GUIDEBOOK

Planning for the Future

Guidance and tools for enhancing the climate resilience of Manitoba's integrated watershed management plans

IISD
International Institute for Sustainable Development

© 2024 International Institute for Sustainable Development | IISD.org

August 2024

© 2024 International Institute for Sustainable Development
Published by the International Institute for Sustainable Development

This publication is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

International Institute for Sustainable Development

The International Institute for Sustainable Development (IISD) is an award-winning independent think tank working to accelerate solutions for a stable climate, sustainable resource management, and fair economies. Our work inspires better decisions and sparks meaningful action to help people and the planet thrive. We shine a light on what can be achieved when governments, businesses, non-profits, and communities come together. IISD's staff of more than 200 experts come from across the globe and from many disciplines. With offices in Winnipeg, Geneva, Ottawa, and Toronto, our work affects lives in nearly 100 countries.

IISD is a registered charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Province of Manitoba and project funding from governments inside and outside Canada, United Nations agencies, foundations, the private sector, and individuals.

Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Website: iisd.org
X: @IISD_news

Planning for the Future:
Guidance and tools for enhancing the climate resilience of Manitoba's integrated watershed management plans

August 2024

Photo: iStock

Acknowledgements

Planning for the Future: Guidance and Tools for Enhancing the Climate Resilience of Manitoba's Integrated Watershed Management Plans was made possible with funding from Manitoba Habitat Conservancy (MHC) through the Conservation Trust. Established by the Province of Manitoba, the Conservation and GROW Trusts are an innovative way to fund nature-based approaches to climate change mitigation and habitat conservation, forever.

MHC and IISD thank everyone who contributed their time and expertise to this report. Thank you to key contributors, including the Prairie Climate Centre (Matthew Loxley and Taylor Livingston) and IISD staff (Jo-Ellen Parry, Ashley Rawluk, Georgia Exell, Cameron Hunter, Madeline Stanley, Marina Puzyreva, Tyler Farrow, Elise Epp, and Marie Royer).

We would also like to extend a special thank you to the individuals who reviewed the guidance and provided feedback:

- IISD: Angie Dazé and Dimple Roy
- Samantha Boardley
- Government of Manitoba: Lacy Kontzie and Madeline Dessler
- Pembina Valley Watershed District: Ryan Sheffield and Cliff Greenfield

Manitoba Habitat Conservancy

Indigenous Lands and Cultures

The region we refer to as Manitoba is home to an incredible diversity of Indigenous cultures. Indigenous Peoples across Manitoba are rightsholders with robust knowledge, close connection to their traditional lands, and jurisdiction over their territories.

The region of focus for *Planning for the Future: Guidance and Tools for Enhancing the Climate Resilience of Manitoba's Integrated Watershed Management Plans* spans Treaty 1 Territory and the ancestral lands of the Anishinaabee, Cree, Oji-Cree, Dakota, and Dene peoples, and the homeland of the Métis Nation.

At IISD, we uphold the agency and autonomy of Indigenous Peoples, supporting their efforts to revitalize and engage with their heritage across traditional, contemporary, and future contexts. We offer respect to those who have long lived with and stewarded lands and waters across Manitoba. We recognize and honour the ongoing leadership of First Nations and Metis communities.

We encourage everyone to visit native-land.ca to learn more about traditional lands and treaties across the Prairies.

Table of Contents

List of Figures

List of Tables

Abbreviations and Acronyms

BMP	beneficial management practice
GHG	greenhouse gas
IWMP	integrated watershed management plan
MEL	monitoring, evaluation, and learning
PCC	Prairie Climate Centre
RCP	representative concentration pathways
EG&S	ecological goods and services

Glossary

This glossary is derived from *Guidance on Good Practices in Climate Change Risk Assessment* (Canadian Council for Ministers of the Environment, 2021) unless otherwise noted.

