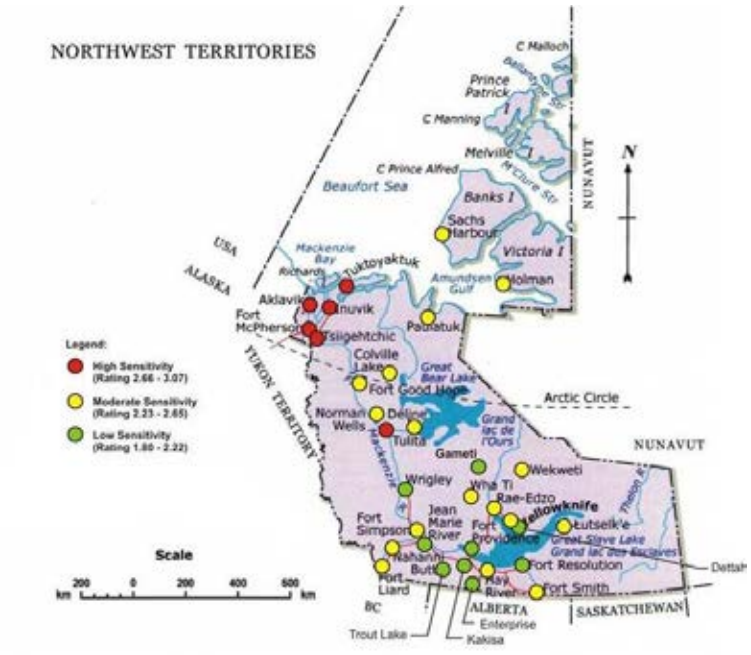
Ulukhaktok permafrost map. Credit: Melanie Irvine

Step Two – hazard levels

Using permafrost as an example, the key questions at this stage include: What is the bearing capacity of the various types of permafrost in your community: poor, reasonable, excellent? Are there areas that show signs of or could be susceptible to differential settlement or thaw slumping? **Map the hazard level to buildings and infrastructure with at least three categories: low, moderate and high.**

Include climate change projections too! Are any local permafrost areas more likely to be affected by climate change and therefore pose a higher hazard? For example, in the discontinuous permafrost zone, small pockets of remaining permafrost may be at high risk of thawing in the near future. In the continuous permafrost zone, some areas may have higher sensitivity to warmer temperatures than others. The map below shows the general sensitivity for NWT communities.

Permafrost sensitivity to climate change in the NWT communities



Courtesy EBA Consulting and NWTAC.

The Red dots show communities most sensitive to impacts of climate change; green dots show the least sensitive.

The Beaufort area is most sensitive because that's where the permafrost is warm, and ice-rich – not much more warming is needed to start having impacts. In the northeast, the permafrost is colder; there is some room to have climate change before it starts to affect building foundations. To the south, there is lower sensitivity for two reasons: one, there is less permafrost; two, the permafrost is already warm and probably wasn't relied on to support a building.

Sensitivity is defined as: *the extent to which permafrost may settle, lose bearing strength, or initiate accentuated frost heave as a result of a warming climate… The likelihood of operational or structural problems developing in a structure on climate change-sensitive permafrost will normally be high, unless steps are taken to mitigate these vulnerabilities.*[5]

If conditions in the future are likely to be considerably different, the permafrost hazard designations should also be based on the probability of degradation due to changing climate, with the hazard level mapped as low, moderate, or high. Base these estimates on the best available data for future conditions.[6] In assessing how far into the future the trends need to be considered, look to the lifecycle of buildings and infrastructure – they should be designed for conditions at the end of life rather than the beginning and hazard maps should take that into account if possible. (You may want to include two hazard maps: current and projected future.)

At this stage you may also include other landscape hazards (e.g. shoreline erosion, environmentally-sensitive areas, slope maps with slumping zones if applicable, forest fire modeling, floodplain mapping or bank erosion areas). For example, the Paulatuk Landscape Hazard Report[7] included coastal erosion and poor drainage areas. The Tsiigehtchic Adaptation Plan recommends that the community "Encourage the Gwich'in Tribal Council (GTC) and INAC to map and monitor landslides in the Gwich'in Settlement Area" (recommendation 27).

It is also good to include the best possible hydrology, watershed, and drainage maps in order to exclude drainage zones from development areas.

Combine or "layer" the maps to determine a final hazard rating that accounts for permafrost conditions under climate change, other landscape hazards, and drainage. This will be used to determine your **land use suitability map in Step 3.**

Note – at its simplest, combining various landscape hazards may consist of a simple overlay of all the hazard areas and their level of risk, as found in the Paulatuk Landscape Hazards Plan[1]. A more complex system scores the various areas for each hazard depending on level of risk, weights and adds the scores, with the final map based on weighted landscape hazards.

Step Three – land use suitability

In steps one and two, you determined the hazard level: high, moderate or low risk to buildings and infrastructure, taking future climate conditions into account. In the third step, you will determine the suitability for development from low to high. Low hazard areas are likely highly suitable for development, while high hazard areas are likely not suitable. Moderate areas may or may not be suitable, and they may require special considerations or requirements in order for development to occur while risk is minimized.

This step deals with how to reduce the risk posed by the hazard. Remember – a hazard may not have any serious consequences if steps are taken to reduce risks.

Determine the general land use suitability for the hazards and permafrost conditions in your community. Based on the known data from Step 1, assess the strength and bearing capacity of the permafrost to determine if it is suitable for building on, or better suited to other land uses such as parks and open space. The Tsiigehtchic Community Permafrost Map contains some of this information as it notes the soils that are better for building on.

Site photos from the Tsiigehtchic Community Permafrost Map: EBA Engineering

One of the questions to ask is whether there **are any special conditions required.** For example, in a moderate hazard area, what would be required to mitigate the hazard and reduce the consequences of the permafrost degrading? Note areas that may require additional, site specific protection (e.g. preserve vegetation) and what those might be. Remember that risk is the probability times the consequences. If you can build in a way that mitigates the consequences – for example, by putting piles down to the bedrock – the changing permafrost conditions will have less of an impact.

The simplest suitability ratings are based on the reversal of the hazard ratings, as shown below.

HAZARD	SUITABILITY FOR DEVELOPMENT	LEVEL OF RESTRICTION
High	**Low** suitability for development	Exclude from development
Moderate	**Medium** suitability for development	Develop with specific conditions
Low	**High** suitability for development	Most suitable for development

Step Four – incorporate into your land use plan

Following on the suitability for development, you may determine the suitable land uses for each designation to use in your land use plan. For example, some high hazard areas may work as parks or recreation areas; others are better designated as environmental reserve or open space (e.g. without any infrastructure). The table below provides examples.

HAZARD	SUITABILITY FOR DEVELOPMENT	LEVEL OF RESTRICTION	SUITABLE LAND USES
High	**Low** suitability for development	Exclude from development	Open space, environmental reserve
Moderate	**Medium** suitability for development	Develop with specific conditions	Parks, non-permanent structures like storage sheds, etc
Low	**High** suitability for development	Most suitable for development	Residential, commercial, town/ hamlet centre, etc

Step Five – zoning, bylaw and plans

In this Step, based on Step 4, you decide on any special conditions for development. These may be site specific, and included in permitting or in contracts for infrastructure and buildings.

For example, for site specific development you could:

- Require that consultants use the CSA technical guide for permafrost, particularly the screening tool
- Ensure community consultants are familiar with the CSA guide
- Include climate change assessment for building/infrastructure end of life

Frequent road maintenance is required on the Dempster Highway because of permafrost thaw and slumping. Photo credit: GNWT

You could also decide on the conditions for development more generally, for example through zoning and bylaws that cover:

- Permafrost protection regulations to protect permafrost during construction
- Site design that includes: site drainage, snow removal plan and maintaining the organic layer around the building

You will need to amend your **zoning bylaw** to include permafrost protection regulations and others as needed. If applicable, you could consider zoning for permafrost protection. For example, some residential areas could be zoned R1P, with permafrost protection measures in effect.

Additional special conditions for development could include developing a community drainage plan, with zoning bylaw requirements that all new developments must include site-specific drainage plans that tie into the community drainage system.

Other zoning regulations should be considered as needed, depending on the various landscape hazards in your community.

Frost heave lifting the fence. Photo: Ellen Pond

How to deal with existing infrastructure in at risk areas?

You may find that existing areas in the community are in zones that are less suitable for development, particularly as your land use planning accounts for future landscape hazards under climate change. The challenge is how to reduce risk for existing buildings and infrastructure.

The following chart outlines suggestions for dealing with permafrost degradation. Other risks to be considered include flooding, wildfire, and erosion. Each of these may require that existing buildings and infrastructure need to be brought up to new standards over time or that retrofits and maintenance are carried out. For buildings not directly under community control, such as private residences, education and awareness may be the best option. For instance, the public can be taught about best practice for building maintenance in permafrost conditions.

OPTIONS TO DEAL WITH EXISTING INFRASTRUCTURE IN HIGH RISK PERMAFROST AREAS

1. **Assign priority areas** to the existing community depending on the probability of permafrost degradation, based on the permafrost map.

2. **Assess buildings and infrastructure to determine the preventive maintenance or upgrades required.** Use existing research to assess particular buildings (e.g. Zhou 2007) and additional assessments as necessary, such as "further study of permafrost maintenance, skirting and drainage issues regarding foundations of houses and community buildings" (Tsiigehtchic Adaptation Plan, Action 23). The Tsiigehtchic Adaptation Plan suggests to "arrange a permafrost and housing foundation assessment with permafrost experts in the community." (Action 24)

3. **Support and encourage** the preventive maintenance required, including community education about permafrost and foundations for private residences. Community engagement could include distributing the Home-owner's Guide to Permafrost (from ENR), showing the NWTAC permafrost 101 video, using "walking visit" assessments in the community or sharing learning about how to properly adjust homes on jacks or other permafrost foundations.

4. For community-owned buildings and infrastructure**, incorporate the assessments into the community's asset management plan and capital planning** if necessary.

5. **Initiate partnerships and/or find funding** to help assess buildings and infrastructure in high risk areas and ensure that critical upgrades are undertaken.

Land Use Plan/Hazard Mapping Checklist

- ❑ Our community has up-to-date permafrost mapping, such as a "permafrost hazard map," including areas with a high probability of permafrost degradation under climate change
- ❑ Our community has recently updated its floodplain or flood risk mapping, taking climate change impacts and projections such as increased water levels, earlier spring melt or other relevant hydrological changes into account
- ❑ Our community has firebreaks designated on our land use plans
- ❑ We have determined suitability ratings and mapped suitable land uses using the hazard maps so as to exclude high risk areas from future development
- ❑ Our land use plan has excluded current and potential future high risk areas from development
- ❑ Our land use plan has an environmental reserve or open space designation to protect lands that improve community resilience (e.g. a buffer), or to set aside lands that are not suitable for development

Resources

Canadian Standards Association

Technical Guide: Infrastructure in Permafrost: A guideline for climate change adaptation. 2010. 118 pgs.

This guide provides comprehensive and detailed technical information on permafrost, climate change impacts in the north, and how to site and build foundations in permafrost conditions. It is intended to "equip community decision makers with the ability to ensure that the impacts of climate change on permafrost are considered during the siting, design, and management of new community infrastructure."

- Available through NWTAC for NWT communities.

Dillon Consulting for Department of Transportation

Climate Change and Transportation in the NWT. 2007. 240 pgs.

- www.dot.gov.nt.ca/_live/documents/content/Climate%20Change%20Report%20for%20posting%20to%20web.pdf

Transportation Association of Canada

Primer on Developing and Managing Transportation Infrastructure in Permafrost Regions. 2010. 8 pgs.

A short introduction to the material about permafrost, roads and airstrips that is found in the detailed technical guide.

- http://tac-atc.ca/sites/tac-atc.ca/files/site/doc/resources/primer-permafrost2010.pdf

Complete guide available at a cost from TAC's online bookstore.

- http://tac-atc.ca/en/bookstore-and-resources

Holubuc Consulting Inc. for Department of Public Works and Services

Geotechnical site investigation guidelines for building foundations in permafrost. 2010. 58 pgs.

A good technical reference describing geotechnical investigations and permafrost.

- http://www.pws.gov.nt.ca/pdf/publications/GeotechnicalGuidelines.pdf

Holubec Consulting for PIEVC

Flat Loop Thermosyphon Foundations in Warm Permafrost.

A technical guide to thermosyphons, including good case studies in the NWT.

- http://www.pievc.ca/e/casedocs/nwt-thermo/GNWT%20Foundations_Northwest%20Territories%20and%20Yukon_Report.pdf

NWTAC's Permafrost 101 video

A video presentation on Permafrost and Buildings by EBA Engineering.

- www.youtube.com/watch?v=H-zC30ivwic.

Endnotes

1 www.arctic-north.com/wp-content/uploads/pdfs/Paulatuk/Paulatuk_Landscape_Hazard_Report.pdf

2 Canadian Standards Association. Technical guide: Infrastructure in permafrost: A guideline for climate change adaptation. 2010.

3 Zhou, F. et al. 2007. Potential Climate Change-Induced Permafrost Degradation and Building Foundations: An Assessment of Impacts and Costs in Five Case Communities in the Northwest Territories.

4 Irvine, Melanie (2011). *Landscape Risks, Climate Change and Infrastructure, Ulukhaktok, NWT*. Page 4

5 Canadian Standards Association. CSA Standards, 2012: 65-66

6 Assessing the bearing capacity in the future requires an assessment of climate trends, local permafrost conditions and climate projections. As all the data may not be available, the best possible assessment with known data should be undertaken. Working with a consultant who can assess risk under changing climate conditions (for example, using the PIEVC risk assessment protocol) is recommended.

7 Ecology North, Gwichya Gwich'in Climate Change Adaptation Planning Project. 2010

Community planning

In This Chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

Community plans are strategic frameworks that plan for growth and development in a community. They outline land uses and help guide future growth as well as decision-making about existing infrastructure. This chapter describes community plans and provides suggestions for integrating adaptation directly into the strategic and detailed components of the plans.

> Climate change and its impacts vary from one location to another, and communities vary in their exposure and ability to cope. In addition, communities facing similar risks and opportunities may make different adaptation choices.
>
> — Climate Change Adaptation for Local Government[1]

This chapter guides the integration of climate change adaptation plans and actions into community planning. The main community planning tools considered in this chapter are:

1. community plans
2. area development plans
3. zoning bylaws

These planning tools enable communities to define and specify design criteria and regulations for various land uses in the community.

The community of Deline. Photo credit: Christine Wenman

There are a variety of tools that will help community planners incorporate climate risk into land use planning. **Land Use Plans**, **Zoning Bylaws**, and **Area Development Plans** are all discussed in this chapter. Each of these may include; standards, guidelines, amenities, site design requirements, bylaws, and risks such as flooding or forest fires.

> Planning tools and climate change risk reduction
>
> Generally speaking, planning tools can be used to reduce climate risks in four ways:
>
> 1. Limiting development in hazard-prone areas
> 2. Ensuring that the built environment can withstand a range of environmental stress
> 3. Helping to preserve natural environments that protect communities against hazards (for example, dunes that absorb [or shorelines that protect against] coastal storm effects)
> 4. Educating stakeholders and decision makers about risks and opportunities and fostering dialogue about adaptation
>
> — Land Use Planning Tools for Local Adaptation to Climate Change[2]

Three key adaptation themes are included in this chapter: protection of permafrost, protection from floods and protection from wildfires. These three themes, with an emphasis on permafrost protection, illustrate how community planning tools can be used to advance climate change adaptation. The chapter sections suggest ways to include these adaptation themes into community plans, zoning bylaws and area development plans.

Some additional specific adaptation actions are also addressed as examples (eg. roof loading and heavier snow loads).

Including climate change in planning is very important for communities that are growing. When building new houses, or adding to municipal infrastructure and services, consideration of where and how to build will be very important to keep construction, operating and maintenance costs down and support community resilience.

Individual communities may want to address other climate impacts using community planning tools. The ideas from this chapter should provide guidance on how to do so.

Jurisdictional authority

The table on page 12 and 13 in chapter 1 shows various climate impacts, taken from community adaptation plans in the NWT, over which communities (hamlets, towns, cities and charter communities) have at least some jurisdiction.

This list should be consulted and adapted to fit an individual community or specific adaptation strategy when developing or revising community plans, zoning bylaws, area development plans, or any other plan or management strategy undertaken by the community.

In many cases, communities can take the lead on integrating adaptation into their operations and planning. Partnerships with the GNWT may be required, with the GNWT providing capacity support. In some cases, authority rests with the GNWT.

This chapter looks at planning that communities can engage in, with support from the GNWT for data and capacity.

Lutsel K'e from the air. Photo: Craig Scott

Community plan

What is a community plan?

A community plan (formerly general plan[3]) is developed and adopted by a community (charter community, city, town, community or hamlet) to plan for community development and the subdivision of land.[4] Community plans are high-level strategic documents that often include a community's vision for itself, as well as goals, opportunities and constraints, and objectives and actions.

> The purpose of the Community Plan is to establish a comprehensive policy framework that will guide the Town's future decisions regarding the maintenance, development and re-development of its land use system: the conservation and use of its natural resources; and the direction and potential for the Town's short-term growth and long term changes.
>
> The policies which make up the Community Plan consolidate all of the information that is required to ensure that the Town will function for its citizens as a safe, convenient, efficient and healthy environment. The Zoning By-law serves to implement the Community Plan and regulate development in the Town.
>
> — Norman Wells Community Plan

> The purpose of a community plan is to provide a policy framework to guide the physical development of a municipality, having regard to sustainability, the environment, and the economic, social and cultural development of the community.
>
> — Community Planning and Development Act[5]

Community plans are prepared in consultation with a professional planner. They must be revised every eight years. Existing community plans or older general plans should be modified to include climate change adaptation when they are updated.

Community plans lay out the land use for a community, including residential, commercial, industrial, and other land uses. Areas with natural and climate related hazards are often excluded from development, instead being designated as open space, nature reserve or recreation areas.

What's in a community plan?

The requirements for community plans are laid out in the Community Planning and Development Act. Several sections are particularly relevant to incorporating climate change adaptation into community plans, and are shown in italics below.

Community plans must (II.4.1.a-e):

- Describe the future land uses for the community
- Incorporate applicable territorial land use policies
- *Contain statements of policy respecting the management of any environmentally sensitive lands or lands subject to natural hazards such as flood or slope instability*
- Address the provision of public services such as transportation, public utilities, and municipal services and facilities, and the land set aside for these
- Include a schedule for development and how municipal services will be provided

Land use descriptions and statements on the management of environmentally sensitive lands or lands subject to hazards can include specific references to climate change, impacts, adaptation and community resilience. Provision of public services should also address changing conditions due to climate impacts.

Community Plans **must also include** (II4.2, II4.3):

- a map or series of maps showing the land affected by the plan and indicating:
  - future land use, and
  - *any land affected by the policies that relate to environmentally sensitive areas or natural hazards*.

Community plans **must be prepared** on the basis of surveys or studies of the community's land use, population growth, economic base, and transportation, communication, public and social services needs (II.4.3.a). The plan must be prepared in consultation with a professional planner (II.4.3.b).

Community plans **may also be prepared** using *surveys and studies that are relevant to the purpose of the plan, including written statements, reports, charts and drawings that express and illustrate information in the plan* (II.4.4.a-b).

> Additional tools relevant to climate impacts could include: permafrost maps, landscape hazards and land use suitability mapping, drainage plans, floodplain maps and wildfire protection plans. Growing communities that require new housing development areas and new water or other infrastructure in particular should include climate change impacts in their hazard and suitability mapping, and consult these when preparing land use and development plans.

Given the above framework for community plans, climate change impacts including risks and hazards to buildings and infrastructure in a community should be included in community plans.

CLIMATE IMPACTS AFFECTING COMMUNITIES IN THE NWT THAT COULD BE TAKEN INTO ACCOUNT IN LAND USE PLANNING
Permafrost degradation (permafrost maps, land use suitability maps)
Landscape hazards such as coastal erosion (landscape hazards maps, risk and suitability maps)
Community drainage (drainage plans, local hydrological, watershed, or drainage maps)
Slope instability and slumping areas (slope maps, thaw slump maps)
Increased flood risk (floodplain maps or flood risk maps)
Forest fire risk (wildfire protection plans)
Erosion and sea level rise (landscape hazards maps, risk and suitability maps)
Food security, including local food storage
Extreme weather impacts, such as increased snow loading on roofs, transportation disruptions, or loss of electricity

> Because Community Plans are required to adopt policies regarding hazards, local governments would be wise to include adaptation to climate impacts in their community plans. Doing so reduces liability.

What's not in a community plan

When incorporating adaptation actions into community plans, it is important to remember that community plans do not include:

- Planning for areas beyond the boundaries of the hamlet, town, or city, such as the forested areas beyond the city where forest fires may be an issue, or travel routes across the land for hunting and gathering
- Control over the highways or winter roads that provide access to the community
- Control over airports or airstrips

- Electricity production and transmission lines
- Influencing upstream water uses, even those that may impact the community downstream.

Communities will need to work in partnership with other levels of government and other organizations to address adaptation actions pertaining to these areas.

If these are raised as issues, they can be included in a plan to communicate with other authorities in order to advocate for the community's perspective. However, these are outside direct community control.

Community planning meeting. Photo credit: Ecology North

Including adaptation in community plans

Community plans do not follow a standard template, and every community can develop their own methodology. Most community plans follow a similar format though, in which a vision, goals, objectives and policies are used to communicate the main messages.

The following sections briefly describe common components of community plans, with suggestions for the inclusion of adaptation language. The components include: vision, goals, objectives/actions, opportunities/constraints and land use. Examples from existing northern general and community plans are provided.

The material is not intended to be an exhaustive list of every possible adaptation action to include in a community plan, but rather an illustration of how to approach thinking through integrating adaptation into community plans.

Vision statements

Some plans start with vision statements or a vision framework for their community. For example, the Fort Simpson General Plan has three points in its vision statement:

> Fort Simpson is an attractive, small northern town with affordable amenities for residents; a place where history and culture are honoured and First Nations and Metis land rights are respected; and, an attractive destination for visitors.
>
> — Fort Simpson General Plan

Community plans could include a high-level, general statement about climate change adaptation or community resilience in the community's vision statement. Because vision statements reflect local values and priorities, it's good to have community input when the plan and vision statement are developed.

Some suggested starting points for developing vision statements relevant to climate change adaptation include:

Our community is…

a community that adapts to climate change

a community that is resilient to future changes including climate change

a community that reduces risks and maximizes opportunities related to climate change

Vision statements could also relate directly to specific adaptation issues, for example:

Our community is…

a community that supports food security for all its residents

a community that understands and adapts to permafrost conditions

a FireSmart community

A Community That Adapts to Climate Change

Iqalungmiut [Iqaluit inhabitants] will partner with the City in studying and finding ways to adapt to climate change.

— Iqaluit General Plan[6]

Goals and/or principles

Some community plans include goals and/or principles. These are not as broad as vision statements. They provide guidance on how decisions will be made, or what the community wants to achieve.

1. To enhance the existing and future quality of life in the Town of Norman Wells by ensuring orderly and phased development.
2. To protect, conserve and promote the management of the Town's natural environment.
4. To minimize development servicing infrastructure costs while ensuring the appropriate provision of municipal infrastructure.
12. To require that all new developments be constructed to a standard consistent with the National Building Code and that also allows flexibility in building design to encourage innovative construction techniques wherever possible.
16. Develop a municipal green plan establishing environmental procedures and encourage environmentally sensitive behavior throughout the Town.

— Norman Wells Community Plan[7]

The Town of Norman Wells. Photo credit: Christine Wenman

Community goals related to adaptation could include language such as:

> Use climate change impacts and landscape hazard risk assessments in the planning and location of municipal utilities, assets, and operations, in order to minimize associated construction, operating and maintenance costs.
>
> Climate change adaptation is considered in all decision-making, planning and regulatory measures.
>
> Minimize risk to the community from permafrost degradation by considering permafrost conditions in land use planning.

Objectives, actions, policies

Objectives and actions state specifically what the community plans to do to follow through on its vision statement and various goals. Objectives and actions may also be stated for each land use.

Fort Simpson's General Plan describes goals, objectives, and policies for land use in the Community that apply to general development issues, or specific land use categories.

"Goals" are the ideal end to which the plan will strive.

"Objectives" are specific aims that can be measured and achieved.

"Policies" are the means by which the objectives can be realized.

For example, a community plan could include an objective with supporting actions and policies dealing with permafrost degradation — and helping to meet a permafrost-related goal. The language could be adapted from the following:

GOAL: Minimize risk to the community from permafrost degradation by considering permafrost conditions in land use planning

OBJECTIVE 1: Reduce the probability of permafrost degradation

ACTION: Use permafrost maps to determine areas requiring special permafrost protection measures

ACTION: Implement construction practices that reduce the impact on permafrost such as: minimizing vegetation disruption, minimizing soil and active layer disturbance and designing a site drainage plan

Policy mechanism - add these requirements to Zoning Bylaw permitting process

ACTION: Implement building standards that protect permafrost by requiring buildings to be designed to the CSA guidelines on permafrost

OR

Require new buildings to be designed and constructed to: 1) meet the CSA guidelines for permafrost foundations; 2) ensure that heat is not transferred from buildings and infrastructure into the permafrost; and 3) prevent snow drift build-up and standing waterbodies on the site

Policy mechanism - add this requirement to Zoning Bylaw permitting process

OBJECTIVE 2: Reduce the consequences of permafrost degradation

ACTION: Use permafrost maps to determine areas suitable for development

ACTION: Monitor permafrost conditions on an annual or as needed basis

ACTION: Assess potential maintenance/operational needs in existing building and infrastructure due to permafrost degradation and seek funding to support necessary upgrades

Proposals for new residential development will be evaluated using criteria that are available to the public that consider the character of the neighbourhood and outline acceptable approaches to traffic, density, landscaping, energy efficiency, visual quality, and municipal servicing requirements

— Fort Simpson General Plan [8]

These requirements provide an opportunity to include criteria relevant to landscape hazards, including permafrost protection, drainage, and FireSmart requirements. For example, in addition to what is already listed, the policy could be amended to add that

> **New residential development will also be evaluated using criteria including acceptable approaches to permafrost protection, site drainage, snow removal/drifting, and FireSmart firewood storage.**

Study the Impacts of Climate Change in Iqaluit

The City of Iqaluit will develop mechanisms to study and monitor the impacts of climate change. It will work with the community to obtain and share this information, and build the knowledge base and adaptive capacity of the community.

Adapt to Climate Change

The City of Iqaluit will take a precautionary approach to development by incorporating the best current knowledge on climate change impacts into its decision-making. By creating a monitoring system, the City will increase its knowledge base and develop policies that build the adaptive capacity of the community.

— Iqaluit General Plan[9]

Opportunities and constraints

Here, key considerations for the community can be laid out. For example, Hay River's General Plan addresses permafrost issues.

> Discontinuous permafrost requires special treatment to allow development to occur; either advance clearing and drainage to encourage thawing, or insulation of foundations to prevent thawing. These approaches add to the cost of urban development and can be avoided by directing growth to existing urban areas through infill development, redevelopment, and adaptive reuse.
>
> — *Hay River General Plan*[10]

Climate change will also alter permafrost, providing greater uncertainty to development in permafrost areas. To account for climate change, Hay River's plan could also include:

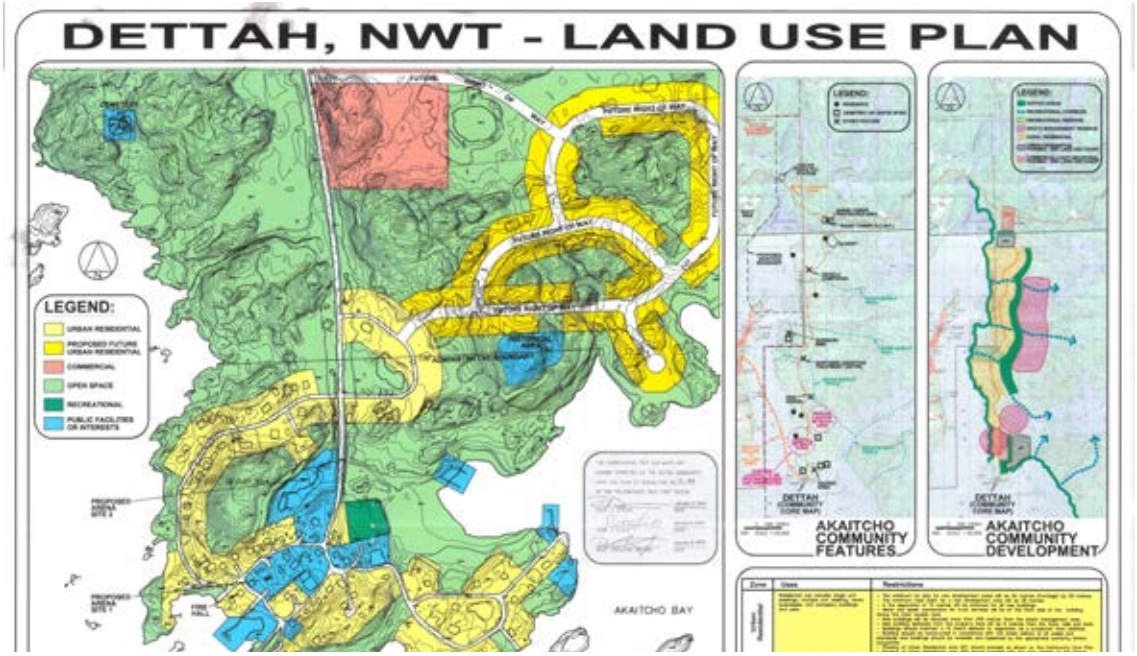
> **Climate change will further alter the nature and extent of the permafrost, with possible impacts on local ground conditions such as drainage, settlement, and bearing capacity. Building on changing permafrost could incur additional operating and maintenance costs in the future.**

This provides an additional reason for directing growth to existing urban areas where permafrost conditions are known or directing growth to areas where permafrost is absent.

Each community will need to assess their approach to climate impacts such as permafrost degradation depending on their locale. For example, the nature and extent of permafrost is important — an area with discontinuous, warm, thin permafrost will require a different approach than an area of continuous, cold, deep permafrost. The approach to permafrost degradation may need to adapt and change over time, as permafrost conditions continue to alter.

Land use planning

Communities can use land use plans to restrict development in hazardous areas, and to protect and manage environmental amenities that help the community remain resilient. Climate impacts related to landscape hazards, as described in the *Land use planning and planning tools* chapter, should be included in community and land use plans. For example, Fort Simpson considered erosion and riverbank slumping in the delineation of its environmental reserve in its general plan. In the future, new data showing how the slumping might change with climate change should be incorporated into Fort Simpson's determination of its environmental reserve land. Another tool is permafrost mapping, now commonly used as permafrost impacts most NWT communities.



Dettah, NWT Land Use Plan. Credit: UMA Engineering LTD

Under the requirements of the Act, a community plan includes a land use map. For example, the Dettah Land Use Map includes land use, land use statements, and the zoning (uses and restrictions). Some community plans include objectives and policies for each designated land use (e.g. Inuvik 2006, Fort Simpson 2008).

Every community has different on-the-ground conditions that impact land use decisions. Climate change has the potential to impact many of these conditions and it is up to the community to be aware of and plan for the potential for changing conditions.

Each designated land use should therefore be reviewed in order to incorporate climate change adaptation objectives and policies, with detailed requirements set out in the zoning bylaw. Examples include:

Residential

Some of the tools that planners have to help mitigate the future impacts of climate change on residential developments include: FireSmart, flood-proofing, reducing snowdrifts, drainage plans and permafrost protection techniques (e.g. leave the existing vegetation and ground cover intact).

Commercial and institutional

Land use planning for commercial and institutional uses is similar to residential; however, a more detailed investigation of conditions such as underlying permafrost is required when designing larger commercial buildings. Using traditional knowledge, ground interpretation, permafrost mapping, and geotechnical investigations to determine permafrost conditions prior to building are important to reduce the risk — and future costs — from permafrost degradation affecting buildings and related infrastructure. Understanding the dynamics of additional climate conditions both now and in the future, such as wind direction, snowdrifting, drainage patterns, snow loads and forest fire conditions, is critical when investing in expensive new buildings.

Industrial

Industrial land use is similar to commercial in that these buildings are often larger and more expensive and thus require more in-depth investigation and planning using future climate projections. Furthermore, industrial areas are typically situated away from the centre of the community and thus require transportation corridors and services, which may be impacted by climate change. Landscape hazards need to be considered when designating industrial land use areas.

Parks and open space, environmental reserve

These designations are some of the most important land uses for adapting to climate change, because they can be used as buffer zones to protect the community from flooding or forest fire, or in areas where permafrost degradation means that building is inadvisable.

> Flooding of the Mackenzie River in Fort Good Hope in May 2005 and Aklavik in May 2006 caused damages in the millions of dollars. Flood zones in communities may have to be redefined due to changes in water levels, heavy precipitation events and melting permafrost. New flood zone definitions might call for the relocation of infrastructure as well as limit community lands available for future development. Also, the eroding shoreline of Tuktoyaktuk is vulnerable to further sea-level rise and storm surges.
>
> — NWT Climate Change Impacts and Adaptation Report[11]

Parks, open space, and environmental reserves can be expanded to include lands that may be higher risk in the future under climate change. For example, lands that have a medium suitability now for development, but a high probability of permafrost degradation (and settling, subsidence, slumping, etc) in the future, should be considered for inclusion in a park, open space or environmental reserve to reduce future liability of the municipality.

Other land use factors affected by adaptation

Wildland fire fuel management areas

The following could be considered in community plans:

- areas within the community where fuel removal or fuel reduction may be required (following FireSmart principles)
- areas where species conversion could be considered (e.g. from evergreen to deciduous trees)
- emergency planning coordination areas

Designating fire breaks within the community as open space or environmental reserve lands will ensure they are protected and not developed.

Snow storage areas and snow drifting

Changing wind directions along with increased snow amounts in the winter in some areas may exacerbate existing snowdrift issues. Snowdrifts in winter combined with

inadequate drainage in the spring and summer can lead to degradation of the underlying permafrost. Snowdrifts insulate the ground in winter, which prevents the permafrost from getting really cold in the winter and leads to faster thawing in the summer. As well, when snowdrifts melt in the spring, standing water and wet soil transfer heat to the permafrost more effectively than dry ground, warming the underlying permafrost around buildings.

Wind direction and the potential for snowdrifting should be considered during land use planning, to reduce drainage issues and improve permafrost protection.

Issues of snow storage — where to store snow safely without increasing permafrost degradation or creating drainage problems or erosion issues in the spring — are likely to increase with climate change, as winter precipitation (snow) has been increasing and is projected to increase further in some areas.[12]

Clearing snow off roofs in Inuvik. Photo: Craig Scott

Snow storage areas, snow drifting and snow fencing should be considered in land use plans. Hay River has a policy about snow storage (4.11.6) Iqaluit uses snow fencing to control snowdrifts, and Paulatuk's adaptation plan notes that snow melting from their snow storage area is causing considerable erosion.

Land related to food security

Land related to food security includes community gardens, harvesting areas and areas for community food storage. For example, the Dettah draft adaptation plan includes an action to promote the harvesting, storage and processing of berries in good years.

Communities can consider land use designations for food production. Photo credit: Ecology North

Local food processing and storage, especially if it is shared or cooperative, might require space in the community and community infrastructure. The land use plan could designate areas for community processing and storage, and have supportive policies. Hay River has policies for local food production.

Some communities (e.g. Hay River) have lands within the community that are suited to agriculture. A land use policy to protect these lands from development can support long-term community resilience and local food security.

Land use related to community energy systems

Several adaptation plans from NWT communities make reference to alternative energies, especially local fuel sources. These provide an alternative to expensive, imported fuels like heating oil. For example, the Dettah draft Adaptation Plan includes a commitment to investigate alternative energies, energy efficiencies and wood and pellet heating options.

Several plans also include energy self-reliance as an adaptation action.

Community energy planning should be considered when the community's land use plan is being developed, particularly for new development areas, because planning for energy is related to land use planning.

Energy considerations for land use planning could include:

- Lot orientation: South-facing lot orientation allows passive solar, solar hot water, or solar PV (electricity) to be integrated within buildings, reducing dependence on outside fuel sources. In communities with frequent strong winds, protecting doors and windows from the prevailing wind direction may be advisable.
- Density: Multi-family buildings are more energy efficient to heat than single-family houses because they have fewer outside walls compared to the interior space. The land use plan should include duplex, triplex, and multi-family zones, possibly mixed into existing residential areas for infill development or included as mixed-use buildings (i.e. with retail or businesses on the ground floor and residential units above).
- Density: District energy systems are more efficient and financially viable when they have shorter pipe distances (length of pipe from the central energy plant to the buildings being served with heat and hot water). In communities with a district energy system, infill buildings should be added in existing developed areas, or new areas developed in a compact way.
- Density: Compact communities use less transportation fuel because the shorter distances make walking and other active transportation more feasible, particularly in summer months. Putting residential areas close to services like health, schools and stores also keeps transportation fuel use down. Another benefit of compact, mixed-use communities is that elders and people without ATVs, snowmobiles, and cars can access community services more easily.
- Energy plant: If your community is considering a district energy system, the land use plan may need to provide an additional area for the plant.
- Energy plant: A land use plan for a community with a biomass (wood/pellets) plant will also need to make room for wood supply and storage. FireSmart considerations (minimum distances to buildings, etc.) will also have to be addressed.

Area development plans

Area development plans are a planning tool under the Community Planning and Development Act that allow communities to set up the framework for subdivision and development, including re-development, of designated areas within a municipality.

Under the Act, area plans must lay out the area affected; current and future land uses; population density; location of transportation routes, public utilities and land for public purposes; the schedule for development; and land acquisition for municipal and public purposes.

When relating to redevelopment, area development plans must also describe plans within the area for preservation or improvement of lands and buildings; rehabilitation of buildings; removal of buildings; and establishment, improvement or relocation of roads, public utilities or other services.

As a tool for climate adaptation, area development plans could therefore potentially be used to:

- ensure that specific at-risk areas have land uses appropriate to the level of risk, or land uses that account for the risk, such as flood-proofing in a flood-risk area
- help communities to plan for building rehabilitation and upgrading to mitigate climate risks (e.g. improved foundations in permafrost)
- help communities to plan for re-alignment of critical infrastructure or relocation of development to lower-risk areas to improve community resilience in the future

Zoning bylaws

What are zoning bylaws

Zoning bylaws lay out what you can and cannot do with a piece of land (a parcel or a lot) and the buildings within the municipal boundaries. According to the Community Planning and Development Act, the purpose of a zoning bylaw is to regulate and control the use of land and buildings, make sure they conform to the community plan, and *"if applicable, prohibit use or development of land or buildings in certain areas."*[13] Zoning bylaws must be adopted following adoption of a community plan.

This means that communities can decide if there are areas of land that should not be developed, such as an area within a floodplain, or an area where the permafrost needs extra protection or is shifting so much that building there should be restricted. Understanding where to allow development or not requires a good understanding of the community's landscape, including slopes, drainage, and landscape hazards; this is covered in the *Land use planning and planning tools* chapter.

This section provides examples of what might be required to prepare a revised or new zoning bylaw with an eye to sections where climate impacts and adaptation should be included. Since zoning bylaws set out the permitted uses of lands and buildings — and conditions of permitted uses like development design standards — they can be a powerful tool for mainstreaming climate change adaptation into community planning.

The examples provided below are not an exhaustive list. The specifics of what would be included will vary for each community, depending on local conditions and needs.

Development permit application requirements

Development permits are required to develop a piece of property, undertake a major renovation, or significantly change the use of an existing building. The community controls the process and can put restrictions on use of a property based on the community's zoning bylaw.

> The Town shall continue to use the Development Application process as a means of maintaining effective control over the development of vacant land and the redevelopment of built-up land. It will be used to supplement the requirements of the Zoning By-law and other by-laws which may apply to development and re-development.
>
> — Norman Wells Community Plan[14]

Development permit applications require the developer to provide relevant information, such as site plans, proposed service schemes and other site-related drawings and information.

To minimize climate change impacts, the following could also be required with permit applications (exact requirements depend on community context):

- **Site drainage plan**
- **Snow removal location**
- **FireSmart principles followed**
- **Foundation plan prepared by a qualified professional according to Canadian Standards Association (CSA) Infrastructure in Permafrost Technical Guide, if applicable**
- **Wildland fire fuel management plan, for rural residential lots or lots within an interface area**
- **Increased settling times for lots; increased depth of gravel pads, if applicable**
- **Minimal disruption of permafrost insulating vegetation**

Provisions in zoning bylaws

Zoning bylaws may include provisions on a large number of factors related to land development, from design standards to landscaping to removal of topsoil to outdoor storage. Several of these provisions should be considered for adoption. The following provides examples.

Design standards

Zoning can include development design standards; here are some examples:

Commercial and institutional buildings could be required to follow the Canadian Standards Association guide to foundations in permafrost. The language could be similar to:

> **Commercial and institutional buildings shall be constructed in accordance with CSA Standards for foundations as found in the Technical Guide: Infrastructure in Permafrost (2012).**

Commercial, institutional and residential design guidelines could include:

- Site planning and landscaping that contribute to permafrost integrity, like minimizing removal of vegetation and topsoil
- Design requirements for flat roofs to address concern about flat roof collapse with additional snow loads (wetter, larger single events)
    - Other design requirements depending on the community, which may require a professional assessment. For example, Iqaluit's zoning bylaws state that a professional architectural or geotechnical assessment may be required for construction on slopes exceeding 25%.

Residential design standards could follow the CSA requirements for fuel tanks:[15]

- **Fuel tanks shall be double-walled and connected using flexible fuel lines.**
- **Fuel tanks shall be located where fuel spills will not drain towards the building.**

Development of buildings on unstable land

> Consider including a flood risk regulation, FireSmart regulation, or permafrost regulation as a section in your zoning bylaw.

Zoning can include provisions about the development of buildings on land subject to flooding; on low-lying, marshy or unstable lands; or close to lakes or streams. Regulations about soils and drainage could include permafrost protection.

The Hay River Zoning Bylaw provides a good example of how climate change can be added to an existing regulation.