Adaptation	Any effort or action to respond to actual or anticipated climate change impacts that minimizes the effects of climate change on built infrastructure, natural ecosystems, and social systems.
Adaptation planning	The process of learning about the potential impacts of climate change on a community. With this understanding, the community can identify and prioritize risks and create plans to ensure that the community is better prepared in the face of an uncertain future.
Beneficial management practices	Agricultural practices that reduce or eliminate environmental risk. They maintain or improve the soil, water, air, and wildlife habitat, contributing to the economic and environmental sustainability of the farm, as well as the surrounding landscape and community (Alberta Agriculture and Forestry, 2018).
Co-benefits	The multiple additional benefits that an action, while implemented for a primary outcome, has on another outcome, subsequently increasing the total benefit to society or the environment (IPCC, 2022). For example, a water retention project can reduce peak flows during floods (primary outcome), while additionally increasing water storage, improving water quality, improving adaptive capacity, reducing soil erosion, and enhancing aquifer recharge (co-benefits).
Climate change	A change in long-term weather patterns over an extended period (often decades or longer) due to natural phenomena and human activities (e.g., use of fossil fuels and release of carbon dioxide) that change the chemical composition of the atmosphere through the accumulation of greenhouse gases. Climate change is contributing to a rising global temperature, changing rain and snowfall patterns, warming oceans, and many other impacts.
Climate hazard	A biophysical event that can cause impacts to built infrastructure, natural ecosystems, and social systems. Examples of hazards include droughts, rain, high winds, tornadoes, wildfires, and hail.
Climate impact	The effects of climate (either existing or forecasted) on built infrastructure, natural ecosystems, and social systems. For example, the impact of drought (a climate hazard) may be reduced crop yields, insufficient potable water, and an increased risk of wildfire.

Climate risk	The potential for adverse consequences from a climate impact, where something of value is at stake and where the occurrence and degree of an outcome is uncertain. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.
Consequence	Something that occurs in response to a particular climate impact. Drought (hazard) causes reduced crop production (impact) which can lead to an increase in insurance claims (consequence).
Ecological goods and services (EG&S)	"The positive conservation benefits that come from healthy ecosystems, including clean water and air, and enhanced biodiversity. EG&S include market goods produced from ecosystems (commodities, food, and fibre), improved wildlife habitat, benefits from ecosystem processes, including water purification or carbon storage, and other values such as improving recreational opportunities" (Manitoba Habitat Conservancy, n.d.).
Integrated watershed management plan (IWMP)	A long-term action plan to manage land, water, and related resources on a watershed basis. In Manitoba, Watershed Districts lead the planning process as they are the designated Water Planning Authorities under The Water Protection Act (2005). The provincial ministry responsible for watershed management planning provides a planning grant, along with a Watershed Planner, to aid in the development of an IWMP (Souris River Watershed District, 2020).
Low- or no-regrets approaches	Actions that always have a positive impact for ecosystems and communities regardless of how the climate changes. These actions do not increase vulnerability to climate change, although they typically do increase the community's and/or ecosystem's adaptative capacity (International Union for the Conservation of Nature, 2022).
Maladaptive	"Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence" (Möller et al., 2022).
Mitigation (of climate change)	"A human intervention to reduce emissions or enhance the sinks of greenhouse gases" (Intergovernmental Panel on Climate Change [IPCC], 2022, p. 2915).

Project management team	In Manitoba, a group of individuals designated by the water planning authority to facilitate a community-led integrated watershed management planning process. Its members can include landscape managers, agricultural producers, and representatives of municipalities, Indigenous communities, and the provincial and federal governments. This team serves as a local steering committee in the development of the IWMP and guides the overall management and development of the plan (Souris River Watershed District, 2020).
Resilience	The ability of built infrastructure, natural ecosystems, and social systems to maintain their essential function when exposed to a hazard. Climate resilience can be increased by making changes in preparation for a hazard, such as relocating a house to a location outside of the floodplain in preparation for the increased frequency and severity of floods.
Vulnerability to climate change	The degree to which built infrastructure, natural ecosystems, and social systems are susceptible to harm or damage from climate change impacts. It is a function of both sensitivity to climate change and capacity to adapt to the impacts.
Water planning authority	The recognized legal organization in Manitoba, authorized through The Water Protection Act (2005), that assumes the responsibility of developing the IWMP (Souris River Watershed District, 2020). Often, the water planning authority is the watershed district(s) that is/are responsible for the watershed of interest.
Watershed planner	A provincial employee that leads the IWMP process by providing support to the water planning authority under The Water Protection Act (2005) (Souris River Watershed District, 2020).
Watershed team	A large team of 30–40 people, with backgrounds in scientific, traditional, and local knowledge, that provides technical information and advice throughout the development of the IWMP. The watershed team may provide an overview of existing information to support public engagement and the understanding of the watershed, as well as identify assets and issues, assess options, and provide recommendations for specific watershed issues (Souris River Watershed District, 2020).

1.0
Introduction

Manitoba's climate has already changed, with Manitobans experiencing hotter temperatures, more wildfires, changing precipitation patterns, and more frequent floods and droughts. The ongoing process of **climate change** is causing the Prairie region to warm more quickly than all other regions of Canada outside of the Arctic (Sauchyn et al., 2020). Reducing the release of the greenhouse gas (GHG) emissions that fuel this process will limit the severity of climate change, but some degree of change is inevitable. Manitoba's watershed districts must prepare for the anticipated impacts of a changing climate, by identifying and implementing actions to reduce risk and increase resilience. The development or update of **integrated watershed management plans** (IWMPs) presents an important opportunity for watershed districts to incorporate climate **adaptation planning**. By integrating climate risks in IWMPs, actors within the watershed district can prepare for changing climate risks and limit the adverse impacts of climate change on the watershed. Adaptation planning can also be useful in identifying and taking advantage of any potential economic and social opportunities that may arise due to the watershed's changing climate conditions.

IWMPs are long-term, collaborative plans to manage the land and water on a watershed basis and provide an ideal entry point to prepare for climate change. Embedding climate change considerations into the IWMP planning process can help increase climate resilience at a watershed scale. This guide has been developed to help the watershed planners, water planning authority, and project management team tasked with leading the IWMP process to incorporate climate change considerations and engage in adaptation planning.

1.1 Why Should Manitoba's Watershed Districts Incorporate Climate Change Considerations Into Their IWMPs?

The Water Protection Act (2005) mandates the development of IWMPs, which outlines goals and actions to manage land and water resources on a watershed basis based on the circumstances unique to each watershed, such as land use (e.g., agriculture or forestry), topography, hydrology, and population demographics.

Climate change will increase the frequency and severity of rapid-onset, extreme weather events (such as floods, droughts, heatwaves, and wildfires) and slow-onset events (such as gradual changes in average temperatures or changes in the length of seasons). Both rapid- and slow-onset events will have implications for water quality and quantity in Manitoba's 14 watershed districts. These changes have consequences for natural systems, like riparian or wetland ecosystems, and the **ecological goods and services (EG&S)** that they provide, such as flood protection and water filtration. Economic sectors like agriculture and tourism, as well as physical infrastructure, such as flood barriers and roads, will also be affected.

As temperatures and hydrological patterns change, watershed districts must consider how to incorporate climate adaptation in their management plans and programs to maintain the health of the watershed and the delivery of ecological, economic, and social benefits that residents enjoy and rely upon, all while facing an uncertain future. A lot of these concerns are already addressed through the IWMP process, making it a convenient entry point for adaptation planning.

1.2 How Can Incorporating Adaptation Improve Watershed District Programs?

The objective of climate change adaptation is to explicitly respond to observed or anticipated changes in climate, based on an understanding of the potential impact of these changes. With this understanding, adaptation is a matter of identifying activities that can help reduce future climate risks. These activities can increase the climate resilience of the watershed and its residents. Many climate-resilient actions provide additional co-benefits that help achieve other watershed management goals, such as soil health improvement, water quality protection, wildlife habitat conservation, or climate change mitigation.

Many of the programs and **beneficial management practices (BMPs)** that the watershed districts currently promote and implement have the potential to provide climate change adaptation benefits. By developing a deeper understanding of a watershed's **climate risks**, watershed districts can continue to use tried-and-true BMPs, as well as develop new programs and actions, to build resilience under the current and future climate. For example, water retention is a program currently popular with watershed districts. To ensure a climate-resilient future, watershed districts need to have considered if or how their water retention activities will remain effective as the impacts of climate change become more apparent. For example, it is important to think about the design of the water retention project with anticipated changes to the timing and volume of precipitation:

- Is the water retention project large enough to capture heavier spring runoff and rainfall predicted in future climate scenarios?
- Does it have enough storage capacity to help alleviate the severity of prolonged drought as considered in climate predictions?

Once climate change has been considered in the decision-making and planning process, the traditional action can be considered an intentional climate-resilient action that explicitly considers and addresses the anticipated risk of climate change (Table 1).