> **No development shall be allowed unless the nature of the surface and subsoil of the land is such that good drainage and the stability of the buildings and structures can be assured.**
>
> — Hay River Zoning Bylaw[16]

This could be expanded with the following text:

> **…within known climate change parameters over the lifetime of the buildings and infrastructure.**

Community Planning Checklist

- ❑ Our Community Plan has a vision statement including adaptation in community planning or enhancing community resilience
- ❑ Our Community Plan has been prepared with consideration of local permafrost conditions (if applicable) and climate change projections for the NWT, using the best available knowledge on climate projections, permafrost degradation and other relevant climate impacts such as extreme weather events
- ❑ Our Community Plan has goals, objectives, actions and/or policies (or the equivalent) that take into account climate change adaptation, including:
    - ❑ protecting permafrost
    - ❑ dealing with flood risk
    - ❑ dealing with wildfire risk
    - ❑ dealing with extreme weather
    - ❑ other local impacts such as food security, energy resilience, and transportation challenges
    - ❑ monitoring and reporting on climate change impacts
    - ❑ incorporating climate change and adaptation in municipal decision-making and operations
    - ❑ engaging the community about climate change, impacts and adaptation
- ❑ The land use component of our Community Plan has considered hazard mapping in designating land use suitability and the development of land use areas
    - ❑ The land use map excludes high-risk areas from development, using open space, parks, environmental reserves or other similar designations
- ❑ Each land use designation (eg. residential, commercial, open space) includes specific objectives and policies to minimize climate change impacts, if applicable
- ❑ Our community has a local permafrost map that has been used in preparation of the land use map

- ❑ When determining areas for new development in our land use plan, we have consulted the community wildland fire protection plan
    - ❑ New development areas do not interfere with existing firebreaks or fuel modification programs and include requirements that meet or exceed existing FireSmart measures in the community

Area Development Plans

- ❑ Area Development Plans have been considered as a planning tool for areas with specific vulnerabilities, such as floodrisk or significant permafrost degradation

Zoning Bylaws

- ❑ Our Zoning Bylaw has specific regulations dealing with landscape hazards facing our community, including (if applicable)
    - ❑ flood risk regulation
    - ❑ fire risk regulation (Fire Smart standards required)
    - ❑ permafrost protection regulation
- ❑ Each land use category (residential, commercial, institutional, etc.) considers climate change adaptation, incorporating specific policies and requirements as applicable
- ❑ Design guidelines include consideration of future conditions, such as increasing snow loads, or orientation of buildings to prevent snowdrift build-up
- ❑ Requirements for development permits include providing materials relevant to reducing climate impacts and increasing community resilience, such as snow removal plans, snow storage locations, drainage plans, etc.

Resources

Public Works and Services: Assessing Building Vulnerability

This short brochure provides some good context and information about PWS approach to adaptation activities for buildings in NWT.

- http://www.nwtclimatechange.ca/sites/default/files/Assessing_Building_Vulnerability.pdf

NWT Centre for Geomatics: Mapping Permafrost Displacement

The Centre for Geomatics has mapped four NWT (Tuktoyaktuk, Inuvik, Fort Simpson and Norman Wells) communities using radar imaging. This brochure outlines the process and provides contacts.

- http://www.nwtclimatechange.ca/sites/default/files/Mapping_Permafrost_Displacement.pdf

Environment and Natural Resources GNWT and Canadian Centre for Remote Sensing

Season surface displacement maps were created for four communities that show seasonal change in the ground surface. These maps show areas where permafrost raises and lowers the ground, providing a good visual representation of where not to put buildings.

- http://www.nwtclimatechange.ca/sites/default/files/Permafrost_Seasonal_Surface_Displacement_Yellowknife.pdf

Community Wildfire Protection Plans

Forest Management Division, Department of the Environment and Natural Resources

- www.nwtfire.com/cms/cwpp

FireSmart Program

Forest Management Division, Department of the Environment and Natural Resources

- http://www.nwtfire.com/cms/pages/firesmart-program

General Resources and Resources for Community Engagement

These additional impacts and adaptation resources are useful for planning and public engagement for communities in the Northwest Territories.

Environment Division

Department of the Environment and Natural Resources.

Homeowners Guide to Permafrost in the Northwest Territories. 2014. See the equivalent online guide from Nunavut at

- www.climatechangenunavut.ca/en/resources/news/homeowners-guide-permafrost-nunavut-just-released

Homeowner's Guide to Oil Tanks

Department of the Environment and Natural Resources. 2010.

- www.enr.gov.nt.ca/_live/documents/content/Homeowners_Guide_Oil_Tanks.pdf

NWT Climate Change

Government of the Northwest Territories

- http://www.nwtclimatechange.ca/content/resources-0

Endnotes

1 J. Fraser and M. Strand, Climate Change Adaptation for Local Government: A Resource Guide (Pacific Institute for Climate Solutions, 2011). pics.uvic.ca/sites/default/files/uploads/publications/Adaptation_Resources_June2011.pdf

2 Gregory R.A. Richardson and José Otero, Land Use Planning Tools for Local Adaptation to Climate Change (Government of Canada, 2012), 2. www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/files/landuse-e.pdf

3 Community Plans were called General Plans under the 1988 Planning Act. Under the new Community Planning and Development Act (2011, in effect as of October 1, 2013), they are now called Community Plans.

4 The Community Planning and Development Act does not apply to Tlicho community governments, established by the Tlicho Community Government Act.

5 Government of the Northwest Territories, Community Planning and Development Act, Part 2, Section 3.1. www.maca.gov.nt.ca/home/for-community-governments/community-planning-and-development-act/

6 Iqaluit, General Plan (2010), Vision Framework. www.city.iqaluit.nu.ca/i18n/english/pdf/GeneralPlanOctober2010Eng.pdf

7 Norman Wells, Community Plan, October 2004 Draft Submission. www.normanwells.com/sites/default/files/Community-Plan.pdf

8 Fort Simpson General Plan (2008), 5.

9 Iqaluit, General Plan, Objectives and Actions.

10 Town of Hay River, General Plan, Bylaw No. 1811 (2004). www.hayriver.com/uploads/documents/by-laws/1811_General_Plan.pdf

11 Department of the Environment and Natural Resources, NWT Climate Change Impacts and Adaptation Report (2008), 26.

12 *Climate Change In The Tlicho Region: Scientific And Local Findings*. Changing Times Project.

13 Community Planning and Development Act, Section 12.1.

14 Norman Wells, Community Plan, 36.

15 Canadian Standards Association, Installation Code for Oil Burning Equipment (CSA B-139-04). www.shopcsa.ca

16 Town of Hay River, Zoning and Building Bylaw (2010), 4.8(1). hayriver.com/uploads/documents/by-laws/1812_Zoning__Building_ByLaw_A-R_Consolidated.pdf

Emergency Planning

In This Chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

This chapter will help your community to understand the basics of emergency management planning. It is based on MACA's Community Emergency Plan template. Knowing the risks your community may face can help you take pro-active action to reduce risk, and also respond better if an emergency does happen.

> Any community is vulnerable to numerous hazards and emergencies. These can be human caused such as transportation accidents, technological such as those involving hazardous materials; infrastructure disruptions that could involve utility and power failures, and natural hazards such as severe weather.
>
> – MACA Community Emergency Plan Template, 2012

The chapter will also help you to include climate change impacts in your plan. Climate change could have an impact on emergencies because new risks develop, or existing risks and vulnerabilities may increase.

The table on the next page shows climate impacts that may affect community emergencies shows some climate changes in the Northwest Territories that may increase the number and severity of community emergencies. This table can be reviewed as part of your community's Hazard Analysis in Step 1 of your emergency planning.

Climate impacts that may affect community emergencies[1]

PROJECTED CLIMATE CHANGE IMPACT	SECONDARY IMPACTS: POTENTIAL COMMUNITY EMERGENCIES
Warmer, drier summers and drier forests	Increased length of fire season, increased fire severity, and more fires in a year
Increased coastal storms and reduction in protective sea ice	Coastal erosion: loss of ground and infrastructure
Changes in river flow and timing, increased ice jams	Increased flooding: both localized and more widespread, with widespread damage already in some Mackenzie Delta communities
More extreme weather, increased number of extreme climate events	Increased power outages - threats to transformer stations, power lines, and other energy systems; ice build-up on power lines and infrastructure Transportation disruptions (air and road)
Increased unpredictability of weather; unpredictable ice and snow patterns	Winter travel more dangerous More need for search and rescue
Increased winter precipitation and increased spring run-off	Building collapse due to increased snow loads on roofs Road wash-outs Localized flooding and permafrost degradation
Permafrost degradation, ground settlement	Disrupted winter roads Fuel spills due to ruptured fuel lines Building and infrastructure damage

Jurisdictional authority - who is responsible?

Communities are the first line of response for emergencies within the community. The Chief/Mayor or Senior Administrative Officer (SAO), or those designated to act on their behalf, have the authority to make decisions in an emergency and implement the Emergency Plan.

If the emergency is bigger than the community's resources can handle, then the community can call on outside assistance from the regional emergency management office, neighbouring communities, and/or the private sector. The MACA Superintendent coordinates GNWT activities in response to a community emergency.

The legal authority for emergencies is shown in Table 2, from MACA's Emergency Plan template. There are four levels of emergency, from those that can be handled locally (Level 1) to those requiring federal involvement (Level 3).

Emergency Response Levels

LEVEL OF EMERGENCY RESPONSE	DESCRIPTION
Level 1 – local control with no GNWT support	• Low impact and short duration (less than 12 hours) • Adequate resources • No state of emergency • No territorial support
Level 2A – local control with GNWT Support	• Moderate to high impact • Medium to long duration (more than 12 hours) • Local state of emergency • Support from the GNWT is required
Level 2B – GNWT control with local coordination	• GNWT control • Local authorities manage their resources with the GNWT • State of emergency is declared by the GNWT
Level 3 – GNWT control with federal support	• Major emergency • GNWT or Federal control • Resources of all levels of government are involved • Local authorities manage their resources within a joint government emergency management structure

What is formal emergency planning?

An emergency plan provides a framework to deal with emergencies in the community. It helps communities to plan how resources and people in the community will respond in a coordinated way, as soon as possible, to an emergency.

Having an emergency plan makes sure that community members and government agencies know what their roles are and what to do in an emergency. It also sets out external contacts and support.

Emergency planning can also help identify potential risks and hazards to a community so that pro-active, preventive action can be taken, including to reduce risks posed by climate change.

> The Emergency Plan is formally put in place by an Emergency Measures Bylaw. MACA's Emergency Plan template includes a Bylaw Template in Appendix B.

Who is responsible in communities?

> The Emergency Response Coordinator or ERC is in charge of all emergency management in a community. The SAO is usually the Emergency Response Coordinator.

In an emergency, the ERC brings the Community Emergency Response Committee together to respond.

The Community Emergency Response Committee has local and GNWT representatives. Individual responsibilities are laid out in MACA's template. Committee members may include:

- Chief/Mayor; SAO/ Emergency Coordinator
- Fire Chief; Community Public Works Foreman
- By-Law Enforcement Officer; Community Housing Manager; Airport Manager
- Nurse In-Charge; RCMP Detachment Commander
- A representative from the NWT Power Corporation; a representative from NorthwesTel
- A representative from each resident GNWT department

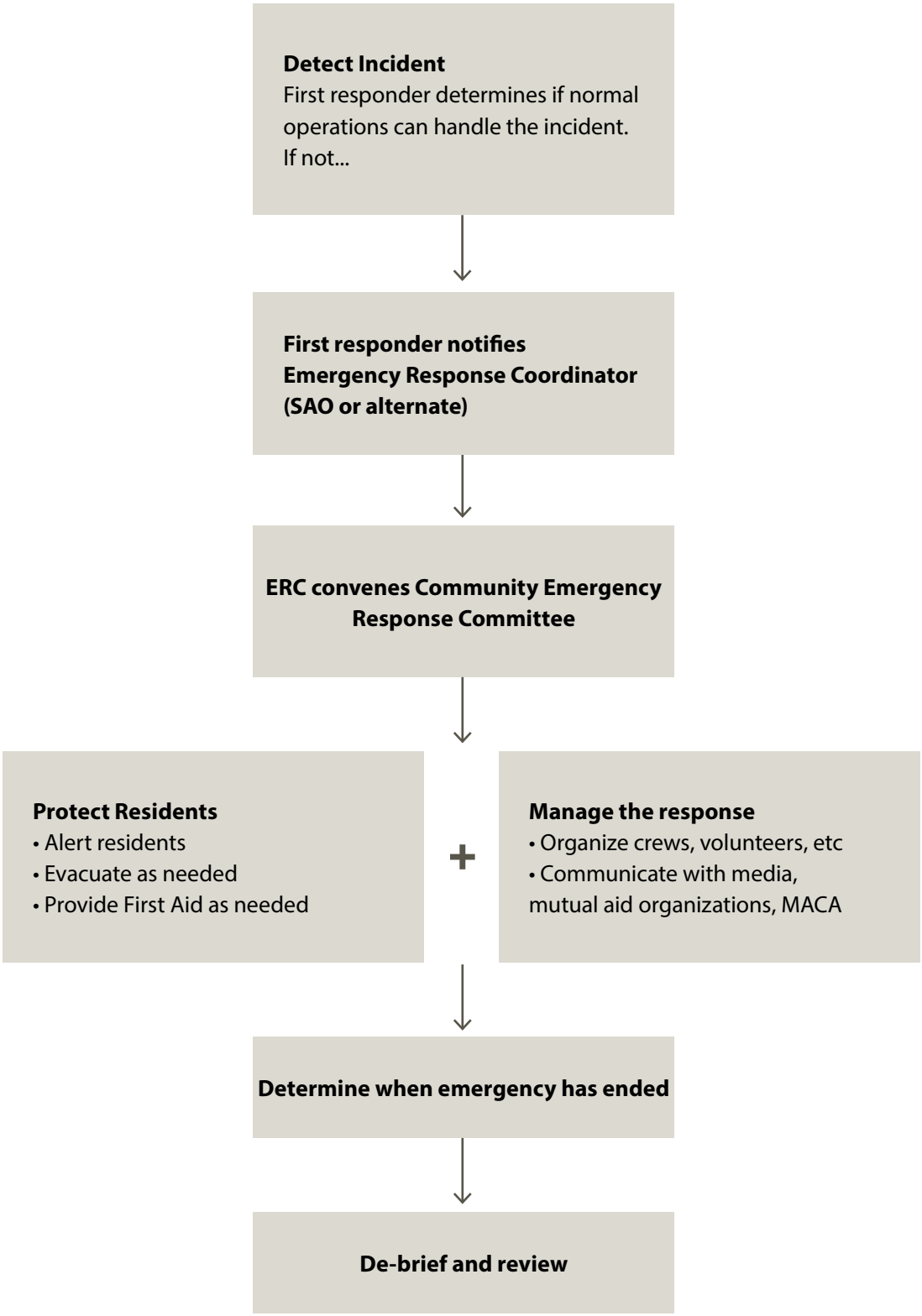
The Emergency Response Coordinator can also assign an *Incident Commander* – a person who coordinates the immediate response to a specific emergency where the emergency is happening.

Who is responsible for what in community emergency planning and incident response.

ROLE	WHO	RESPONSIBILITIES
STRATEGIC LEVEL		
Community Leader	Chief/Mayor or designate	• Declares/cancels State of Emergency • Notifies MACA Minister
Emergency Management Agency	Chief/Mayor and Council, CERC members	• Ensures that community has an Emergency Response Plan, a Coordinator, and a Committee
PLANNING AND IMPLEMENTATION		
Emergency Response Coordinator (ERC)	SAO or alternate	• Chairs the CERC; implements Emergency Response Plan • Recommends declaration/cancellation of state of emergency • Ensures all personnel and agencies are notified of emergency
Community Emergency Response Committee (CERC)	Community and local organization representatives; GNWT representatives	• Activates Emergency Plan • Assesses situation; determines response • Coordinates resources • Notifies public and agencies; requests mutual aid; liaises with government officials
OPERATIONS		
Incident Commander (IC)	Person designated by ERC	• Site level coordination of emergency response • Communicates with CERC and ERC
Emergency Operations Centre (EOC)	Community Centre, Band Council/City Hall, or other central location	• Location for coordination of emergency response by the CERC

Another term for "who does what" is the *Incident Command System*.

What happens in an emergency? Incident Detection/Emergency Response



Financial resources for emergencies

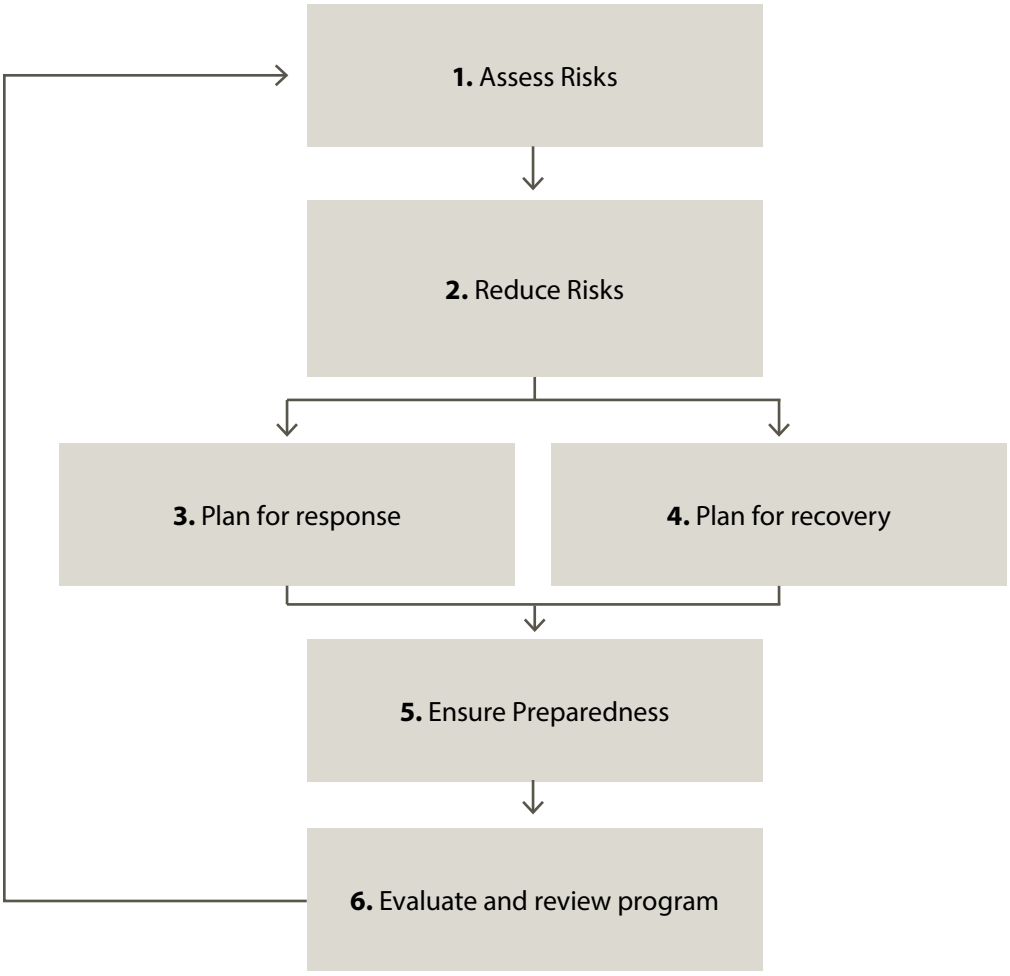
MACA can help communities figure out how to get reimbursement for emergency costs. It is important to coordinate with MACA as soon as possible during an emergency.

Communities could also consider setting aside reserve funds for emergency planning and preparation, possibly with small annual contributions, as MACA and other funding sources may not cover every cost incurred during or after an emergency.

Six steps in emergency planning

Emergency management is about more than dealing with an emergency when it happens. There are six objectives of emergency management, with six steps for holistic emergency management.

Figure 1: Six steps for holistic emergency planning



Step 1: Assess Risks

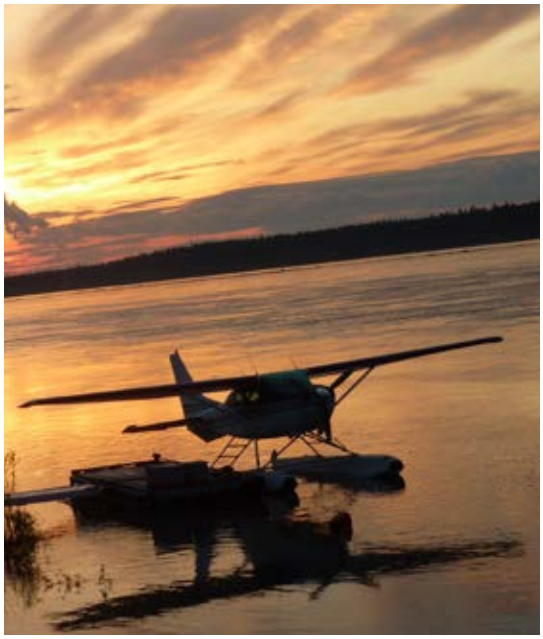
The first step includes thinking through all the risks to the community, and then prioritizing them. This step should include a "Business Impact Analysis" – figuring out how to respond if a critical piece of community infrastructure, like the main generator, stops working.

Climate change should be part of the risk assessment too. New climate extremes mean that some risks like flooding and wildfire might be increasing. Reviewing community Adaptation Plans is a good place to start. Climate change impacts identified at the beginning of the chapter summarizes risks from a number of adaptation plans for NWT communities. ***Include these risks in the "Specific Hazard Management" section of your Emergency Plan.***

> Hazard analysis, also called HIRA (Hazard Identification Risk Analysis), determines:
>
> - What hazard events might occur
> - How often they are likely to occur
> - How vulnerable the community is to the hazard events
> - What protective measures could be taken
>
> ***Additional hazards due to climate change should be incorporated into the hazard analysis.***

Step 2: Mitigate Risks

Step 2 work on preventing emergencies and reducing how bad they are if they do occur. Communities have control over some ways to reduce risks – like not developing buildings and infrastructure in high hazard areas. Other levels of government play a part too, for example, through developing better building codes and standards that communities can adopt.