Table 1. Example of an existing program that, when viewed through a climate adaptation planning lens, may also increase the resilience of the watershed, taking water retention from a traditional action to a climate-resilient action

Program	Water retention
Description	The construction of small dams, water retention basins, and temporary back floods, or the addition of infrastructure, like berms and gated culverts, to store surface water runoff.
Climate risk addressed	Increased intensity and frequency of extreme weather events, like floods and drought.
Benefit specific to increased climate resilience	Enhanced water storage capacity (that considers climate change impacts) can moderate the timing of peak flows and runoff velocity to reduce downstream flooding; enhanced water storage can assist in holding water on the landscape, recharging the groundwater aquifer, and possibly preserving a water source during drought.
Climate lens	Consider how precipitation is anticipated to increase: Does the control structure need to be larger? Will the footprint of the water retention pond increase? Consider how drought is anticipated to increase. Can the storage capacity be increased to hold more water in case of drought?
Co-benefits	Improves water quality, reduces soil erosion.

Source: Authors.

Tip: Actions, old and new

To help distinguish existing BMPs and programs that do not consider climate risk from new or updated actions that do consider climate risk, the guidebook uses the following terms:

- **Traditional actions** include the programs and BMPs that the watershed districts currently promote and implement that do not explicitly consider climate risk.
- **Climate-resilient actions** include both existing and new BMPs or programs that explicitly consider climate risk and are implemented to provide adaptation benefits.

1.3 About This Guidebook

This guidebook has been developed to support the water planning authority, project management team, and watershed planner(s) integrate climate change considerations as they initiate, undertake, and contribute to the process of developing or updating the IWMPs.

The application of this guidance and its associated tools is expected to

- help assess how the anticipated impacts of climate change will affect the watershed and identify actions that will reduce the risk and severity of these climate impacts;
- increase the knowledge of the water planning authority, project management team, and watershed planner(s) about climate change risks within their watershed and build their capacity to manage these risks;
- streamline the time and resources required for adaptation planning by integrating it within the existing IWMP process;
- ensure that investments in the watershed are appropriate to the changing climate in the long term and are less likely to be maladaptive.

The guidebook is structured to incorporate the climate adaptation planning process into the existing IWMP processes by identifying entry points at different stages of the IWMP process. Each section identifies

 the team members that will lead that entry point, and

 associated tools.

After a description of the integration of the IWMP and adaptation planning processes (Section 2), the guidebook focuses on entry points during the stages of the IWMP process:

- Preplanning (Section 3),
- Gather Information (Section 4),
- Plan Drafting (Section 5),
- Plan Review and Plan Approval (Section 6), and
- Implement (Section 7).

The appendices include detailed guidance and tools to support the suggested entry points:

- Appendix A. Example of Written Content to Include in the terms of reference
- Appendix B. Summary of Climate Projections for the Province of Manitoba
- Appendix C. The Climate Atlas of Canada for Accessing and Interpreting Climate Data
- Appendix D. Suggested Climate Variables Relevant to Watershed Management
- Appendix E. A General List of Hazards, Impacts, and Consequences
- Appendix F. Menu of Climate-Resilient Actions
- Appendix G. Suggested Questions for Engagement With Watershed Residents
- Appendix H. Climate Risk Matrix Exercise
- Appendix I. Build an Initial List of Climate-Resilient Actions
- Appendix J. Evaluation of Climate-Resilient Actions
- Appendix K. Resources

This guidebook is intended to be used by leaders in the IWMP process, such as the water planning authority, watershed planner, and the project management team. No previous experience with the adaptation planning process is required because the guidebook provides background information about climate change and adaptation and provides step-by-step guidance for navigating entry points into the IWMP process. Key terms or concepts are bolded throughout the guidebook, and definitions for each of these bolded terms can be found in the glossary. Resources to strengthen knowledge of these topics are provided within relevant sections of the guidebook. For easy referral, these resources, and more, are included in Appendix K.

2.0 Integration of Climate Adaptation Planning and the IWMP Process

2.1 The IWMP Process

Manitoba's existing IWMP process, with the six stages shown in Figure 1, provides an ideal opportunity to build climate change resilience by incorporating the key steps in the climate adaptation planning process. Specifically, ensuring that the IWMP process explicitly incorporates an understanding of key climate impacts, resulting risks to key sectors and actors, and adaptation actions across the watershed to reduce these risks will result in more resilient watershed management plans.

Figure 1. Manitoba's Integrated Watershed Management Plan Process

Source: Government of Manitoba, n.d.

The IWMP is led and developed by participants with defined roles, along with collaboration across many organizations, including the watershed district, all levels of government, Indigenous communities, conservation agencies, and watershed residents, enabling coordinated decision making and actions. As watershed districts are already leading collaborative water management across their jurisdiction, and often as the designated water planning authority, they play a critical role in integrating adaptation planning into the IWMP process, supporting efforts to prepare for and reduce the risks associated with climate change (Box 1). IWMPs are periodically reviewed and updated, typically on a 10-year timeline.