A quiet evening on the Mackenzie River at Fort Simpson. Photo credit: Teresa Chilcowitchz

MACA's Emergency Plan template provides specific actions to mitigate risks from flooding, wildfire, winter power failure, and disease outbreak. Reducing these risks now also reduces your community's vulnerability to climate change impacts in the future.

Communities can also be involved in public education so that community members can take action to reduce their own risk. A good example is helping community members understand and practice FireSmart behaviour around their houses and businesses.

The end of this chapter provides a checklist of actions that communities can take to reduce their risks from climate change.

Step 3: Plan for response

This is the action part of emergency management. The Emergency Planning Committee makes sure they have taken all the actions in the Emergency Plan checklist on page 9, and are ready to go if something happens.

Because climate change may be increasing landscape hazard risks to communities over time, like flooding and wildfire, the Emergency Response Committee should consider how to deal with more than one emergency at a time (see Scenarios, pg 15).

Step 4: Plan for recovery

This includes the physical restoration of buildings and infrastructure after an emergency. It also includes helping people get re-established, making sure there is counseling in the community, getting financial assistance programs in place, and setting up temporary housing.

> Post-traumatic stress is long-lasting stress in first responders and community members that can persist over a number of years. Counselling and other longer-term resources can help individuals and the community to deal with the long-term human impacts of emergencies.

As the climate changes, communities may deal with emergency situations more often. Recovery is really important, especially if the community can learn and adapt with each emergency, so that risk can be reduced over time and protective measures are put in place.

Driftwood on the shores of Fort Resolution is testament to the power of the water.
Photo credit: Kim Rapati

Step 5: Ensure preparedness

This means getting ready! It means practicing the plan, making sure equipment and other resources are ready to go, and making sure that everyone knows who is in charge in an emergency.

Community members should know:

- Who is in charge during an emergency
- How the emergency is going to be communicated to them
- How to volunteer to help
- Where to go if they need to leave their homes

Step 6: Evaluate and review

The Emergency Response Committee should review the Emergency Plan every year, and validate it every two years to make sure it is up-to-date and still meeting the needs of the community. For example, some of the internal or external contacts might have changed.

> Emergency plans should be reviewed annually, when there is a new SAO, or when the community's Band/Council changes.

The annual review is a good opportunity to review the latest updates on climate change, and make sure that the Plan has properly assessed any increasing or new risks.

Planning for the worst case - using scenarios

Climate change may increase not only the intensity of some events, like floods and wildfire, it may also increase the frequency of events, or how often they happen. Emergency planning should consider what might happen if emergencies happen close together (like a few wildfires in one season or floods several years in a row) or at the same time (like a flood and a power outage). Can the community still respond?

> One of the ways to test whether you are ready is using "scenario" planning. Scenarios are stories about possible futures that let you explore a range of situations and response options.

For example, "what-if" scenarios let you imagine situations in the future, and see how you might respond. What-if scenarios can help you identify gaps in your current thinking or gaps in your current emergency response. Examples could include asking: what if we had a flood, and we were also cut-off from other communities? What if our back-up generator didn't start? What if we already have wildfire evacuees from a nearby community, and now the wildfire is threatening our community? The key is to ensure that your community keep critical infrastructure working and respond to these emergencies.

Scenarios are not meant to scare you! They should help you to think out what you would do under a variety of conditions in the future, including "worst case" situations, so that you are prepared to handle them.

Hazard Identification Risk Assessment (HIRA)

GNWT's department of Municipal and Community Affairs released a hazard identification risk assessment in April of 2014. This assessment provides an examination of the risks that pose the greatest threat to the people, property, environment and economy of the NWT. The complete HIRA includes a main document with an overall assessment for the Territories and five regional summaries as annexes.

This resource provides communities with an excellent overview of the risks they face, and prominently includes climate change as a factor influencing these risks. The regional reports use narratives that illustrate the risks posed by communities using real examples and stories. These assessments provide a clear description of risk, how risk might manifest itself, how climate change might impact the risk, and regional examples of historical emergencies.

Figure 1: 2012 Flooding in Nahanni Butte (Source: GNWT, MACA)

Definition	**Class**
An overflow or surge of water which causes or threatens loss of life and property and environmental damage	Natural Hazard
NWT greatest impacts to date 1800 Evacuated Estimated Total Cost $3,500,000	
Climate Change Projected to increase both frequency and consequence	

Mitigation Strategies	✓ Outline a water management and community development policy. ✓ Develop and exercise plans/programs for: ○ watershed management; ○ river/lake/ocean modeling/prediction and monitoring; ○ erosion control; and ○ flood response. ✓ In the face of rapid snowmelt and intense rains in spring and summer, communities susceptible to flash flooding should review and improve their drainage facilities and protect vulnerable buildings and facilities.

Vulnerability	**Description**
People	Evacuation of communities due to flood events is common. Deaths and injury due to flooding can occur during heavy rainstorm events which can interfere with evacuation attempts. Deaths in the NWT due to flooding are rare.
Infrastructure	Personal property damage can be extensive. Contamination by floodwaters, structural damage, and mold can destroy buildings. Roads can be damaged or washed away. Damage to infrastructure can be extensive. Flooding can also negatively affect utilities and critical infrastructure. Utilities such as wastewater treatment, electricity and gas may be disrupted in the event of a flood. Emergency ground vehicles may be unable to respond if roads and bridges are flooded, washed out or covered by debris.
Communications	Communication towers can be damaged by flooding events.

Credit: MACA, Deh Cho Hazard identification risk assessment. 2014

Social networks and emergency response

Communities also have informal response networks, like large extended families or a group of neighbours who pitch in and help each other out. These informal networks can be a really important part of an emergency response, especially if they are tied in to the Emergency Response Committee so the effort is coordinated. Having people signed up in advance as volunteers is one way of tapping into these networks (MACA's guide has a volunteer sign-up template).

Vulnerability is reduced when a community can adapt to change and cope with stressors. Social networks like getting to know neighbours, being part of church groups, being active in local organizations, or bingo nights, build social connections that help a community respond in an emergency. Informal networks add to, but should not replace, a coordinated, practiced emergency response plan.

Other ways to be prepared

Individuals can help with emergency planning too, by reducing risks and being prepared. FireSmart and flood-proofing homes are two ways home-owners can prepare.

Emergency plans can identify clear roles, responsibilities and resources in advance of an incident. Photo credit: Craig Scott

Reducing your community's risk from climate change

Reducing the impact of climate-related emergencies is part of Step 2 in emergency planning.

In some cases, climate change may increase existing risks that are already in the community. For example, the wildfire season may get longer and the severity of wildfires may increase. In these cases, communities already have many tools to reduce their risk, such as Community Wildfire Protection Plans. Following these plans, and updating them regularly, can help to keep the risk of wildfire low in the community, even as the climate changes.

MACA's template includes a table of "Hazard Specific Plans" in Appendix D. Many communities in the NWT have adaptation plans which lay out actions to reduce the risk from climate change. The following checklists of additional recommendations that may be relevant to your community are drawn from these adaptation plans.

Reducing community risk from climate change

Reduce wildfire risk

- ❑ Maintain firebreaks around the community (with ENR), as identified by your community's Community Wildfire Protection Plan (CWPP)
- ❑ Reduce fuel loads in the forests around the community, especially those in the path of the dominant summer and fall winds, as identified in your CWPP
- ❑ Increase FireSmart awareness and education (Wekweeti Adaptation Plan)
- ❑ Follow the additional recommendations in your community's Wildfire Protection Plan
- ❑ Update your CWPP regularly
- ❑ Share locations of land camps and important cultural locations so they can also be protected (Wekweeti Adaptation Plan)

Reduce flood risk

- ❑ Ensure you have a floodplain or flood risk regulation in your Community Plan that regulates development within your floodplain: new developments should be outside of designated risk areas, including flood risk areas projected for the future with climate change
- ❑ Homes in existing flood risk areas should be flood-proofed (eg. built using construction standards for flood risk areas)
- ❑ In the long-term, consider moving infrastructure out of at-risk areas. This is called "managed retreat."
- ❑ Update your floodplain zone to account for the potential increase in flood waters due to climate change; review existing flood plan and identify where it needs to be strengthened (Aklavik Adaptation Plan)

Reducing community risk from climate change

Reduce climate-related risks associated with traveling on the land

- ❑ Provide access to safety equipment for harvesters (spots, satellite phones, life jackets, beacons, radios) (Fort McPherson and Ulukhuktok Adaptation Plans)
- ❑ Have a website and dedicated radio time to promote safety and knowledge, and also provides updates on current/predicted conditions (Fort McPherson Adaptation Plan). The Northern Search and Rescue website provides safe travel plan guides: http://www.northernsar.ca/en/safe_travel_plans.htm.
- ❑ Establish more emergency camps out on the land (Fort McPherson Adaptation Plan)
- ❑ Review and update Search and Rescue measures (Ulakhuktok Adaptation Plan)
- ❑ Offer workshops on forecasting, mapping, GPS, sea ice reading, tracking, satellite phones (Ulakhuktok Adaptation Plan)
- ❑ Mark dangerous spots on the land (Ulakhuktok Adaptation Plan)
- ❑ Increase capacity to treat accidental injuries locally (Ulakhuktok Adaptation Plan); provide wilderness first aid training in communities

Reducing community risk from climate change

Reduce vulnerability to transportation disruptions

- ❑ Local food harvesting, processing and storage ensures that the community still has a food supply even if it is cut off (several Adaptation Plans)
- ❑ Ensure proper drainage along roads and manage snow build-up and snow removal (including where the snow gets put) to reduce run-off problems in the spring (Wekweéti Adaptation Plan)

Reduce the impact of power outages

Power outages may be due to extreme weather, wildfire, flooding, or other emergencies.

- ❑ Make sure that you have a back-up generator and communications equipment for the designated Emergency Operations Centre
- ❑ Have power generation back-up for all critical infrastructure, including community evacuation centres, power generating stations, telecommunications, water treatment plants, sewage lift stations, and any mechanical sewage treatment plants (MACA Emergency Plan template)

Emergency Plan Checklist

Having an Emergency Plan means your community has:

- ❑ Set up a Community Emergency Response Committee
- ❑ Designated an Emergency Response Coordinator, usually the SAO (with a replacement coordinator in case the SAO is not available)
- ❑ Identified who is vulnerable in the community and who might need special help during an emergency (for example, elders)
- ❑ Designated an Emergency Operations Centre (for example, City Hall, Band Council offices, Fire Hall) – this is where the emergency response will be coordinated from
- ❑ Designated emergency shelters – the place for community members to go in an emergency - like the community centre, the school, or the health centre centre
- ❑ Determined when and how to issue warnings, and how to evacuate the community
- ❑ Determined the available human and material resources in the community to help with an emergency, like people with special knowledge or skills, useful construction materials, or facilities such as houses with wood stoves
- ❑ Assessed possible hazards, and explored "what if" scenarios to prioritize preparations and identify critical infrastructure and back-up systems (for example, is there a backup generator if the main generator fails?)

Acronyms

BIA **B**usiness **I**mpact **A**nalysis: a process to look at critical infrastructure and make sure that key services can still be provided during an emergency, like having functional back-up generators

CERC **C**ommunity **E**mergency **R**esponse **C**ommittee: a group of representatives from community organizations that are responsible for emergency planning in the community. The CERC provides oversight and direction to respond to an emergency and is sometimes referred to as the Emergency Management Committee.

CWPP **C**ommunity **W**ildfire **P**rotection **P**lan

EMA **E**mergency **M**anagement **A**gency: Mayor/Chief and Council members; may also have CERC representation

ENR **E**nvironment and **N**atural **R**esources, GNWT Department

ERC **E**mergency **R**esponse **C**oordinator: chairs the CERC, makes sure the emergency plan has been prepared and updated annually; coordinates emergency responses; usually the SAO

IC **I**ncident **C**ommander: the person in charge of dealing with an emergency on-site, designated by the ERC

SAO **S**enior **A**dministrative **O**fficer

EOC **E**mergency **O**perations **C**entre: where the CERC works during an emergency.

HIRA **H**azard **I**dentification **R**isk Analysis: a process to identify potential hazards that could lead to emergencies in the community, and how to respond to them. A HIRA helps the CERC prepare for a variety of possible emergencies, and prioritize protective action.

MACA **M**unicipal and **C**ommunity **A**ffairs, GNWT Department: supports communities in their emergency response, including with financial paperwork

Resources

MACA: Family Emergency Brochure

This fun plain language brochure is an accessible and helpful resource for community members.

- http://www.maca.gov.nt.ca/wp-content/uploads/2011/09/MACA-family-emergency-brochure.pdf

MACA: Community Emergency Plan Instruction Manual

This four page document highlights the steps involved in developing a community emergency plan. There is also a template that communities can download which makes the process easier still.

- http://www.maca.gov.nt.ca/wp-content/uploads/2012/05/MACA_Public-Safety_Community-Emergency-Plan-Instruction-Manual_2008.pdf

MACA: Community Energy Management Video

This video is split into 9 parts. It highlights emergency planning with an NWT focus. With good camera work, and clear messaging these videos are effective at explaining emergency planning for community staff or residents.

- http://www.maca.gov.nt.ca/home/for-community-governments/safety-emergencies/developing-a-community-emergency-plan/#!prettyPhoto

ENR Forest Management Division: NWT Fire website

This site has wildland fire maps, values at risk (cabins, and important community and heritage areas to be protected in event of a fire). It also has fire prevention information, and the FireSmart program information.

- http://www.nwtfire.com/cms/

ENR Forest Management Division: Community Wildfire Protection Plans (CWPP)

Every community in the NWT has a CWPP. Communities should be aware of this plan and revisit it before the fire season is upon them.

- http://www.nwtfire.com/cms/cwpp

ENR Forest Management Division: NWT Homeowner's FireSmart Manual

This guide is focused on homeowners but is relevant to all buildings in communities, and even the areas around communities. By practicing preventative maintenance communities can avoid significant risk (and worry) during bad forest fire years.

- http://www.nwtfire.com/cms/sites/default/files/5th_Edition_FireSmart_Homeowner%27s_Manual_2012_WEB.pdf

Government of Canada: Floods; what to do?

This brochure provides basic information that homeowners should know about flooding and their homes.

- http://www.maca.gov.nt.ca/wp-content/uploads/2011/09/flds-wtd-eng1.pdf

MACA: Hazard Identification Risk Assessment (HIRA)

This document and the five regional summaries are an extremely useful tool for communities to identify risk factors facing their communities. The assessment uses real examples that provide an effective narrative that highlights the risks each community faces and even some recommendations to tackle these risks. A must read for Community Government decision makers.

- http://www.maca.gov.nt.ca/hira/

Endnotes

1 Municipal and Community Affairs, GNWT. Hazard Identification Risk Assessment. 2014.

Strategic Planning

In This Chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

Within the new Gas Tax Agreement the Government has removed the requirement to complete Integrated Community Sustainability Plans (ICSPs). Although MACA still encourages community governments to develop the implement the following plans, only the Capital Investment Plan is with a requirement under the Community Public Infrastructure Funding Policy:

1. Community Strategic Plan: Planning for long term priorities of the community
2. Capital Investment Plan: Preparation of a multi-year capital investment plan
3. Community Energy Plan: Taking stock of existing energy consumption and developing a plan to reduce energy and improve efficiency
4. Human Resource Plan: Planning to make manage and promote human resources and build capacity.[1]

What is a Strategic Plan?

The Strategic plan is a short, high-level plan outlining the direction the community intends to follow and the goals the community hopes to meet. The Strategic Plan has elements which may be similar to sections of a Community or General Plan. In particular, the vision and goals may be consistent or even identical in each of these plans; the vision and goals from one can inform updates of the other.

When renewing either the Strategic or Community Plan, it is important to think about how climate change may impact the community and incorporate those changes in that plan, as shown in the Community Planning chapter.

The Strategic Plan typically has the following elements:

- A Vision Statement
- Goals and Objectives
- Actions or Policies

Developing a Strategic Plan generally involves considerable community consultation to develop a vision or mission statement, goals and objectives and the actions to achieve those goals. MACA defines the process as:

> *"A Strategic Plan outlines the values of communities and sets out a road map to where the community plans on going in the future and what it wants to achieve in the long run.*
>
> *The planning process is about taking a clear look at your community's situation, problems and solutions, and figuring out a series of actions to reach priority goals. Strategic planning focuses on developing a broad vision and specific goals, strategies and actions that will have the most impact.*
>
> *But Strategic Planning in the community context is not an exercise for someone sitting at a desk. Successful strategic plans are effective only when residents and organizations have an opportunity to contribute. Therefore, successful strategic planning is a collaborative process that draws partners and stakeholders together to create and work towards a community integrated approach.*
>
> *Integrated approaches are used to drive the development of community priorities and specific actions needed to turn the vision into reality."*[1]

New section

Mainstreaming Climate Change Adaptation into the Strategic Plan

Incorporating climate change into the planning process will be key to ensuring future community resilience. Understanding and referencing the impacts of climate change and thinking about how those impacts should be included the community's planning processes in the future will be essential to adapting effectively in a rapidly changing climate.

Below are several examples of communities that are mainstreaming climate change into their planning processes.

The Town of Inuvik in the rapidly changing Beaufort Delta is a good example of a community that mainstreams climate change in its Strategic Plan, including a reference to climate change right in its vision statement.

> *Inuvik is a healthy, welcoming and culturally proud community that works, shares, and enjoys life: - caring for friends, families and visitors, while strivingto live in harmony with nature.*
>
> *As a barometer of climate change, Inuvik is a looking glass for the rest of the world and as such we will endeavor to be a leading example of sustainable innovation."*[2]

The Community of Ulukhaktok has a detailed and lengthy vision statement that includes climate change.

Ulukhaktok seeks ways to enhance and promote our environment and energy conservation techniques as well as understanding climate change.

One way that experts recommend thinking about these important vision statements and goals is to think about building community resilience in the face of change. Working with the community of Whati, the Conference Board of Canada recommends four guiding principles to developing local resilience. Plans should be:

- Inclusive and simple using a "whole of community" approach
- Flexible and adaptive
- Comprehensive and able to establish a broad-based context
- Iterative and able to facilitate continual improvement[3]

Strategic Planning Checklist

- ❑ Our Strategic Plan has a Vision statement that includes adaptation in community planning or enhancing community resilience
- ❑ Our Strategic Plan has been prepared by a consultant or community staff who understands climate change and the implications of climate change on our community
- ❑ Our Strategic Plan has Goals, Objectives, Actions that take into account climate change adaptation when relevant
- ❑ Our Strategic Plan uses the concept of a resilient community when developing vision statements and goals

Resources

NWTAC: Integrated Community Sustainability Planning Toolkit:
Although the Integrated Community Sustainability Plan is no longer a requirement on communities, the ICSP Toolkit is still a valuable tool for communities. It is available upon request from NWTAC. This toolkit outlines the process communities should follow to develop a Strategic Plan as one component of the ICSP.

- Please contact sara@nwtac.com if you would like a copy of the ICSP Toolkit

Endnotes

1 MACA website. www.maca.gov.nt.ca/home/for-community-governments/community-government-toolkit/integrated-community-sustainability-planning/ Accessed May 1, 2014.

2 Inuvik website: www.nwtac.com/icsp/strategy/ accessed May 1, 2014.

3 Building Community Resilience in Whati, Northwest Territories. The Conference Board of Canada. Briefing March 2014.

Financial planning: asset management and capital plans

In This Chapter

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> "Infrastructure challenges are more than a daily inconvenience; they pose real risks to the future prosperity of our communities, and to the entire country."
>
> Former Federal Finance Minister Jim Flaherty

Introduction

Communities in the Northwest Territories own and operate many assets, from equipment to infrastructure such as vehicles, roads, arenas and landfills. These assets provide services to the community and are expected to function for many years. They cost a great deal to purchase or build.

This chapter is about financial management of community assets. We are going to deal with two related types of financial management: capital plans and asset management. Climate change affects community infrastructure and assets and therefore needs to be included in both asset management and capital plans.

Asset management looks at the long-term requirements for existing and planned infrastructure, such as how to maintain infrastructure to extend its life, and how and when to replace it when needed. Asset management includes both capital costs and operations and maintenance costs. Ideally, an asset management plan supports capital planning.

Capital planning operates in a shorter time frame, generally working within 1 and 5 year time lines (1 year plan is detailed, 5 year plan is more general). When capital planning it is important to lensure that the communities strategic plans as well as other community plans are considered to ensure that all community plans complement one another.

Communities use capital plans to decide what needs to be purchased or replaced and how much it will cost in the shorter-term, while asset management looks at existing infrastructure and plans for maintenance and eventual replacement over the longer-term.

Capital assets vs operations & maintenance

Capital assets are tangible items with a single up-front or capital cost including:

- land
- infrastructure
- buildings and their contents
- equipment
- vehicles
- computer hardware and software

Operations and maintenance (O&M) costs are on-going costs needed to run or maintain the capital equipment. O&M costs include:

- Salaries
- Fuel or energy costs for buildings or equipment
- Preventative maintenance and repair costs

Although O&M costs are paid for from a different budget than capital costs, the O&M implications of capital purchases have to be considered because they affect the annual operating budget. For instance, if a community is going to prioritize the purchase of an additional garage for Public Works, the costs of heating and utilities for that building (say $40,000 per year) will be paid out of the O&M budget, reducing the community's annual budget by $40,000 a year.