Tip: Participants in the IWMP process

A variety of representatives participate in the IWMP process:

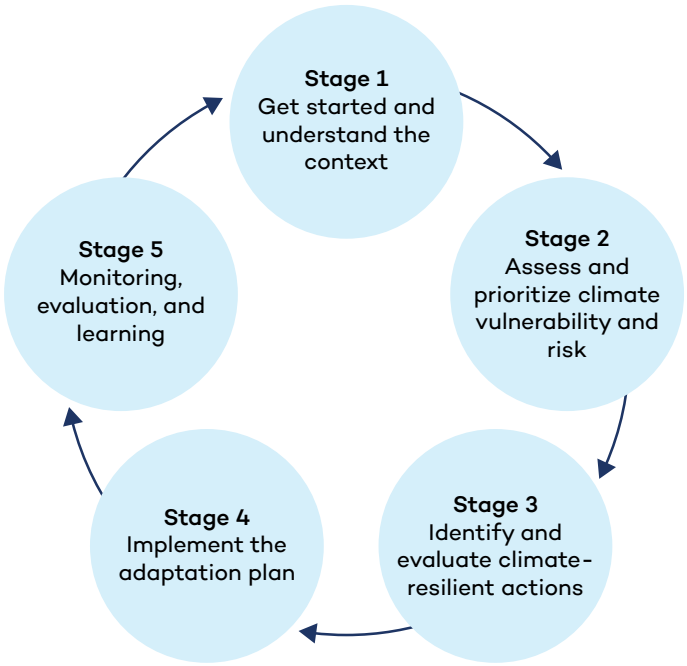
- The water planning authority is the recognized legal organization that assumes the responsibility of developing the IWMP. Often, the water planning authority is the watershed district that is responsible for the watershed of interest.
- Watershed planners are provincial employees who provide professional planning support and guidance throughout the IWMP process.
- The project management team serves as a local steering committee in the development of the IWMP. The project management team can include landscape managers, agricultural producers, municipalities, representatives from Indigenous communities, and the provincial and federal governments within the watershed.
- The watershed team includes 30–40 people with expertise in a variety of areas who provide technical information to the project management team and watershed planner throughout the IWMP process.
- The project management team and watershed planner must engage with the municipalities, Indigenous communities, residents, and the watershed district board from the watershed of interest throughout the IWMP process.

2.2 The Adaptation Planning Process

Like the IWMP process, adaptation planning is a cyclical, iterative process that moves through a series of five interrelated stages, as shown in Figure 2:

1. Getting started: Adaptation planner leaders raise awareness around predicted impacts of climate change for the region and engage with community members and relevant stakeholders. The scope and objectives of the adaptation planning process are determined, and necessary resources confirmed.
2. Assessing and prioritizing climate vulnerability and risk: Those working on the adaptation planning process identify, assess, and prioritize current and future climate risks most relevant to key sectors and community residents for the overall objective.
3. Identifying and evaluating climate-resilient actions: Measures that can reduce the priority climate risks are determined and prioritized.
4. Implementing the adaptation plan: An adaptation plan that includes the selected climate-resilient actions is finalized and implemented over a set timeframe.
5. Monitoring, evaluation, and learning (MEL): Progress on the implementation of the plan is measured and evaluated. The plan is periodically updated based on the lessons learned and new information on projected climate risks.

Figure 2. The adaptation planning process



Source: Adapted from the Intergovernmental Panel on Climate Change [IPCC], 2014.

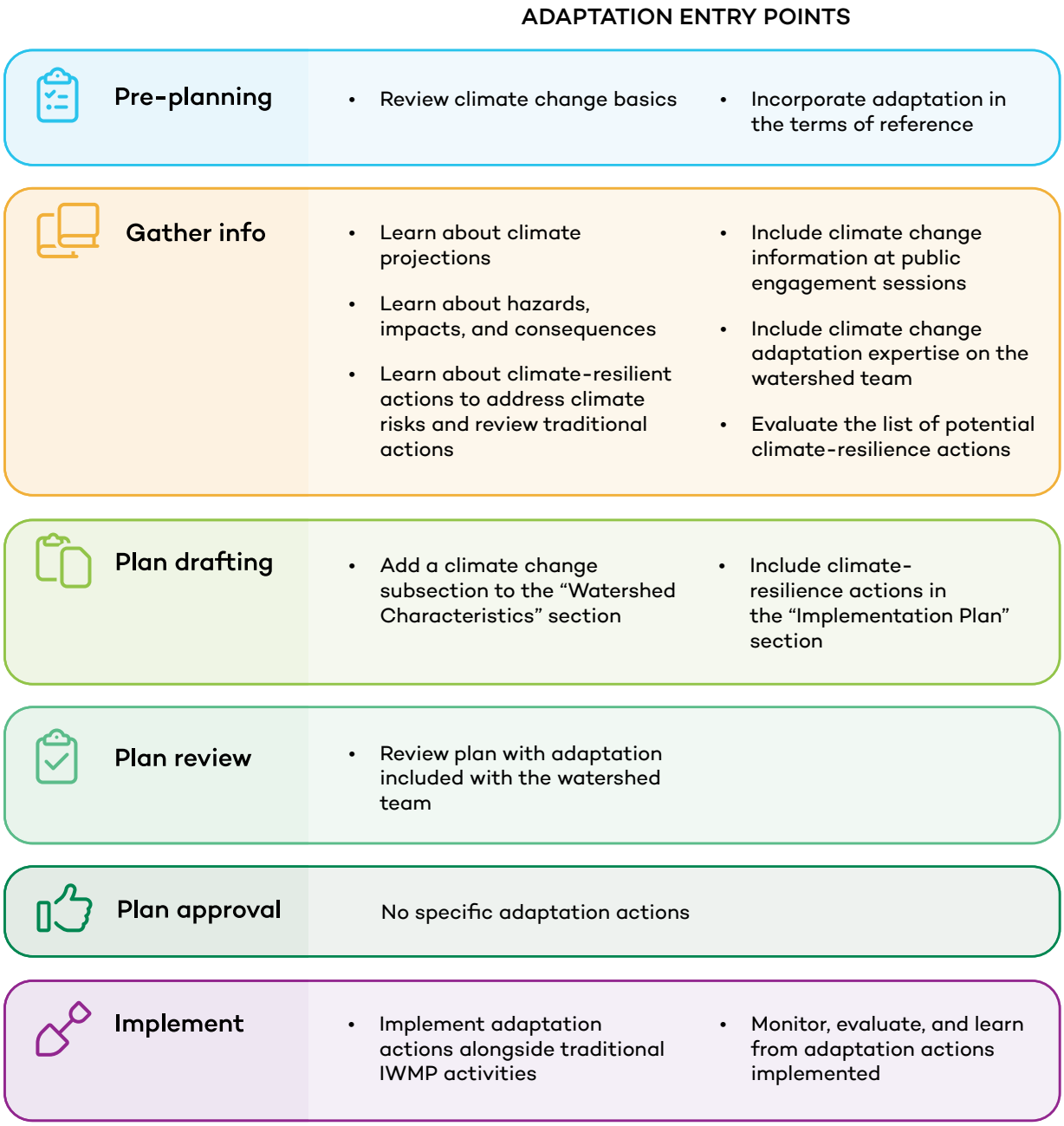
2.3 Adaptation Entry Points in the IWMP Process

With lots in common between the two processes, there are many opportunities to incorporate adaptation into the IWMP process:

- Both processes involve a heavy emphasis on participatory and collaborative engagement with residents, stakeholders, and government officials to ensure they accurately represent the goals, issues, and priorities of the region.
- Both processes are place-based, meaning that the identified issues and risks and the associated response strategies are largely determined by local circumstances and capacities.
- Both processes are guided by the collection of information and analysis of available data, including scientific data sources, local experience, and Indigenous knowledge.
- Both processes include monitoring and evaluation to monitor progress, evaluate results, and learn from and adjust action based on those results.
- Both processes are iterative and include opportunities to adjust efforts and actions for better outcomes.

In recognition of the opportunities to strengthen the IWMP process by integrating adaptation, this guidebook identifies adaptation entry points at different stages of the IWMP process (Figure 3). While these entry points will require some extra time and effort in the IWMP process, the result is a stronger IWMP that is more resilient and responsive to climate change, both today and in the future.

Figure 3. The adaptation entry points identified in Manitoba's IWMP process



Source: Authors' diagram.