Mainstreaming climate change considerations into community financial management plans is a very important way to ensure that climate change is being incorporated into municipal functions. It is becoming increasingly obvious just how expensive climate change adaptation already is and is going to be for community governments. Mapping out projected costs over time will help your community plan for the capital costs internally, and keep operations and maintenance budgets in line. Financial planning will also help to build a case for receiving additional support through funding

Climate change adaptations like these thermosyphons are expensive and may need to be considered in capital plans Photo credit: Craig Scott

applications.

Asset management and capital planning begin with three primary questions: "**What do we have**," **"What do we need?"** and **"Why do we need it?"** These questions then lead to related questions:

- How long will our equipment and facilities last?
- How can we best maintain our equipment and infrastructure, and can we extend their expected life?
- What upgrades will be needed and when will they be needed?
- Where will we find the money?
- Which need is most important to the community and why is it important?
- How can we best schedule specific projects?

Climate change impacts could shorten the lifespan of infrastructure in your community, or impact asset performance — your community may need to plan for increased maintenance budgets or large capital outlays sooner.

Climate change, asset management and capital planning

> The more extreme weather associated with climate change, along with other climate change impacts, can cause infrastructure to age more quickly or to sustain greater damage than anticipated. This chapter shows you how to include these impacts in your capital plans and asset management so that your financial planning is climate-wise.

The changing climate could affect financial planning in three ways:

1. Climate change impacts may mean that the community must spend more on capital or O&M costs than they otherwise would have expected.
   For example, many communities that never required drainage plans are finding that flooding and pooling of water are becoming serious issues and drainage infrastructure is now required.

2. Planning for climate change impacts may change (and most likely increase) the initial capital cost of a project.

   For example, permafrost degradation is increasing the cost of building foundations. Adaptive action such as using deeper pilings or thermosyphons increases the capital cost of buildings. However, these higher upfront capital costs should save resources over the longer-term due to reduced maintenance.

3. Adopting a climate change lens may change (generally shorten) the life expectancy that is considered for capital items in asset management plans.

   For example, permafrost degradation can shorten the life of buildings (such as garages with a slab-on-grade foundation) by years and in some cases decades, so that they have to be replaced sooner.

A number of climate change impacts identified in community adaptation plans have financial planning implications; examples are shown in the table below.

Financial implications of some climate impacts.

POTENTIAL IMPACT	ANTICIPATED ACTIONS	O&M COST IMPLICATION	CAPITAL COST IMPLICATION
Sea level rise, shoreline erosion and storms put buildings at risk	1. Move buildings	No	Yes, high
	2. Install erosion control	Yes	Yes, if need to purchase additional equipment or material cost
Forest Fires pose risk to community buildings	1. Practice Firesmart	Yes, staffing and fuel and maintenance for equipment	Yes, if need to purchase additional equipment
	2. Do nothing	No	Yes, potentially high replacement costs
Permafrost degradation threatens Hamlet owned building	1. Level building annually	Yes, staff time	No
	2. Foundation and structural repairs	Yes, costly repairs	Yes, costly repairs
	3. Replace building	No	Yes, potentially very high replacement costs
Wastewater infrastructure, e.g. sewage lagoons	1. Add reinforcing berms	Yes	May require new equipment and/or materials (ie. granular materials)
	2. Re-clearing swales for drainage	Yes	May require new equipment

What is capital planning?

> Capital planning is the process of looking ahead to determine what a community's costs are going to be within a specified time period, usually 1 year (a capital budget) and 5 years.

Knowing what costs are likely to arise down the road will help a community to prioritize and ensure that basic needs are met in a timely way. Since capital purchases for municipal governments can be extremely costly, saving or fundraising initiatives may be needed to meet the cost. This requires careful planning, often over years.

Capital planning Process

The steps of the process are laid out by MACA and are generally well understood.

Steps three and four below are very similar to asset management. Capital plans provide more detail on how to provide new assets or replace existing assets at end of life, through nine additional steps.

1. Identify services "What services does your community provide its residents?"
2. Identify community needs
3. Identify community capital assets
4. Evaluate useful life of existing infrastructure
5. Determine minimum community requirements
6. Ensure compatibility of new assets with planned projects and existing infrastructure
7. Develop capital cost estimates including O&M values (net of inflation)
8. Prepare preliminary first cut capital plans (1 year, 5 year)

9. Determine the impact of proposed program requirements on existing infrastructure
10. Identify funding sources
11. Prioritize projects
12. Approve plan tentatively
13. Review and monitor plan and revise and update as needed[2]

What is asset management planning?

> Asset management planning is the process of collecting information on the infrastructure in your community and using that information to develop plans for maintaining, repairing and replacing that infrastructure in coming years.

Communities need to deal with aging infrastructure, which can be expensive to maintain and extremely expensive to replace. Planning now for the long term maintenance of infrastructure with the goal of extending the life of infrastructure and delaying the eventual replacement of that infrastructure will save money in the long-run and avoid future financial crises.

Asset management planning also helps communities think about the longer term operational and maintenance impacts from purchase decisions they are making today. For example, purchasing a fleet of trucks locks the community into ongoing maintenance and operational costs (e.g. mechanical, gas, insurance, etc). Before purchasing, the full capital, operating and maintenance (O&M) and replacement costs should be considered.

> Asset management plans support making the best possible decisions around building, operating, maintaining, and replacing the infrastructure in your community.

Asset management planning is important because

- Infrastructure ages and needs to be replaced – **and climate change may increase the costs of maintaining and replacing community infrastructure**.
- It helps with better resource allocation decisions: it may be too expensive to replace all of a community's infrastructure at one time, or very expensive even to keep it working, so you may need to decide where and when to spend limited funds.
- Asset management helps to maximize the useful life of an asset by ensuring that investments are made at the right time and at the right cost.
- It is a proactive way of dealing with infrastructure investments, both O&M and Capital, to minimize problems and potential crises.
- It helps a community government provide better and more consistent service to citizens, at reduced cost.
- **Climate change could shorten your infrastructure's lifespan or impact its performance, and it is important to plan for large capital outlays.**

> Climate change is going to cost communities money – money rebuilding foundations, servicing roads more frequently, and dealing with more extreme weather events. Having an asset management plan helps your community be financially prepared to maintain and replace infrastructure.

Step by Step guide to asset management

The following six steps will help to understand the basics of asset management planning and to include climate change impacts and adaptation process. The asset management basics are based on the Federation of Canadian Municipalities' National Guide to Sustainable Municipal Infrastructure or Infraguide (see the resources section at the end).

The steps to developing an asset management plan can also be described using six questions, as shown below. Climate change questions should be added too.

While asset management planning may seem like a big job, many of the steps may already be part of your municipal operations and your capital planning.

STEP	KEY QUESTION
Inventory	1. What do you have and where is it? *Will climate change require you to change or add infrastructure?*
Valuation	2. What is it worth?
Consequence of Failure	3. What is its condition? *How might climate change impact asset conditions and lifespans? Will climate change impact the consequences of failure?*
Service Level	4. What is the expected level of service? *How will climate change affect expected service levels?*
Construct/maintain/ replace	5. What do you need to do to build, maintain or replace an asset? *Will you need additional maintenance to adapt to climate impacts?*
Financial plan	6. How much will it cost to maintain or purchase and how will you fund it?

Step 1: What do you have and where is it?

The first step includes developing an inventory of your community assets, through data collection and compilation. List out all categories of things that are owned by the community.

What is an infrastructure asset? Think about different types:

- Buildings (offices, recreation center, warehouse, shop, etc)
- Above ground (roads, bridges, landfills, etc)
- Underground (water pipes, sewer pipes, storm drains, culverts, etc)
- Equipment that moves (trucks, cars, buses, forklift, etc)
- Stationary equipment (pumps, compressor, etc)

For each asset, provide as many of the following details as possible:

- Asset type (e.g. road, building, vehicle, etc)
- Location (How can the asset be specifically identified?)
- Quantity and size (e.g for pipes include the length and diameter, tanks include volume, roads include the area and approximate depth of each layer)
- Material (what it is made out of?)
- Useful life (the full expected lifespan of an asset)
- Install date or age
- Remaining life (expected lifespan minus current age, with condition and deterioration rate considered if possible)
- Consider the impacts of climate change on that asset: is there a chance that climate change may impact the life of the asset?

For example, an inventory of roads would ideally include specified location, total length, width, material, year of construction, a list of maintenance conducted to date with associated dates and expected reconstruction date. You could also include new requirements for drainage or erosion control related to climate change.

Some of this data may already be tracked in your maintenance records or other financial planning. The level of detail for your inventory will depend on the information that is available and the complexity of the asset. More expensive assets generally should have more detailed data collection.

Start with most expensive or complex assets. You can add to your asset inventory over time.

> **Asset components**
> It is best to separate assets into components or parts in the inventory if they can be replaced independently from other parts and the parts have a different lifespan (e.g. some parts are likely to be replaced more or less often than other parts).
> For example, a road can be separated into the foundation, basecourse and top surface. The three layers will likely require replacement at different times and have different maintenance schedules as well.

Step 2: What is it worth?

Understanding an asset's value supports good decision-making and financial planning about the operation, maintenance and eventual replacement of that asset.

Place a value on each asset, or asset component, in your inventory. Ideally, this value is the current replacement cost for the asset – how much it would cost to fully replace that asset today (including material, labor, engineering, construction and administration).

Ensure that replacement costs are specific to northern conditions. You may need to contact contractors to get replacement cost estimates for parts of your inventory.

Initially, average unit replacement costs can be used for groups of assets. Plan to improve the quality of cost data over time.

Step 3: What is its condition and what is the risk of failure?

This is where climate impacts are really critical to consider.

The condition of an asset is determined by comparing its current state to that of a brand new one. In a general sense, the condition can be estimated from the asset's age and ideally any repair and maintenance history.

Climate conditions could increase wear and tear. Monitoring maintenance trends may help identify infrastructure that is being affected by changing conditions.

NWTAC organizes through Northern Communities Insurance Program (Norcix) appraisal for buildings in all non-designated authority communities every five years. These appraisals lead to funding reports that identify the useful life, O&M and capital upgrade options on each building. These funding reports provide a valuable tool for communities to identify needs.

For non designated authority communities, or for non-building infrastructure the community is responsible for appraisals and assessments. Assessments may be possible through visual inspections but more expensive and complex assets may require professional help. NWTAC can help identify help for these assessments.

Tracking asset condition or deterioration rates over time lets you predict optimal maintenance activities and future budget requirements.

Deteriorating condition of an asset might lead to a failure. You can assess the risk of an asset failing by asking:

1. How likely is the asset to fail in a specified time period (e.g. 1 year, 5 years, 10 years)?
2. What is the consequence of that failure (e.g. service disruption, safety issue)?
3. Will climate change impact the risk of failure, by increasing either the likelihood of failure, or the consequences of failure? For example, increased snow loads could increase the likelihood of structural failures in buildings.

Getting a sense of the failure risk of key assets supports prioritization of maintenance and replacement activities. Prioritize upgrades or replacement of those assets that are most likely to fail and with the highest potential consequences from failure.

Step 4: How will you operate it? (What is the expected level of service?)

The level of service from an asset is what that asset provides; when, where and to whom. For example, a municipal water distribution system might be expected to provide clean water to all buildings in the community on a year round basis. Many assets can be maintained or operated at different levels, which will usually have an impact on the level of service that asset provides.

Climate change can impact how you will operate an asset. For example, in the case of drinking water treatment systems, increased turbidity (particles in the water) caused by severe weather or increased erosion can impact water quality and the cost of providing water services.

Generally, higher levels of service increase the life cycle cost of that asset. It is important to understand the expected level of service, and the full cost of providing that level of service.

Example: A rural gravel road could be maintained at various levels of service. At current level of service, it is graded once per month.

Grading every two weeks would be an increased level of service, likely resulting in a smoother road surface and possibly a safer road, but this comes with an increased cost.

Decreasing the level of service might mean grading every six weeks, at a decreased cost, but this low level of service might begin to seriously degrade the road surface.

Step 5: What do we need to do?

What you need to do for each asset might range from minor regularly scheduled maintenance activities, to one-time overhauls, to full replacements. Minor maintenance activities are likely already included in your annual budgets.

Major maintenance activities or overhauls can extend the service life of an asset. These might include repairing water mains, replacing pumps or motors, or resurfacing roads.

At the end of life, replacement of an asset may be required. This is usually the most expensive option. Examples include the complete reconstruction of a road or replacement of an entire water distribution system. Asset management planning will help you appropriately plan for these major upgrades and replacements so that you have funding options or sources available.

Use the information from Steps 1 to 4 (particularly condition, failure risk, and level of service) to **develop a maintenance and/or replacement plan for each asset**. Prioritize plans for your most expensive, oldest and highest risk assets.

Many assets (such as buildings, roads, sewer and water systems) will likely have a number of maintenance or replacement options (e.g. preventative maintenance, new technology) with varying costs and service impacts. Over time you can improve your asset planning by considering more of these options.

Dempster Highway Photo credit: Craig Scott

Step 6: How much will it cost and how to fund it?

Estimate costs for the maintenance or replacement plans (step 5) for each asset. This will likely require requesting cost estimates from contractors, especially for the bigger items. Include this cost data in your capital and operating plans.

If you are planning for a capital cost over a longer time period, including an estimated inflation rate of 3.5 % per year will help you to plan for the fact that things may inevitably be more expensive, once the day comes to actually make the purchase. Inflation basically means that over time, we can usually purchase a little less for the same amount of money.

Since asset management predicts the cost and timing of future infrastructure spending, it allows you to extend your financial planning from annual cycles to longer timeframes (for example, 5-20 years). This longer term planning can protect communities from the financial shock of asset failures, replacements or unplanned maintenance activities.

> An asset management plan makes it much easier to write grant or funding applications, demonstrate financial need and demonstrate that sound decision-making has led to the need to replace certain assets.

The foreman explains annual maintenance work needed to maintain berms at the wastewater lagoon, Trout Lake Photo credit: Christine Wenman

Some communities have future capital investment funds (sometimes referred to as reserves) that they build up over time either through a savings plan or by generating revenue from the infrastructure itself. For instance, if landfills are gated and managed with tipping fees, some costs (although minimal) can be recuperated as revenues paid by those who bring items to the landfill or by shipping valuable items like used batteries or scrapped metals to companies that will pay to recycle them.

Cooperating with other communities on a regional basis can also sometimes bring down a project's capital costs.

Is our asset management working?

Implementing an asset management plan should reduce unplanned expenditures on repairs and replacement.

Tracking unplanned spending on an annual basis can confirm that your asset management plan is effective, **and help to identify emerging climate impacts that you need to take into account in your asset management plan**.

Preventative road work may save costs down the road. Photo credit: Ecology North

Examples of efficiencies found by regional cooperation:

Bulk tender for drinking water plants – Municipal and Community Affairs

Excerpt from Northern News article: ***Drinking straight from the tap*** by Roxanna Thompson (Thursday, December 8, 2011)

New water treatment plant improves water quality in Jean Marie River

A new facility has Jean Marie River residents drinking the community's tap water instead of buying bottled water.

Jean Marie River's new water treatment plant started operations in October. Designed and built by Corix Water Systems of Vancouver, the plant arrived mostly constructed inside a 18 by five metre trailer.

"People are proud of this plant," said water treatment plant operator Gerald Grossetete. "They've been waiting a long time for this," he said.

[Municipal and Community Affairs] used $8 million from the federal government's Building Canada Plan to contract the installation of new treatment plants in five communities, including Jean Marie River, Trout Lake, Wrigley, Lutsel K'e and Fort Good Hope.

The five plants from Corix Water Systems are primarily the same. Each was based on the treatment and filtration requirements for the specific community, Young said.

This is the second time the department has used a bundled contract approach for purchasing water treatment plants. The department earlier assisted Deline, Ulukhaktok, Aklavik, Edzo and Tuktoyaktuk to install plants, completed in March 2010.

"The communities have been happy with the approach," Young said.

The bundled approach is more cost effective than individual tenders and because the plants are similar in design there is an opportunity for training between the communities, Young added.

Checklist: Financial planning

- ❑ We have an inventory of community infrastructure and assets, including
  - ❑ Buildings and facilities
  - ❑ Transportation infrastructure
  - ❑ Water (drinking, storm) and sewer infrastructure
  - ❑ Solid waste infrastructure (e.g. landfills)
  - ❑ Equipment and vehicles
- ❑ For each asset, we can answer the following questions
  - ❑ What is the age of the asset/component?
  - ❑ What is its expected remaining service life? (depending on maintenance levels)
    - How could climate change (e.g. extreme weather, increased snow loads, increased freeze-thaw cycles, permafrost degradation, changes to fire season, etc) affect the condition and remaining service life of the asset
  - ❑ What level of service is expected from this asset?
  - ❑ How might climate change affect the service level provided by the asset?
  - ❑ What is the full cost (operations, maintenance, early or later replacement, etc) of providing that level of service?
  - ❑ Do we need to prioritize the levels of service required from our assets?
  - ❑ How might climate change impacts affect service levels? Will we need increased servicing in the near, medium or long-term future?
  - ❑ Have we assessed the risk (probability of failure and consequence of failure) for each community asset, including climate change impacts?
- ❑ We are tracking our annual maintenance for increases in unplanned repair and replacement expenses to make sure our asset management is working and identify climate trends that might be affecting community infrastructure.

Checklist: Implementation

- ❑ Have you cross-referenced the expected impacts of climate change against your asset management inventory?
- ❑ Have you identified cost estimates of climate change impacts?

- ❑ **People**: Are the right people involved in this project? Large capital projects usually require a clear lead or champion who can see it through from start to finish.
- ❑ **Information:** Is the needed information available? For instance,
  - ❑ Have all components of a structure been considered in an asset management plan?
  - ❑ Are replacement costs known?

- ❑ **Information Technology** Is the information in your capital plan and asset management plan laid out in a database that your senior staff know how to use?
  - ❑ Is someone responsible for updating it once new budgets are made and more accurate cost estimates become available?
  - ❑ Do you have a plan to review new climate change information and incorporate it into your asset management plan in a systematic way?

Resources

Federation of Canadian Municipalities (FCM): Infraguide

This series of videos and supporting documents provide some valuable advice for communities doing financial planning.

- http://www.fcm.ca/home/programs/past-programs/infraguide/e-learning-tools.htm

B.C. Asset Management Road Map

Several communities in British Columbia worked together to come up with a simple asset management process.

- http://www.assetmanagementbc.ca/home.asp

The Tk'emlúps te secwépemc asset management

This 4 page case study is a good example of how to explain what asset management planning means for a small community and how to include the community in understanding why asset management will help. "When we wait for things to break down before we repair or replace them, it causes an emergency situation."

- http://www.civicinfo.bc.ca/Library/Asset_Management/Case_Studies/TIB_Asset_Management--LGAMWG--April_23_2012.pdf

NWTAC: Asset Management Slideshow

This slideshow highlights the process and benefits of asset management. This includes reserve fund calculations, maintenance inspections, smart management practices, and fiscal support programs. It also highlights communication tools and the benefits of proper asset management.

- http://lgant.ub5.outcrop.com/sites/default/files/2011%20-%20NWTAC%20NCIP%20-%20Asset%20Managment.pdf

NWTAC: Community Owned Affordable Insurance brochure

Outlines the NWTAC's insurance program and appraisals.

- http://www.nwtac.com/wp-content/uploads/downloads/2014/02/2014-02-NCIP-Affordable-Insurance-Brochure-FINAL.pdf

Financial resources

Here are some funding programs that provide support to communities in climate change adaptation planning. Unfortunately, these programs tend not to support implementation costs or large capital costs.

Aboriginal Affairs and Northern Development Canada Climate Change Adaptation Program

- http://www.aadnc-aandc.gc.ca/eng/1329158189051/1329158264671

Health Canada's Health and Climate Change Adaptation Program for Aboriginal and Inuit Communities

- www.climatetelling.ca

Federation of Canadian Municipalities - Green Municipal Fund

Supports plans, studies, or tests for projects that show innovation in sustainable development in the energy, waste, water, brownfield development, and transportation sectors. Below-market loans, often combined with grants, are available to implement capital projects.

- www.fcm.ca/home/programs/green-municipal-fund/about-gmf.htm

Endnotes

1 Jim Flaherty speaking to the Whitby Chamber of Commerce, March 9, 2006. FCM Asset Management BC slide show.

2 MACA SCG capital planning process 2007 MS Word document.

3 The GNWT has also provided Community Infrastructure Assessments on buildings, landfills and sewage lagoons to many communities.

Community Energy Planning

In This Chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

This chapter will help your community to understand the basics of community energy planning (CEP) and how to mainstream climate change as part of the process.

> An energy plan shows what a community decides to do, over a certain period of time, to change how energy is used — to find better ways to make and use energy, saving money for the community.

When thinking about climate change it is important to understand the difference between climate change adaptation and climate change mitigation. **Adaptation** refers to planning for the effects of climate change, or how we will adjust to the changes occurring now and in the future. **Mitigation** refers to how we can stop or slow down climate change by reducing the amount of fossil fuels we consume. In the long-term, mitigation is very important to adaptation — it will make sure that the changes we have to adapt to are not necessarily catastrophic.