3.0
Preplanning

Preplanning

The preplanning stage includes:

- The development of a memorandum of understanding between the Government of Manitoba and the relevant watershed district(s), designating them as the water planning authority and listing their roles and responsibilities in the development of the IWMP.
- The water planning authority and watershed planner form the project management team and develop the terms of reference for the IWMP.

3.1 Review Climate Change Basics

Who is responsible:
Water planning authority and watershed planner

At the beginning of the IWMP process, the water planning authority and watershed planner will benefit from reviewing or learning about climate change and adaptation planning. This can be done as a group at an early, bimonthly meeting, or each member can review the suggested content individually. The following online information and webinars are useful:

- The Climate Atlas of Canada has a variety of articles and short videos, with the option to filter by "climate science" (or tune into to all to learn about health, Indigenous knowledge, cities, and more).
- The Prairie Climate Centre (PCC) prepared a report, Manitoba and Climate Change (PCC, n.d.), that summarizes the expected impact of climate change for Manitoba.
- Manitoba Climate Resilience Training provides training to access, use, and apply knowledge and tools on climate change adaptation. It includes foundational training as well as presentations (and associated slide decks) on infrastructure and Indigenous knowledge and climate change solutions. The module A Path Forward includes information about the integration of climate change into IWMPs.

3.2 Incorporate Climate Change Adaptation in the Terms of Reference

Who is responsible:
Water planning authority and watershed planner

The water planning authority and watershed planner may create terms of reference that lists information about the development of the IWMP, including the purpose of the plan, suggested representation of the project management team and watershed team, participant roles and responsibilities, schedule, budget, and other information to guide the planning process.

The water planning authority and watershed planner can help ensure that climate change adaptation is considered early in the IWMP process by clearly identifying and including terms like "climate change," "climate risk," "resilience," and "adaptation" in the terms of reference for the IWMP. See Appendix A for an example of written content that can be used or modified when developing the terms of reference to show commitment to incorporating climate change adaptation early in the IWMP process.

Further guidance:

Appendix A. Example of Written Content to Include in the Terms of Reference

4.0
Gather Information

Gather info

Throughout the information-gathering stage of the IWMP process:

- The project management team and watershed planner begin to collect and compile existing information and studies to build the Watershed Characterization section.
- Through public engagement and watershed team meetings, the project management team and watershed planner will also map regions with water management issues and develop a list of prioritized issues and options. Adaptation planning ideally follows a similar approach, where team leaders gather information specific to the region and engage with residents to understand local challenges.

The information-gathering stage is an ideal opportunity to learn about the projected changes to the climate of the watershed as a key element of the IWMP-specific information.

4.1 Learn About Climate Projections for the Watershed

Who is responsible:
Project management team, watershed planner, and watershed team (as required)

Gathering and compiling technical reports and information on future climate change projections can help understand what the watershed's climate may look like in the future and assist with planning for those coming changes.

Some key questions to consider when reviewing and interpreting climate data for the watershed are provided in Table 2.

Table 2. Key questions and possible answers when reviewing and interpreting climate data

Some key questions to consider when reviewing and interpreting climate data for the watershed	Examples of possible answers
How have climate variables such as temperature and the number of heavy rainfall events changed over the past 50 years?	The summers seem hotter, and there seem to be fewer gentle summer rains.

Some key questions to consider when reviewing and interpreting climate data for the watershed	Examples of possible answers
How do the climate projections indicate that variables, such as temperature and the number of heavy rainfall events, will change in the future?	Climate projections show that summers will have higher average temperatures, with more hot days that last for longer stretches of time.
How are these changes expected to affect water (quantity or quality), land cover, or other key EG&S?	There will be more spring runoff that may cause flooding. Hotter temperatures during summer may cause drought, along with heavy, extreme rainfall.
Are there any significant variations around seasons or locations? For example, are weather trends more pronounced during the winter?	There are more frequent freeze–thaw events during winter.
Are upstream reaches of the watershed affected differently than downstream?	There is more flooding in regions that are predominantly annual cropland.

Source: Authors.

The following three approaches can be used to learn about climate projections for the watershed. The three options range from simple to more complex. Choose the approach that best suits the scope of the IWMP or the expertise of the watershed team, who can gather and interpret this information to share with the project management team and watershed planner.

Simple: Broad Climate Change Projections for the Province of Manitoba

PCC published a summary of anticipated changes in climate variables across Manitoba, as well as a description of how these changes will impact economic sectors and local residents. Although the information is not specific to any one watershed region, it does provide insight into general trends that can be shared with the project management team, watershed planner, and local residents. This general information can help identify climate hazards of concern to the watershed (now and in the future) and the selection of actions to address these concerns.