Community energy planning addresses both adaptation and mitigation. It is conventionally more about helping communities to mitigate their climate change impact, by reducing their fossil fuel use and saving energy. However, saving energy and money can also be considered part of adaptation because energy planning saves resources, both economic and human, that would otherwise be spent on energy.

> For communities such as Yellowknife or Iqaluit, a 20% reduction in energy expenditures could result in millions of dollars being available to be spent in other, more meaningful ways. Even for smaller communities it may be possible to save many thousands of dollars annually.
>
> — *Community Energy Planning*[1]

Because the lack of community resources is a major challenge when attempting to adapt to climate change in the north, reducing the amount of resources spent on energy frees them for other uses. Energy planning can therefore improve the ability of communities to adapt to climate change.

Fire burning in the distance. Risks to energy infrastructure and supply lines need to be considered in a community's energy plan and a community's emergency plan.
Photo credit: Craig Scott

Climate change impacts like extreme weather events and permafrost degradation also pose a risk to energy infrastructure. Revised community energy plans should take energy resiliency into account. For example, increasing extreme weather events could cause more power outages, or disrupt the transportation networks that bring energy like diesel into a community. Communities that have a diversified energy supply, especially locally-sourced, may be more able to cope with power outages and other energy system disruptions.

Climate change may also increase the potential of some alternative energies; for example, warmer weather might increase the growth of willow, which can be used as a fuel source.

With limited jurisdictional authority and challenges related to local staffing, budgets and isolation, NWT communities may find that energy planning adds an additional layer of complexity to planning. However the impacts of climate change are likely to only add additional burdens to the plates of municipal decision-makers. Identifying and planning for more efficient use of energy within the community infrastructure, developing local energy independence and ensuring that climate change considerations are integrated into the community energy planning process, will help communities to make the best use of limited resources.

Benefits of community energy planning (CEP)

- Reducing energy use, which:
  - Saves costs for the community and community members
  - Reduces greenhouse gases and air pollution, improving the local and global environment
  - Reduces the risks of local oil spills
- Keeping money that might have been spent on energy in the community
- Educating consumers on the costs of energy usage
- Supporting the implementation of alternative energies
- Providing training and employment for local residents
- Reducing dependence on imported fossil fuels.

— Community Energy Planning [1]

Key areas of success in NWT communities, as a result of CEPs are the increased use of wood stoves and wood pellets for heating and improved programs and actions on energy efficiency. Alternative energy pilot projects in numerous communities, research and pre-feasibility studies into the potential for mini-hydro, wind and transmission projects are also the result of CEPs. Reducing dependence on external energy by reducing demand and switching the supply to local sources increases community resilience, which is in itself a form of climate adaptation.

Photo caption: Thinking about energy use. Photo credit: Ecology North

What is community energy planning?

NWT communities have some of the highest energy costs in Canada, with electricity and heating costs much higher than the Canadian average. Community energy planning helps communities to identify and address their energy needs, identify energy efficiencies, reduce energy costs, improve air quality and provide economic development opportunities. Community energy planning can also make communities less dependent on outside resources.

> A community energy plan shows how a community changes how they use energy today, to meet their vision of how they want to use energy more wisely in the future. It shows the process and information the community uses to decide what they want to do, how they want to do it, and who will do the work.

All NWT communities have completed community energy plans, the earliest being Fort Simpson in 1997-98 and Whati in 2004. Energy plans deal with the delivery and use of energy in the community.

> Energy planning has implications for community infrastructure planning, strategic planning and human resource planning.

Typically the majority of energy use in the larger communities comes from imported fossil fuels, primarily diesel, fuel oil, propane, gasoline and aviation fuel. These energy sources heat buildings (homes, schools, health centres, etc.), run diesel generators and in some cases generate electricity through local diesel powered plants in smaller communities, and supply the energy for most transportation (cars, trucks, ATVs, snowmobiles, airplanes).

There are significant energy resources in proximity to many NWT communities. The potential for using local hydroelectricity, natural gas, and increasingly, alternative energy resources such as biomass (wood) are becoming more accepted and seen as viable options.

Most of the 33 NWT communities are not connected to an electricity grid, and have their own local diesel powered electricity system. Some communities, including: Yellowknife (and Dettah), Behchoko, Edzo, Hay River, Fort Smith, Fort Resolution and Enterprise are connected to small hydro powered electricity systems by overland transmission lines.

Although NWT communities do not have direct control over the source and provision of their local electrical energy, they have an increasing voice in deciding the energy mix available and implementing cost-saving measures within their communities. They are also responsible for dealing with the immediate response to emergencies in the community such as power outages. Communities can also make decisions directly about how their municipal buildings are insulated, maintained and heated, and the fuel efficiency of their vehicle fleets.

Community energy planning is a community-driven process in which local leaders and residents have both choice and responsibility for their energy decisions and how to use energy wisely.

The community energy planning process

For energy planning, communities must think about how energy is used (energy demand) and how it is provided and delivered (energy supply). Both demand and supply will be affected by climate change impacts.

Arctic Energy Alliance (AEA) has developed a guide for community energy planning. The guide is designed to help communities overcome some of the barriers noted above and to assist local governments in managing their energy and utility costs.

> Using principles such as sustainability, affordability and environmental preservation, communities engage in a multi-step planning process to identify and evaluate how energy is used in the community (energy demand) and how that energy is supplied to the community (energy supply).[1]

AEA is available to help set up the process for developing a community plan, but a successful plan requires a lot of local commitment and support. The process is highlighted here in point form; more information is found in *Community Energy Planning: A Guide for Northern Communities*.[1]

Developing a community energy plan[1]

1. Establish a local steering committee
2. Appoint a champion
3. Identify community goals and objectives
4. Develop an energy profile
5. Conduct energy assessment(s)
6. Involve the community in setting priorities
7. Meet with community members on a regular basis
8. Describe the current energy situation
9. Identify projects or activities to be completed
10. Identify funding requirements and funding sources
11. Revisit the profile in a few years

It is important to note that the CEP is a living document, renewed every few years (exactly when depends on the community).

Climate change and community energy planning

As climate change continues to impact community functions, capacity and energy systems, communities must adapt by incorporating these impacts into the CEP process. There are a number of ways that the energy systems can be impacted by climate change:

- Energy security may be reduced as transportation systems for fossil fuel deliveries are at risk (i.e. shorter ice road season, lower water levels that reduce barge delivery, forest fires cutting off road access, landslides on all-season roads)
- Hydroelectric generation and transmission lines are at greater risk due to ice storms, forest fires, increased lightening, and extreme weather events that might increase the occurrence and length of power outages
- Climate changes may impact the options for alternative energies (e.g., altered flow patterns in rivers and lower water levels could reduce hydroelectricity generation; wind pattern changes may reduce wind energy production)
- Increased flooding and increased forest fires may pose increased risks to community energy infrastructure

Positive benefits are also occurring:

- The accelerated growth of willows along the Peel River has provided Fort McPherson with a renewable source of biomass energy
- Warmer temperatures may reduce heating demand

Renewed community energy plans should take these impacts into consideration. As part of the energy situation assessment (Steps 4, 5 and 8 above), a risk assessment of energy infrastructure should be carried out, based on the community's future projected climate scenario. Each component of the energy system should be assessed for infrastructure longevity, stability of supply, and alternate in case of failure. Community infrastructure to be assessed includes:

- electricity generating station or overland transmission lines for hydro communities (in partnership with NWT energy providers)

- diesel generators, transmission lines and power poles within each of the thermal communities
- diesel or fuel oil storage tank sites
- diesel fuel pumps or other distribution systems
- residential and institutional fuel oil tanks
- emergency back-up diesel generators
- wood and wood pellet supply and storage
- other energy infrastructure depending on the community

A pellet boiler in Fort McPherson provides district energy and with increased growth of Willows, biomass can now be harvested locally for energy. Photo credit: Davis Heels

Partnerships between communities and other authorities, e.g. energy companies, will be required. Engagement with community members, such as programs to encourage the uptake of energy efficient wood stoves or to provide education about how to avoid fuel tank spills on private property, is also important.

Case Study: Fort McPherson willow biomass project

Fort McPherson has been looking at its energy supply in light of a climate change impact on its doorstep. Willows have been expanding both in range and size along the Peel River as flooding and growing conditions become more ideal for them. Willows regrow quickly, and the same stand can be re-harvested in 7 to 10 years. They have similar energy density to other wood, and are easy to harvest.

In 2011 the community test-harvested willows along the river to determine the most efficient method of harvesting and storing the willows, with the intention of using them as fuel to heat local buildings in a district heating system. Fort McPherson has installed a biomass boiler that will be able to burn wood pellets, wood chips from their sawmill, and willow chips.

Case Study: Tsiigehtchic EPA Woodstove Change-out for Elders

In February 2010, AEA partnered with the Tsiigehtchic Charter Community for a pilot project to replace old inefficient wood stoves with efficient, modern wood stoves. Seven Elders were selected by the community to be the beneficiaries of the project. The aim was to spread awareness of clean-burning, efficient wood stoves certified by the U.S. Environmental Protection Agency, which are available for sale throughout the NWT.

Feedback from users of the new wood stoves speaks to the project's success:

"I really like the stove. I get up in the morning and my stove is still burning, my house is warm and I am burning less wood."

Community Energy Planning Checklist

- ❑ Our community has an up-to-date community energy plan
- ❑ The energy plan takes into account risks associated with the changing climate, including:
  - ❑ Increased wear and tear on electricity infrastructure (more ice on wires, etc.)
  - ❑ Increased risk from extreme weather events and possible power outages
  - ❑ Increased risk of disruption to transportation infrastructure and fuel supplies from outside the community
- ❑ We have started to implement the recommendations of the community energy plan
- ❑ We have integrated risks to energy infrastructure with our emergency plan and we have functional backup energy systems for critical community infrastructure
- ❑ We have plans to renew and update the community energy plan

Glossary

Capacity
Capacity is the knowledge, skills, people power, time, energy, money, and other resources that a person, group, or community has. We can increase capacity any time we increase any of these resources.

Energy audit
An energy audit measures how a building uses energy and what you can change in the building, to save energy.

Energy efficiency
Energy efficiency means to use less energy and still do the same amount of work. An energy efficient vehicle uses less gas to go the same distance. An energy efficient refrigerator uses less electricity to keep things cold. Energy efficient habits are things people do that use less energy – such as turning off lights when you don't use them, walking instead of driving, using a clothesline instead of a dryer.

Fossil fuels
Fossil fuels include gasoline, diesel oil, and natural gas. Fossil fuels come from deep in the ground and they are a non-renewable resource. Once we use them up, they are all gone. Their use is primarily responsible for greenhouse gas pollution.

Renewable energy
Renewable energy is energy that comes from things that can last forever. Renewable energy is never all gone. Examples of renewable energy sources include the sun, wind, moving water, and wood.

Resources

Arctic Energy Alliance (AEA)

AEA is a non-governmental organization whose purpose is to help NWT residents and communities reduce their energy costs and greenhouse gas emissions. AEA is the government lead for Community Energy Planning, and has developed tools for helping communities develop CEPs and reduce energy use. They have offices in Yellowknife, Fort Smith, Fort Simpson, Norman Wells and Inuvik. Call (867) 920-3333 or http://www.aea.nt.ca/

Government of NWT - Environment and Natural Resources (ENR)

ENR maintains several funding programs to help communities to realize the recommendations from their CEPs. These programs include:

> **Energy Conservation Program (ECP)** to help retrofit community buildings, reduce energy and/or water use, or replace inefficient lighting. http://www.enr.gov.nt.ca/programs/energy-conservation
>
> **Alternative Energy Technologies Program (AETP)** to help your community add alternative energies such as solar panels, wind turbines, or other innovative energy. http://www.enr.gov.nt.ca/programs/alternative-energy-technologies
>
> **Biomass Strategy** has some discretionary community funding available to help promote biomass energy initiatives. http://www.nwtclimatechange.ca/content/biomass

Northwest Territories Association of Communities (NWTAC)

NWTAC develops and houses a variety of resources for communities.

http://www.nwtac.com/action/projects/energyplanning/

Federation of Canadian Municipalities – Partners for Climate Protection (PCP)

The PCP program empowers municipalities to take action against climate change through a five-milestone process that guides members in creating GHG inventories, setting realistic and achievable GHG reduction targets, developing local action plans, and implementing plans using specific, measurable actions to reduce emissions.

http://www.fcm.ca/home/programs/partners-for-climate-protection.htm

Aurora Research Institute (ARI)

Licences scientific research in the NWT. This includes research on energy.

http://nwtresearch.com/

Natural Resources Canada (NRCan)

Office of Energy Efficiency is Canada's centre of excellence for energy, efficiency and alternative fuels information.

https://www.nrcan.gc.ca/energy/offices-labs/office-energy-efficiency

Endnotes

1 Arctic Energy Alliance, *Community Energy Planning: A Guide for Northern Communities,* 9. aea.nt.ca/files/download/31

Human Resource Planning

In This Chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Introduction

As your community adopts the climate change planning lens, you will identify new tasks, roles and responsibilities. Who is going to be responsible for each of these new tasks? To answer this, you can incorporate climate change adaptation tasks into your human resource plan.

Considering human resource (HR) planning implications of climate change adaptation is a key component of mainstreaming climate change adaptation. Too often, community governments identify actions that can be taken to proactively reduce negative climate change impacts, without being about clear how these actions are going to be implemented, or by whom.

Mainstreaming also requires an examination of each job description to identify how existing staff members can address identified climate change adaptations. Although a stand-alone climate change planning position can sometimes be helpful, it is rarely feasible from a cost perspective and many of the required tasks could be integrated into existing roles with sufficient planning and training.

Your human resource plan can be reviewed on an interim basis with a climate change lens, or you can consider climate change adaptation in more detail when you review and revise your other plans. As job descriptions are revised or jobs are posted, climate change adaptation roles and responsibilities can also be incorporated.

Human resources should be considered throughout the development of your other community plans. For example, for every action prioritized in a land use plan, an emergency plan or a source water protection plan, the planning committee can consider how an action is going to be implemented and who is ultimately responsible for each step.

Aurora College students in Fort Smith. Photo credit: Kim Rapati

Consider, for example, the following questions:

1. Which climate change adaptation activities require a response by the community?
2. Do these climate change adaptation activities generate new responsibilities?
3. Can these roles be filled by existing staff members?
4. Where are the gaps?
5. How can these gaps be addressed?

There is no single method for identifying human resource needs. MACA provides a guide and some templates that can help communities to identify their staffing and training needs, as well as associated costs. In this guide, we use MACA's approaches and suggest some ways that communities can build on them to plan for the human resource requirements that will come from climate change adaptation planning.

Examining existing plans for climate change human resource needs

To identify the human resource needs associated with climate change adaptation, consider facilitating exercises in which community government staff and/or Chief and Council go through each plan (such as your community plan, your energy plan or your stand-alone climate change adaptation plan if you have one) and dissect each goal or action that may be impacted by climate change into more detailed lists of roles and responsibilities.

The following tables illustrate two simplified examples using actions that have been identified as priorities by several NWT communities' Adaptation Plans. The steps and HR implications illustrated here are fictional, but the point is to illustrate a process for dissecting actions into specific steps, and then appointing these actions to staff positions.

The same exercise could be followed for an emergency plan, a community plan, or a land use plan. You will also want to consider timelines and more detail about how each new task or role fits into an employee's work plan.

Example climate change adaptation plan actions – HR implications

Action example 1: Dredge sewage lagoon to increase capacity

1. Tender RFP for project coordination and dredging plan
2. Work with successful contractor to submit water license amendment
3. Implement dredging plan

Impacted personnel:

PERSONNEL	TIMELINE AND COMMITMENT	GAPS IDENTIFIED	TRAINING	HR COST IMPLICATIONS
SAO	Write and tender RFP; establish and lead committee to review proposals; meet with successful contractor bi-weekly to monitor progress. One week to tender contract, 5 hours per week throughout project	Expertise in writing RFP	Seek advice and review from MACA staff; find case studies, templates or examples	None – include in existing work load
Assistant SAO	Research templates and case studies; assist throughout. Five days to write RFP, 5 hrs/wk throughout contract.	Finding examples	Contact MACA, Northwest Territories Association of Communities	None – include in existing work load
Foreman	Liaise with successful contractor throughout work; manage public works staff and equipment. 50% of time through August.	No additional time. Existing workload will need to be reduced accordingly.	None required	Will require sewage and water truck driver hired to cover existing workload in August. $5,000
Heavy equipment operator 1	Work under supervision of hired engineer to implement plan. Full time August.	None	None – has certification and is under supervision of engineer and foreman.	None
Heavy equipment operator 2	Work under supervision of hired engineer to implement plan. Full time August.	Lack one heavy equipment operator	Identify interested candidates and Aurora College training opportunities	$15,000 estimated HR costs

Action example 2: Inventory and replace rigid fuel line connections

1. Develop inventory program and database
2. Conduct inventory on existing municipal buildings
3. Estimate costs of replacements and order materials
4. Replace each inventoried

Impacted personnel:

PERSONNEL	TIMELINE AND COMMITMENT	GAPS IDENTIFIED	TRAINING	HR COST IMPLICATIONS
SAO	Supervise development of program and inventory database. Minimal time commitment.	None	None	None; can incorporate in current role
Assistant SAO	Lead development of program and develop database to inventory fuel lines. Two days.	None	None	None
Human resource director	Initiate process for hiring summer student. Three days total over three weeks for hiring process.	None	None	None
Foreman	Supervise summer intern in project; train in fuel line replacement; assist with sourcing and ordering parts. 30 minutes per day July and August.	None	None	None
Summer student	Conduct inventory. Order parts. Replace fuel lines. 50% of time, July and August.	None	Will be trained and supervised by foreman	$6,000 Funding secured through intern program

Climate change adaptation roles and responsibilities may impact many job descriptions. Photo credit: Craig Scott

Applying the climate change lens to all positions

The Government of Northwest Territories, Department of Municipal and Community Affairs (MACA) provides some useful templates that communities can use to build their human resource plans.

Consider facilitating an exercise among your staff to review all positions with a climate change lens.

- Are all staff familiar with the community's planning documents?
- Are all staff familiar with climate change?

Consider some preliminary climate change education for your staff. It may be important to go over the basics of climate change, what will the climate be like in the future, how will that impact the community, and what is adaptation. You may be surprised by the knowledge and insight that some staff members have. On the other

hand, it may be surprising how little knowledge some people have of climate change and its potential repercussions.

If staff members are involved in workshops that identify and discuss the goals and actions identified in the relevant plans and how they pertain to climate change, they may see how they can contribute to the desired outcomes within their own job descriptions. This way, staff members are able to identify how their own skillsets can be applied to achieve the goal or where their interests could be applied with further training.

The best way to look at how climate change is going to affect human resources within your community is to look at your climate change adaptation plan, or the climate change impacts that have been identified by the community, and try to determine the HR repercussions of each. Have a list of staff and their responsibilities, alongside the identified impacts for your community and who and how community staff will adapt to these. Try to go through this exercise with all the identified impacts in your community (some may not impact human resources). For each impact identify who is primarily responsible within the community, how their job may change (adaptation), what training implications there are for that staff member, and the estimated cost of this adaptation to the community (both one-time and annual).

As tasks are identified and assigned, be sure to update the job descriptions associated with the position.

When reviewing job descriptions, or when writing new ones, adopt a climate change lens. How can each staff position contribute to climate change related goals outlined in your plans?

Remember to consider and plan for cost implications.

Filling human resource gaps

Identifying how to fill gaps is likely not going to be an easy task.

With full plates, how can staff members take on new responsibilities?

Here are some suggestions of ways community members may consider finding human resource solutions.

1. Are there regional solutions?
2. Can other levels of government provide support?
3. Can new roles and responsibilities be added to existing job descriptions?

Are there regional solutions?

It may be that a specific role or responsibility requires some specialization but that a full time employee is not necessary for a single community.

Is there a role for regional management bodies in the task identified?

Could your community leadership negotiate with other communities in your region to "job-share" a person with this expertise? What about co-operating on a regional basis to bring in a shared consultant for training or planning purposes?

If tendering a short-term contract for the project is an option, are there neighbouring communities addressing the same challenge? Can the work be done more cost effectively if a regional tender is developed? Are there regional bodies that could house shared staff?

Here are two examples of regional collaboration from NWT and Yukon regions.

Photo credit: Craig Scott

Regional Resource Sharing Example: The Yukon's Circumpolar Relations Department

Under the general direction of the Grand Chief, the Yukon Circumpolar Relations Department was established to monitor and address international and circumpolar issues that may affect the interests of Yukon First Nations peoples. As climate change continues to be an issue affecting First Nations communities in the north, the Circumpolar Relations department created the Climate Change Coordinator position. The primary duty of the CC Coordinator is to provide relevant information on climate change and global warming issues to Yukon First Nations Communities and to support communities in building their climate change capacity through different types of educational experiences. Specifically this person is responsible for ensuring the following:

- Ensure Yukon First Nations receive relevant information on climate change
- Coordinate Elders Panel on Climate Change meetings and assist in the further development of a northern strategy on climate change
- Coordinate community workshops
- Develop an information package on the ACIA (Arctic climate change Impact Assessment Report)

More information can be found at www.cyfn.ca

Hazardous waste left by industrial exploration in Fort Good Hope. Regional efforts can save money on challenges common to communities. Photo credit: Christine Wenman

Example: Regional request for proposals for hazardous waste inventories

Many communities are faced with a daunting stockpile of hazardous wastes in their landfills. As drainage in and around solid waste facilities changes as a result of thawing permafrost or changing climate patterns, dangerous chemicals in the hazardous waste streams can become increasingly mobile and leach into the surrounding environment.

Improving hazardous waste management is a "no-regret" climate change adaptation. Communities will want to do it anyway to protect the health of their community members and the surrounding environment, but climate change makes improved management even more urgent.

The job of identifying, labeling, segregating, properly storing and inventorying hazardous waste in preparation for transportation and disposal is time and labour intensive and requires special training. Community staff can and should develop the necessary knowledge and skills to do much of this work independently; however, when it comes to dealing with old stockpiles, it may be worthwhile to bring in expert help. Doing so at a regional level, through municipal cooperation, can reduce costs.

In 2012 to 2014, two such initiatives took place: one in the Sahtu region coordinated by Ecology North with funding from Environment Canada's Environmental Damages Program, and one in the Beaufort Delta region, with funding provided from the Aboriginal Affairs and Northern Development Climate Change Adaptation Program through the Government of the Northwest Territories. By reducing mobilization costs for expert contractors, tens of thousands of dollars were saved. Now, each community in these regions has an inventory of hazardous waste being stored in their landfill as well as an estimate for its transport and disposal.

Can other agencies or levels of government provide support?

A specific task may seem daunting to you in your role with the community government. However, chances are, there is one person at the Territorial Government level who has specific expertise with this issue and who is partially tasked with the job of helping you.

Often, this territorial expert has a regulatory role as well as a role in helping all 33 communities. It can be daunting for him or her to know where to start but if he or she is contacted by a community member and knows the interest is there, then he or she may be able to provide substantial support.

Don't be afraid to ask! Territorial Government workers are often busy but are usually grateful for a chance to pull themselves away from their computer, out of their cubicle and into the world of contact with real people! Try to find the person who can help you in the government directory. If you aren't sure, keep asking until you are directed to the right person. Often, your regional superintendent from the Department of Municipal and Community Affairs is a great starting point and can further connect you with territorial resources.

Gerald Enns from Environment and Natural Resources teaches about managing hazardous waste in Trout Lake.
Photo credit: Caroline Lafontaine

Sampling water in Trout Lake. Photo credit: Christine Wenman

Example: Wek'èezhìi Land and Water Board community training in wastewater sampling

As part of their water license, community governments are required to monitor water in their wastewater lagoons as well as along the effluent pathway out of lagoons. Specific monitoring requirements (such as where, how often, and for which parameters) or detailed within the water license.

Waste water sampling is an example of a "no regrets" adaptation action. It is required by law and is important in order to ensure that the waste water facility is working well and therefore protecting community members' health. With climate change, wastewater monitoring may be even more important because thawing permafrost, seasonal changes or increased precipitation could impact the lagoon system, changing the amount of time that wastewater is in the lagoon.

For some community staff, this responsibility seems somewhat new and has not been clearly explained. Recognizing the challenge, the Wek'èezhìi Land and Water Board staff developed training materials for each Tlicho community. They also coordinated hands-on workshops with community staff, MACA staff, Environmental Inspectors and staff from Environment and Natural Resources. This collaborative approach meant that everyone could share their knowledge and ensure that everyone knew how to monitor wastewater and why the monitoring was important for community health.

More information about this initiative can be found at:
www.wlwb.ca/content/community-based-monitoring

Can new roles and responsibilities be added to existing job descriptions?

If the project requires a substantial amount of effort over a short period of time, then consider seeking funding through an external funding mechanism (see the resources section under capital planning) or see if a consultant can be hired to use a one-off expenditure within your capital budget.

For new responsibilities that will be required on occasion to meet an ongoing need such as monitoring of wastewater or standing water around a landfill, ensure that the new responsibilities are properly built into existing job descriptions and that there are mechanisms in place to ensure accountability and knowledge transfer. For example:

- Are the roles and responsibilities built into the job description?
- Is there documentation describing the task in detail so that a new staff person will know what to do if there is turn over?
- Has an alternate (second) staff person also been trained in this task?
- Are there reporting and accountability mechanisms such as documentation that has to be sent to an external body? Does this fall within a standing agenda item in Council meetings so that Council can follow the progress of the task?

Human resource planning & climate change checklist

- ❑ Identify all new tasks and responsibilities associated with climate change adaptation actions
- ❑ Ensure each action is broken down into detailed steps
- ❑ Determine if existing staff can absorb new responsibilities
- ❑ Assign tasks to existing staff and explore how new roles or responsibilities fit into their work plan
- ❑ Identify and provide training and capacity building that might be needed
- ❑ Outline human resource gaps
- ❑ Consider if regional solutions exist
- ❑ Prioritize filling gaps
- ❑ Reallocate financial resources or identify potential funds

Resources

MACA: Community Government Human Resource Development System

MACA developed a toolkit for human resources management in local communities. This booklet was designed specifically to assist northern communities with their human resource capacity building needs.

The human resources toolkit encourages local governments to proactively support their employees through effective human resource management practices. It promotes activities that support employees and it helps municipalities identify and correct issues that impact successful attraction and retention of employees.

- http://www.maca.gov.nt.ca/school/tools/CGHRDS%20Manual%20.pdf

Training and information resources

There are a number of organizations in Canada that provide distance education for climate change adaptation. Ensuring your human resource coordinator is on these mailing lists can help ensure that your staff members are connected to relevant webinars and conferences as they arise. Here are some examples:

Climate Change Adaptation Community of Practice

This on-line community offers a portal of climate change adaptation publications that is easily searchable and usually links you directly to the document of interest. The Community of Practice also hosts webinars or sends notices about webinars that other institutions or agencies are hosting. Regular e-mails also notify recipients about the publication of new documents, research results, training opportunities or other relevant news items.

- www.ccadaptation.ca

Water and Climate

Another information portal, water and climate specifically houses links to research and reports related to water and climate change.

- www.waterandclimate.ca

International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability

ICLEI was founded in 1990 as the 'International Council for Local Environmental Initiatives', and has since changed its name to ICLEI—Local Governments for Sustainability' with a broader mandate to address all sustainability issues. ICLEI is a forum for international knowledge sharing on issues related to local governments and sustainability, and frequently hosts conferences or provides information about climate change adaptation.

- www.icleicanada.org

Northwest Territories Association of Communities

Of course, your very own Northwest Territories Association of Communities continues to work to provide tools and training for communities to adapt to climate change. Be sure to watch their weekly newsletters.

- www.nwtac.ca

You can also sign up for their partners' communications lists:

- www.ecologynorth.ca and www.pembina.ca

Funding opportunities for training and skills development

Aboriginal Affairs and Northern Development Canada First Nation and Inuit Skills Link Program

Financially supports initiatives focused on training and employability initiatives for First Nation and Inuit youth aged 15 to 30. Also supports mentored work placement costs to full percentage of wage as well as some additional costs.

- www.aadnc-aandc.gc.ca/eng/1100100033627/1100100033637

There are a number of opportunities for municipal governments to find additional resources for human resource positions particularly for trainees, students or young persons. All participating departments can be found at:

- www.servicecanada.gc.ca/eng/epb/yi/yep/newprog/general.shtml

Some resources that a community government could link to climate change adaptation initiatives are listed here:

Youth employment strategy

Canadian Mortgage and Housing Corporation (CMHC): Housing Internship Initiative for First Nations and Inuit Youth

Financial contributions towards the wages of First Nation or Inuit youth ages 15-30 in the realm of housing activities such as, but not limited to: housing administration, construction, renovation, maintenance, and client counseling. Local governments would be expected to cover administrative costs and provide some contributions towards salary.

- http://www.cmhc-schl.gc.ca/en/ab/noho/noho_007.cfm

Service Canada: Skills Link Program

Support for partial or full funding for wages for youth aged 15 – 30 who are out of school, not on employment insurance, and require support to overcome employment obstacles. The Skills Link Program supports a broad range of employment and skill-building opportunities.

- www.servicecanada.gc.ca/eng/epb/yi/yep/newprog/skillslink.shtml

Service Canada: Career Focus

Funding to support employment for underemployed youth under 30 years of age, and recently graduated from an approved post-secondary institution. The youth's employment position can be in any thematic areas so long as it helps them meet their career objectives. Other sources of funding are encouraged but not required.

- www.servicecanada.gc.ca/eng/epb/yi/yep/newprog/career.shtml

Service Canada: Youth Employment Strategy

The Government of Canada has funding available for internships for recent university graduates. These positions may help you to bring added resources to a specific community project. Typically, the Government of Canada will only provide 50% of the funding so you will need to find the matching funds either through the municipal budget or from other, non federal-government funding sources. Youth Employment Strategy opportunities are housed in the following departments:

Environment Canada's: Science Horizons

Funding up to $12,000 and 70% of overall costs for an internship of at least 6 months in the realm of environmental sciences and within Environment Canada's stated priorities.

- www.ec.gc.ca/scitech/default.asp?lang=En&n=B58899DC-1

Agriculture and Agri-food Canada: Career Focus Program

Funding up to $20,000 and 50% of total costs for internships from 4-12 months in the realm of agriculture-related work experience.

- www.agr.gc.ca/eng/?id=1280434970527

Natural Resources Canada Science and Technology Internship Program

Maximum funding of $13,200 for an internship up to 52 weeks for recent university graduates to gain experience in the realm of science and engineering.

- www.nrcan.gc.ca/careers/87

Student Summer Jobs

AANDC First Nations and Inuit Summer Work Experience Program

- www.aadnc-aandc.gc.ca/eng/1100100033610/1100100033615

Source water protection planning and other related plans

In this chapter

Photo: Allan Farrell, Flickr CC (creativecommons.org/licenses/by/2.0/)

Community of Ulukhaktok. Photo credit: Christine Wenman

Introduction

"If mitigation is about carbon, then adaptation is about water."

- Jim Mattison, 2008[1]

Mainstreaming climate change adaptation planning into routine municipal decision-making cannot be achieved without consistent consideration of climate change impacts to water and water related infrastructure.

So dramatic are the impacts of climate change on water, that changes to the water that surrounds us can completely alter the landscape, and will necessitate enormous shifts in the way that we plan for our communities.

Climate change can alter water flows in a number of ways, as listed in the table below:

CLIMATE CHANGE FACTOR directly impacting water	**SECONDARY IMPACTS** that could impact source water
Changes to frequency and magnitude of rain and snow events.	Can perpetuate and accelerate permafrost thaw.
	Can contribute to flooding, which may pose vulnerabilities to water, wastewater or solid waste infrastructure.
Timing of precipitation	More rain on snow or rain on frozen ground events could contribute to flooding hazards.
	More rain on thawed active layer (seasonally unfrozen layer above permafrost) could increase sediment entering streams and lakes from run-off and increase erosion rates.
Timing of melt / thaw	River and lake break-up and freeze-up dates changing (for example, the Fort Providence Ice bridge has been reduced by thirty days in the past forty years)[2].
Sea level rise	Shoreline erosion can jeopardize near-shore infrastructure (for instance, the landfill in Tuktoyaktuk)
Extreme weather events	Increased shoreline erosion from storms in the longer ice-free seasons in the Beaufort Sea may increase flooding risk and jeopardize infrastructure
	Frequency and magnitude increases of precipitation as well as changes to the timing of thaw can lead to increased flooding such as the floods experienced in 2012 in Nahanni Butte and 2013 near Fort McPherson
Permafrost thaw liberates ice as water	Lakes drained where water was retained by surrounding permafrost
	Raised peat plateau shift to inundated fens – consequent shift in ecology (example, black spruce dominated to fen landscape with more water tolerant shrubs)
	Changes in drainage patterns and stream channels
	Erosion such as thaw slumps can result in changes to water quality, increased turbidity, altered productivity in lakes, changes to lake chemistry, and impacts on aquatic life.

Across Canada, planners are recognizing that the past is no longer the same marker of the future as it once was considered to be. Although one or two hundred year peaks in precipitation were an engineering standard to ensure conservative and safe estimates, one in two hundred year events are increasingly becoming the new norm. Cities like Toronto have completely reconsidered and redesigned storm water infrastructure, for example, investing billions to reduce flooding risks and replacing storm water pipes

that used to be built for one in five year rainfall events with pipes sized to handle one in one hundred year events.[3]

In the north, the same pattern is evident in many regions. In the Peel Plateau where Fort McPherson is situated, the last five years have brought the top five ranked rainfall events that have ever been recorded. Since rainfall volume has been tracked in that region, which includes a patchy record since 1915 but a consistent one since 1986, the five largest rainfall events occurred in 2010 and 2012. These new large rainfall events are as much as three times the highest rainfalls previously recorded.[4]

The impacts of such changes for communities are significant. In May of 2013, the community of Fort McPherson was taken by surprise by massive flooding along the Peel River caused by an ice jam downstream. The event coincided with rainfall events of unusual frequency and magnitude in surrounding foothills. Several community members' cabins lining the banks of the Peel River were uprooted and were seen floating down the river. Community members at camps were evacuated and brought back to the safe, drier ground inside municipal boundaries.

Elsewhere, in June 2012, nearly the entire community of Nahanni Butte was under water because of the Mackenzie River's high water levels. Almost every resident in the community was evacuated to Fort Simpson and much of the community has required reconstruction.

Cabins were uprooted and floated down the Peel River during 2013 spring flooding near Fort McPherson. Photo credit: David Cook

With such stark examples in our own backyards, it is clear that mainstreaming climate change into municipal decision-making also requires considering impacts on water. We should include planning for the management of wastewater and soild waste when thinking of protecting communities drinking water, and/or source water. Ensuring that solid waste and wastewater facilities are resilient to climate changes will help to ensure appropriate source water protection now and into the future.

What is source water protection planning?

Source water protection planning is part of a multi-barrier approach to ensuring that human health is protected from waterborne diseases and contaminants.

Multi-barrier approach – Ensuring safe drinking water all along the pathway from its very source through to the tap from which it is drunk.

Source water is defined as the water from which a community draws its drinking water.

Planning for source water protection means thinking about protecting the entire watershed from which a community draws its drinking water into its water treatment plant. It is very important to make sure that this water is kept free from contamination and human disturbance.

In all NWT communities, drinking water is filtered and chlorinated. Also, additional steps and monitoring occur after the drinking water treatment process, to make sure that water is not subsequently contaminated. For example, in communities with trucked water delivery, trucks are cleaned regularly and samples are taken from water in the truck to ensure there is sufficient chlorine and no bacterial contamination. In addition, periodic samples are taken from water tanks in public buildings and tested for the presence of ***E. coli***, a bacteria that can be associated with human or other animal feces and that is an indicator of health risk.

Each of these steps provides a barrier that protects the public from becoming sick. Source water protection planning starts even earlier than the water treatment process and makes sure that the source water stays as clean as possible.

Multi-barrier approach to safe drinking water:

1. Source water protection
   ↓
2. Water treatment
   ↓
3. Distribution
   ↓
4. Monitoring
   ↓
5. Response plan

Tip: Definitions to words in bold text can be found in the glossary at the end of this chapter.

Why is source water protection important?

Source water protection planning has become an expectation of municipal governments throughout Canada since seven people died and more than 2,300 people became ill in the community of Walkerton, Ontario in 2000. The cause of the Walkerton water crisis was a dangerous strain of *E. coli* that got into the drinking water supply system from manure spread on land near to a well intake. Although sufficient **residual chlorine** and low **turbidity** levels would have prevented infection from the *E. coli***,** operators were not sampling and recording residual chlorine levels daily as they should have[5].

Similarly, over 700 people became ill in the community of North Battleford in Saskatchewan in 2001 from a parasite called **Cryptosporidium**, which seems to have entered the source water from an upstream sewage treatment plant that was in ill repair. The contamination event appears to have occurred because of a malfunction in the system used to reduce turbidity and the failure of drinking water operators to report or remedy the issue.[6]

These cases emphasize the need for a multi-barrier approach, in which water is not only being treated but is being protected at its very source. Effective source water planning could have helped to reduce the risk of contamination at its very source – by recognizing that the sewage treatment plant upstream of North Battleford desperately needed repair, or by identifying the risk of the water intake well in Walkerton and protecting it from agricultural contamination.

Northwest Territories residents are blessed with relatively pristine water and many fewer threats to water quality than southern neighbours. Without large urban centres and significant agricultural practices, some of the major causes of waterborne illness are largely avoided. Nonetheless, with climate change impacting water flows in and around our communities, good source water protection planning that considers climate change factors will help to ensure the health of local environments and residents.

Photo 5: Great Bear Lake, Deline. Photo credit: Kenny Kenny

Five Steps of source water protection planning

The Department of Environment and Natural Resources worked with Dr. Bob Patrick at University of Saskatchewan to develop a guidance document, based on Northern experiences with source water protection. The associated template can guide communities in developing a source water protection plan. This guide breaks the process down into five steps:

1. Establish a working committee
2. Complete a source water assessment
3. Identify management actions
4. Develop an implementation strategy
5. Review the source water protection plan

Resources[7] for community source water protection planning can be found at: www.nwtwaterstewardship.ca

Climate change can and should be considered at each step of the source water protection planning process. For each step below, examples of climate change considerations are listed.

Step 1: Establish a working committee

> Consider who can bring climate change information to the table and include them in a working committee or a technical advisory committee.

The first step establishes a working committee of individuals in your community who will help to develop the plan. Although exactly who is on the committee will depend on the needs of your community, you will at minimum want to include those responsible for the management of drinking water and sites that may put source water at risk (such as the solid waste facility and the wastewater facility). The committee should therefore include the community foreman and drinking water plant operators. Decision-makers such as the Senior Administrative Officer will also play important roles.

Consider who is best able to bring climate change information to the table and make sure that person is included in the planning process. For example, you may want to include elders or land users as they may be able to offer perspective about local changes to the land and water. Public works staff may have information and data about climate change impacts on infrastructure that have been witnessed to date.

One approach is to establish a technical advisory committee that can provide technical advice to the working committee. Consider including academic partners or territorial or federal government partners who can bring climate change data, expertise and advice to the planning process.

A working group has sketched a map of source water risks in Ulukhaktok. Photo credit: Ecology North

Step 2: Complete a source water assessment

> Climate change perspective: Once risks to source water are identified, consider if climate change impacts magnify or mitigate these risks in any way. Consider how climate change is impacting or is projected to impact water locally and explore whether these changes present new risks to source water.

The source water protection planning template provides a list of questions that you can ask about your drinking water source to complete the assessment. These questions include things like considering the source, the intake, the treatment type and monitoring of the raw water source. The template leads the working group to consider any potential contamination routes or threats to source water (lake, river or groundwater).

Consider also examining changes to the source water that are evident either through traditional knowledge or through the available data.

Some communities in the NWT have already started to look at their source water with a climate change lens. Some of the identified threats and corresponding management strategies that they identified are listed below, but these are in no way considered a complete list of potential threats or mitigating actions.

With the right people taking part in your working committee and with sufficient time dedicated to the planning process, your community will generate a more comprehensive list of risks and management actions specific to your context.

Examples of identified ways that climate change could impact source water with example questions to help assess risk (probability and consequence).[8]

- Flooding, thawed permafrost or increased water flows could impact wastewater lagoons and wetland systems or solid waste facility sites:
    - Are there drainage plans in place for these sites?
    - Are you encountering challenges with standing water accumulating in your solid waste facility?
    - Have changes in weather events or changes in permafrost patterns impacted the efficacy of your community's wastewater lagoon? Has your community been able to maintain the required free board (distance from the top of the water level to the top of the wastewater lagoon's berm) of 1 metre or is overflow or flooding a risk? Has the retention time of wastewater in the sewage lagoon decreased noticeably in recent years?
    - What type of land does wastewater effluent or solid waste leachate run into (ie. wetland versus bedrock) and how far is it from your source water?
    - Are berms and swales used to facilitate effective drainage in good repair?
    - Are your berms dependent on permafrost?
- Increased turbidity levels in source water:
    - Have turbidity levels changed over time?
    - Has the magnitude of high turbidity events during spring thaw or during the fall increased?
    - Does your community's water treatment plant have the ability to store water for treatment during break-up while turbidity levels are high? Is this storage volume sufficient and does it still leave room for longer periods should that prove necessary in the future?
    - Is erosion around the lake or river where drinking water is taken from increasing?

    - Are there any landscape disturbances upstream of the drinking water source that could impact water quality - either natural or human landscape disturbances?
    - Is there permafrost thaw occurring in or around your community that is impacting runoff into source water?
- Other sources of contamination could be increasingly mobilized because of permafrost thaw or changes in precipitation and drainage:
    - Is there any risk from industrial development past or present that may impact the source water? (for example, sumps)
    - Is there any risk that hazardous materials from your solid waste area could migrate into your source water area?

As these examples show, climate change factors can impact how your working group assesses risk. For a closer examination of how to consider climate change in risk or vulnerability assessment, see the chapter titled "Climate Change Adaptation Plans" of this guidebook. For example, some threats that may have been unlikely in the past (such as severe flooding or consequent overflow of a wastewater lagoon) may be increasing in probability and frequency because of observed or predicted climate change impacts.

Understanding the importance of turbidity levels

Turbidity levels in source water are very important because disease-causing agents can be bound to particles suspended in the water. Turbidity can also interfere with the effective treatment of water form chlorine. Turbidity is a challenge for drinking water provision around the world and in the north ,where risks from agriculture or large urban centres are low, turbidity is probably the biggest challenge. New water treatment plants in communities are designed to filter out as much sediment as necessary for that water source. This doesn't mean that challenges aren't encountered, however, especially during spring break-up when there is a lot of runoff into water and a lot of mixing in rivers and lakes disturbing sediment in the river or lake bottom.

How can climate change impact turbidity levels?

Many communities are noticing that climate change impacts are causing increases in turbidity levels in some water sources around their communities. This can happen because permafrost thaw liberates water that was frozen within soils as ice and brings with it sediment when it flows into water. In some parts of NWT, such as the Peel Plateau, permafrost thaw results in land slumping because the ice-rich permafrost releases so much water when it thaws that the land subsides. This can drastically increase turbidity levels in surrounding streams and lakes.

Permafrost thaw can also cause increases in erosion to river and lake banks, also increasing the rate of sediment run-off into surrounding rivers and lakes.

Changes to patterns of spring thaw and precipitation can mean that rain falls more frequently on a thawed active layer, rather than on frozen ground. The rain then washes more sediment into surrounding water than it would if it fell on frozen ground.

Increased flooding due to ice jams, high precipitation, or extreme weather events can also increase turbidity levels.

Increased erosion is common through many regions in NWT. Photo credit: Jamie Bastedo

Step 3. Identify management actions

> If there are specific threats to the source water that may exist or be increased because of climate change, consider how these threats can be mitigated.

Once the potential risks to source water are identified, the working group will need to consider specific management actions that could eliminate or at least reduce the identified threat.

Some case studies and management actions that NWT communities have identified in their planning processes are shared here. Consideration of some of the tools in the community planners tool-box for source water protection are explored in the next section.

Management responses to high turbidity levels

Some communities where turbidity is a particular challenge have reservoirs in which they can store raw water that is taken from the water source during periods of lower turbidity and stored in a reservoir for settling, which reduces the turbidity even further. This is particularly common in communities that use river water as source water. River water can have high turbidity levels in general and very high seasonal peaks. However, it is also part of water treatment plants in some communities that use lake water as their source water but that still encounter high turbidity levels. Trout Lake, Jean-Marie River, Tuktoyaktuk and Wrigley all have reservoirs that allow for pre-settling of water prior to treatment. Ensuring that sufficient water storage space is available to provide water for the community during periods of high turbidity is important as is filling reservoirs during periods of low turbidity. If turbidity challenges increase or the period of time with high turbidity increases, a community may need to invest in more reservoir space. The community of Norman Wells, for example, has recently identified that an additional water silo is needed to meet demand and this cost has been added to their capital plan.[9]

Management responses to flooding in and around solid waste facilities or wastewater treatment lagoons

Changes in hydrology around these sites may necessitate changes to operations and maintenance (O&M) or changes to the anticipated time of replacement. O&M adjustments might include:

- More frequent maintenance on berms and swales surrounding these sites to ensure that water is redirected away from lagoons and waste sites.
- Consistent monitoring during summer months of wastewater effluent and leachate from landfill sites to ensure that nearby water is not being contaminated.
- Establishment of new ground water monitoring sites if increased permafrost thaw may be allowing increased infiltration of water.
- Lagoon dredging earlier than planned to increase capacity and increase free board to prevent flooding.
- Site planning and design for new sites downstream of water intake if sites are currently upstream.

Other examples

Depending on the threat identified, you may be able to identify mitigating management actions. For instance, many residents are aware of sumps that have been used to bury industrial wastes in the past, with the intention that the shallow buried waste will not travel anywhere because of permafrost. Now, with permafrost thaw, some community members ask what impact those sumps may have on surrounding water bodies.

- Identify GPS coordinates for sumps near the community or near important water bodies.
- Notify the Contaminants and Remediation Division of Aboriginal Affairs and Northern Development of the Government of Canada.
- Notify Environment and Natural Resources of the Territorial Government.
- Seek support from other levels of government to identify sump contents, any mobility of contents and to remediate if a threat is identified.

Step 4: Develop an implementation strategy

Once threats have been listed, risks assessed and subsequent management actions identified and prioritized, the working group will need to consider how the actions will be implemented. This will require careful consideration of each step and who will take on the associated roles and responsibilities. Many of the management actions may have financial implications that will need to be considered in your operations and maintenance budget or in your capital plan.

Step 5: Review the source water protection plan

Like all planning processes, source water protection planning is an iterative process that should be reviewed every few years. Review will help to identify what goals have been achieved or where gaps remain in the identified management actions. Moreover, it will provide a chance to review any new threats and to adaptively manage climate change impacts as they are experienced. Climate change projects involve a certain degree of uncertainty, so it will be important to revisit the plan every few years and see if changes are occurring as predicted or if new considerations have arisen.

Tools for source water protection planning implementation

Planning for source water protection inevitably will allow community leadership and staff as well as the general public to recognize the importance of other key aspects to community level water-related planning, monitoring and stewardship. NWT communities have a lot of tools available to them in the toolbox to ensure that they are protecting source water and are resilient to change.

Zoning, land-use planning and bylaws

Land use planning, zoning and associated bylaws are explored in detail in the chapters of this guidebook entitled *land use planning and planning tools* as well as *community planning*. Please refer to these chapters for more detailed information about using these planning tools.

Keep in mind during your source water protection planning process, that these tools are available to you when thinking about how to protect the source of your community's drinking water. For example, in its climate change adaptation plan, the community of Ulukhaktok identified restricting the land around their source water lake from all terrain vehicle and snowmobile traffic in order to protect the source water from bank erosion and from harmful liquids that could leak from mechanized vehicles.[10] Such a prohibition may be enforceable purely through public education and communication; however, bylaws could also be used to help ensure that compliance can be enforceable.

Zoning can be used to keep such sensitive areas surrounding river banks or lake shorelines off-limits for development. Such actions may help to prevent erosion.

Zoning can also be used to facilitate drainage planning. Good drainage can help redirect water away from wastewater and solid waste facilities, which is particularly important for those communities whose solid waste or sewage sites are located upstream of the drinking water intake. Land designated as community right-of ways can be set aside for future development of drainage swales, wetlands, channels or

pipes. Communities where drainage is just beginning to be identified as a challenge may want to make these designations early on, so they have time to identify capital funds to construct the actual infrastructure. Similarly, land located at a higher elevation above a solid waste or wastewater site could be protected to ensure that land development does not exacerbate runoff towards solid waste and wastewater sites.

Solid waste and wastewater facility operations and maintenance plans

Many communities in NWT have solid waste and wastewater facilities located upstream of their drinking water intake. In most of these cases, a substantial wetland between the facilities and the source water ensures that any effluent or leachate is well treated before it enters the source river or lake. Nonetheless, best practice in site design and in operations and maintenance will ensure the continued protection of source water and is an important part of a multi-barrier source water protection approach.

NWT communities are required to submit an operations and maintenance (O&M) plan for their solid waste and wastewater facilities in order to obtain a community water license to run these facilities. It is important that senior staff and works staff are familiar with the O&M protocols for each site and that associated roles and responsibilities are clearly attributed to personnel and included in job descriptions.

If your community is looking at improving implementation of an existing O&M plan or is developing a new one because of water license renewal or licensing of a new facility, ensure that site selection and the O&M plans include climate change considerations, including:

- Site permafrost has been considered in site selection. Solid waste sites are either on bedrock or permafrost that is not susceptible to thaw within the planning timeframe (usually 20 years).
- The impact of permafrost thaw on wastewater lagoons has been considered. Site selection has been chosen to minimize the risk of water infiltration and permafrost is avoided where possible.
- Site drainage has been considered in site selection. As dry an area as possible (typically an elevated area) has been identified. Drainage capacity allows for increases in water flows if this has been identified as a climate change risk for your community and that site.

- The solid waste facility O&M includes a detailed section on hazardous waste management that minimizes on-site storage, ensures dry storage for hazardous waste, keeps an inventory of hazardous waste and plans for routine transportation of hazardous waste to a registered receiving facility.
- The O&M includes water surveillance sites with monitoring protocols. Sites are being routinely sampled as required by the water license.
- Groundwater is being monitored where groundwater contamination is a risk.
- The O&M prescribes monitoring and maintenance of drainage components of the sites such as consistent reinforcement of berms and clearing of swales. These infrastructure components are in good repair and are the clear responsibility of a works staff person.

Safely stored and labeled hazardous waste in Norman Wells is ready to be transported to a registered receiving facility for disposal. Photo credit: London Enns, KBL Environmental, Ltd.

Tips for managing hazardous waste

Hazardous waste, if mixed with regular waste and buried in the solid waste facility, can pose a risk to source water. Changing water flows in and around solid waste facility sites could cause increased leaching of toxic substances from hazardous waste.

Typical hazardous wastes in NWT communities include (but may not be limited to):

- Hazardous liquids: used oil, glycol and other antifreeze, unused or expired fuel,
- Contaminated soil, snow or water
- Oil debris
- Lead acid batteries from vehicles
- Asbestos
- Paint
- Propane tanks
- Household hazardous waste such as: aerosols, household cleaners, pesticides
- Refrigerants (left in old fridges and freezers)
- Mercury containing materials, like vehicle switches, thermostats and fluorescent lights

Collecting hazardous waste separately, each in its own designated and clearly labeled area of the landfill site, will help to ensure that it does not contaminate the surrounding environment. It will need to be shipped out of the community annually, or every two or three years (depending on the size of your community).

Keeping all waste labeled and maintaining an up-to date inventory of hazardous waste will help to ensure that waste is being securely stored and is ready for transport out of the community to a registered receiving facility.

Hazardous waste disposal needs to be included in a community's operations and maintenance budget. There are generally fees for both transport and disposal once the waste reaches the receiving facility. Both the transporter (truck or barge) and the receiving facility need special registration and shipment manifests must be completed.

Special training is needed to properly handle and transport hazardous wastes. At minimum, workers should be certified in Workplace Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods Regulations (TDGR).

Through a hazardous waste management planning process, your community will decide what kinds of hazardous wastes are accepted and from whom. Although residents need a place to bring their hazardous waste, governments and businesses are legally required to dispose of their waste themselves and most NWT community landfills are not registered to accept waste from those sectors. Once you know what kind of waste you are accepting, you can then use the planning process to decide in detail how the waste will be stored, labeled, tracked and transported for disposal.

Best practice

A few basic precautions can make handling and managing hazardous waste much simpler, cheaper and safer.

1. Store like with like. Keep used oil, waste fuel, contaminated water and glycol in separate containers.
   Storing mixed liquids is dangerous. Disposing of drums with mixed contents is expensive.

2. Seal drums tightly.
   Water and melted snow will get into drums without tight seals and will bulge or overflow. Drums must be tightly sealed to be transported. Keep extra bungs on hand.

3. Do not fill drum to the brim
   Liquids can expand and cause the drum to overflow, bulge and leak.

4. Keep hazardous waste dry.
   Hazardous waste stored in wet conditions will corrode and leak. Store drums, pails, batteries and propane cylinders on pallets. Store other hazardous waste in sealed plastic containers or drums.

Hazardous waste management planning resources

GNWT - Environment and Natural Resources has a number of publications available that can help you manage your community's hazardous waste. Search for *Hazardous Waste* at http://www.enr.gov.nt.ca/publications to find how-to guides about:

- Household hazardous waste
- Management of waste asbestos
- Management of waste batteries
- Management of waste lead and lead paint
- Management of waste paint
- Management of waste solvents

A hazardous waste management plan should be included in water license applications and a template for developing a plan is available from the Mackenzie Valley Land and Water Board: http://mvlwb.com/resources/policy-and-guidelines.

An instructional video that can help get you started on managing hazardous waste in your community is available at:

http://www.maca.gov.nt.ca/home/for-community-governments/school-of-community-government/training-videos/

Additional tools to support resiliency

One of the best ways that communities can prepare for climate change is to support their adaptive capacity through best practice in management, monitoring and staff training. Ensuring that your drinking water management system is well planned and implemented by trained staff will help to ensure that it is resilient to any risks exacerbated by climate change.

Your source water protection planning working committee may want to spend some time thinking about different ways to optimize the management of drinking water and ensure the system is as resilient as possible. Some examples are provided here:

Ensure emergency protocols are well developed and practiced.

NWT systems have been designed to manage the high turbidity spikes that might be anticipated within their life span but seasonal or unanticipated spikes may result in the need for water advisories including boil water advisories. These should be recognized as a necessary part of safe water management and not something to avoid, if indeed problems are identified as outlined in the Health Canada document *Guidance for Issuing and Rescinding Boil Water Advisories*[11]. Boil water advisories due to high turbidity levels occur even in urban centres with large and elaborate drinking water treatment facilities.

Ensure that protocols for quickly disseminating information about boil water advisories are in place and consider liaising with residents and media in advance of an event so that the public better understands the use of advisories as a preventative measure.

Ensure drinking water is protected along the entire line of delivery

Once drinking water arrives at a residential home tank, it becomes the responsibility of the homeowner or resident to ensure that it isn't subsequently contaminated. For residents who rely on home water tanks, this means keeping water pipes and tanks clean. Some communities actively support residents in this task, as it can seem daunting. Consider taking an active role in communicating the importance of clean home water tanks and provide residents with information about how to clean their own tanks. The department of Municipal and Community Affairs of the Government of Northwest Territories has created a *How to Clean Your Water Tank* video with step-by-step instructions, at http://www.maca.gov.nt.ca/home/for-community-governments/school-of-community-government/training-videos/.

Public education

No matter what actions are identified in your source water protection plan, you'll likely need to foster public support.

Consider outreach and communication initiatives in all of your related plans. For instance, household hazardous waste collection events and associated promotion can help community residents to understand the importance of separating hazardous waste from their other waste (and how to do it!).

Understanding the important role of chlorine in killing bacteria, even after the water has left the water treatment plant is also important. Sharing this information with residents or encouraging the boiling of untreated water will likely help to protect public health. Municipal and Community Affairs has also created a video explaining the role of chlorine in the drinking water treatment process and another explaining the various ways that drinking water in the NWT is kept clean and safe. The two videos, *Chlorine: How it works and why we use it* and *Life source: Ensure safe drinking water* can be found at http://www.maca.gov.nt.ca/home/for-community-governments/school-of-community-government/training-videos/.

A household hazardous waste roundup like this one in Fort Smith is an effective way to keep hazardous waste out of the landfill and to educate the public. Photo credit: Gerald Enns

Checklist: Considering climate change in source water protection

- ❑ Our community's source water protection planning process included climate change experts and department of works staff on the working committee and on a technical advisory group.
- ❑ Our community's assessment of source water threats considered regionally projected climate change impacts including the potential for:
    - ❑ increased flooding,
    - ❑ increased erosion,
    - ❑ melting permafrost, and
    - ❑ increased turbidity in source water.
- ❑ Threats to the source water were assessed with the climate change impacts above in mind.
- ❑ Our community has a certified water operator and a certified back-up operator who has up-to-date training. Staff attend annual conferences and workshops for continued professional development.
- ❑ Turbidity levels of drinking water are kept within acceptable levels before chlorination, even during periods of high turbidity, such as break-up. There is sufficient reservoir space to handle higher than normal turbidity spikes if necessary.
- ❑ Boil water advisory protocols in our community are clear and emergency scenarios are practiced by staff. Community members are aware of boil water protocols and their role in prevention of illness.
- ❑ The design and maintenance of our **solid waste and wastewater facilities consider** assessed climate change impacts.
    - ❑ Our community has an up-to date operations and maintenance plan for both the solid waste facility and the wastewater treatment system. Works staff and senior administration are familiar with these plans and the plans are being implemented on the ground.
    - ❑ Our waste facilities are adequately separated from our source water area, including under changing conditions such as permafrost thaw.

- ❑ Wastewater and solid waste facility design includes appropriate drainage plans in and around the facility that account for the risk of increased water flows, if applicable.
- ❑ The solid waste facility and wastewater facility operations and maintenance plans include surface and, where appropriate, groundwater monitoring sites that are regularly sampled during the summer for specified water quality parameters. These results are submitted to the land and water board.

❑ Our solid waste facility operations and maintenance plan includes a detailed hazardous waste management plan.

- ❑ A regular inventory of hazardous waste is conducted at the solid waste site.
- ❑ Hazardous waste is labeled and stored in safe, dry, separate locations ready for shipment out of the community.
- ❑ Hazardous waste is routinely transported to a registered receiving facility with a registered carrier and with completed shipment manifests.

❑ Households in our community have access to information on how to clean and maintain water tanks.

❑ Our source water protection plan is reviewed and updated approximately every five years, with appropriate consideration of climate change impacts.

Glossary

Berm
A raised barrier separating two areas. In the context of source water protection, a berm is a build-up of gravel and clay material intended to keep water inside the berm from flowing out and / or to keep water from outside the berm from flowing in. Most sewage lagoons have a berm built-up around them and berms are sometimes used in solid waste facilities to re-direct water flow.

Cryptosporidium
A chlorine tolerant parasite that can contaminate water through the feces of many invertebrates, and in sufficient quantity can cause human illness.

E. coli
Abbreviation for *Escherichia coli*. A family of bacteria that is found in the intestinal tract (and therefore the feces) of many vertebrates. *E. coli* is frequently used as an indicator of the presence of feces in water. Some strains of *E. coli*, if present in drinking water, can cause human illness.

Effluent
Wastewater that flows out of or is discharged out of a sewage lagoon.

Free board
The vertical distance from the top of a wastewater lagoon's water level and the top of the berm surrounding the lagoon.

Leachate
A solution formed by water passing through matter and collecting particles or contaminants. In this context, leachate from a landfill is water that has come in contact with waste and may have picked up some contaminants.

Residual chlorine
Refers to the amount of chlorine that remains in water after addition, as chlorine will evaporate over time or bind to other elements in the water. There are minimum and maximum levels of chlorine that need to be maintained in drinking water to ensure that the chlorine can continue to keep the water clean but not be too high for human consumption.

Source water protection planning
Planning to keep the source (river, lake or groundwater) of community drinking water clean.

Swale
A gently sloped channel in the landscape that often conveys water. In this context, generally referring to artificial swales (or channels) used to redirect water flow.

Turbidity
A measure of how much light can pass through water. When water contains more suspended particles (sediment), less light will be able to pass through it and it will appear muddier or more turbid. Disease-causing agents may be attached to those particles, so drinking water has to be kept below a threshold of turbidity. These same particles can also bind to chlorine, rendering it inactive and disrupting the treatment process. This is why water is filtered before it is chlorinated.

Resources

Northwest Territories Source Water Assessment and Protection (SWAP) Guidance Document.

ENR has a plain language guidance document and a workbook available to help communities with the source water protection planning process.

- http://nwtwaterstewardship.enr.gov.nt.ca/sites/default/files/SWAP_Guidance_web.pdf

Workbook available on-line at:

- http://nwtwaterstewardship.enr.gov.nt.ca/sites/default/files/SWAP_Workbook_web.pdf

Ecology North

Navigating the Waters of Change: Strengthening the Capacity of NWT Communities to Respond to the Impacts of Climate Change on Municipal Water and Wastewater Systems.

- http://www.ecologynorth.ca/knowledge/water/

ENR – GNWT: Community Catchment Basin Maps:

GNWT has produced source water catchment maps that illustrate the source water basin for every community in the NWT

- http://www.geomatics.gov.nt.ca/maps.aspx?i=8

Source water protection video

- https://www.youtube.com/watch?v=TiDwvwuDWKw

Water Quality and Quantity in the NWT Water Today. 2010.

This brochure outlines water issues in the NWT, including water monitoring programs, and answers a variety of other water quality and quantity questions.

- http://www.enr.gov.nt.ca/sites/default/files/water_today.pdf

Endnotes

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5 Mr. Justice Dennis O'Connor. 2002. The Walkerton Commission of Inquiry. Available on-line at: www.attorneygeneral.jus.gov.on.ca/english/about/pubs/walkerton/

6 The Honourable Justice Robert D. Laing. Commissioner. 2002. *The North Battleford Water Inquiry Report*. Available on-line at; www.justice.gov.sk.ca/nbwater/

7 Government of Northwest Territories, Environment and Natural Resources, 2012. Northwest Territories Source water Assessment and Protection (SWAP) Guidance Document. Available on-line at: http://nwtwaterstewardship.enr.gov.nt.ca/sites/default/files/SWAP_Guidance_web.pdf

Workbook available on-line at: http://nwtwaterstewardship.enr.gov.nt.ca/sites/default/files/SWAP_Workbook_web.pdf

8 These climate change impacts and management actions were identified in the following suite of documents:

Ecology North (Ripley). 2009. Navigating the Waters of Change: Strengthening the Capacity of NWT Communities to Respond to the Impacts of Climate Change on Municipal Water and Wastewater Systems.

Ecology North (Nesbitt). 2010. Protocol to assess the vulnerability of northern water and wastewater systems to climate change impacts.

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Ecology North (Wenman). 2011. Navigating the Waters of Change in Ulukhaktok. Planning for community watershed protection and climate change impacts on community water, wastewater and solid waste infrastructure.

Ecology North (Wenman). 2011. Navigating the Waters of Change in Sambaa K'e. Planning for community watershed protection and climate change impacts on community water, wastewater and solid waste infrastructure.

9 John Greathead, Water Plant Manager, Town of Norman Wells. Personal Communication, March 2014.

10 Pearce T, Caron A, Prno J, and Smith T (2010) Climate Change Adaptation Action Plan, Ulukhaktok, Northwest Territories. Guelph, Ontario. Joint Publication of the Community of Ulukhaktok and Arctic North Consulting.

11 Health Canada (2014). *Guidance for Issuing and Rescinding Boil water Advisories*. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water. Consultation version, consultation period ends June 16, 2014. Available on-line at http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/consult/_2014/boil_water-eau_ebullition/consult-eng.pdf accessed April, 2014.