Appendix B provides a summary of the projected temperature trends and potential major impacts of climate change for the Province of Manitoba.

If broad climate change projections for the province do not provide the necessary level of detail, two free sources of climate data are also available: the Climate Atlas of Canada and ClimateData.ca. These datasets are used in the intermediate and complex approaches described below.

Intermediate: General Climate Change Projections for the Watershed Region

The Climate Atlas of Canada is a user-friendly source of climate data for watershed-level initiatives. The Atlas provides an interactive map that can be used to explore how climate variables, such as temperature, precipitation, and length of the frost-free season, are projected to change in the near and longer terms for a particular province, region, town, or city under either a scenario in which there is a significant reduction in greenhouse gas emissions (low-emission scenario) or in which greenhouse gas emissions continue to grow (high-emission scenario).

Appendix C provides resources that can assist the project management team and watershed planner with using the Climate Atlas.

Appendix D provides a fillable table with suggested climate variables that may be relevant to watershed management. The table provides a comparison of the recent past with projected near-term changes (2021–2050) to explore how the variables are projected to change.

Complex: Detailed Climate Change Projections for the Watershed Region

If detailed and location-specific climate projections are required for the watershed, ClimateData.ca can provide this level of data. ClimateData.ca provides the user with many options to specify physical regions, including watersheds, and specific climate variables, time frames, and emission scenarios. The increased ability to customize the type of data accessed requires a greater level of technical expertise to navigate, access, and interpret the data. Watershed team members may already have the expertise required to carry out a detailed analysis; otherwise, an external climate scientist or trained expert is required.

Tip: A Prairies-specific resource

ClimateWest offers a virtual help desk that provides free assistance in connecting with a climate scientist or trained expert to support access to and interpretation of the climate data.

The climate projections and table of climate variables (Appendix D) can be shared during project management team or watershed team meetings and public engagement sessions to share climate trends and to gather additional information about firsthand experience and knowledge of the changing climate in their watershed (see Section 4.4). The climate projections and summary can also be included in a new "Climate Change" subsection of the "Watershed Characterization" portion of the IWMP (see Section 5.1).

Further guidance:

Appendix B. Summary of Climate Projections for the Province of Manitoba

Appendix C. The Climate Atlas of Canada for Accessing and Interpreting Climate Data

Appendix D. Suggested Climate Variables Relevant to Watershed Management

4.2 Learn About Hazards, Impacts, and Consequences for the Watershed

Who is responsible:
Project management team and watershed planner

Applying local knowledge and with guidance from the watershed planner, the project management team begins by identifying the climate hazards that have affected the watershed in the past and thinking about how these hazards are anticipated to change in the future.

Climate hazards are biophysical events or processes that can cause harm to human health, infrastructure, natural resources, and ecosystems. These may include

- single events, such as thunderstorms, freezing rain events, heatwaves, and wildfires, that have a defined beginning and end;
- slow-onset hazards, such as gradual changes in average temperatures or changes in the length of seasons.

Begin by thinking about the single-event and slow-onset hazards that may be relevant to the watershed. Then, drawing upon the knowledge gained through the review of climate change projections for the region, include available information on how these hazards may change over both time and region, with key questions to consider when thinking about hazards and examples of potential answers in Table 3.

Table 3. Key questions and possible answers when considering hazards

Some key questions to consider when considering hazards	Examples of possible answers
If the watershed is prone to flooding from heavy rainfall, how are these events expected to change in frequency, duration, or intensity over time?	Heavy rainfall events during the summer are predicted to be more frequent and with greater amounts of precipitation.
Which sections of the watershed are typically more at risk of flooding from heavy rainfall, and how might these at-risk areas increase/decrease over time?	The flood footprint of (name of area/region) may expand due to greater volumes of precipitation or be flooded more frequently.

Some key questions to consider when considering hazards	Examples of possible answers
In addition to considering how historical climate hazards will change over time, also take note of any new climate hazards projected for the watershed (e.g., more extreme heat days).	The watershed could see more extreme heat (both hotter days, for longer periods).

Source: Authors.

Tip: Hazard, Impact, Consequence?

Remember the differences between hazard, impact, and consequence with the following examples.

Prolonged drought (**hazard**) may cause limited surface water and groundwater drawdown (impact), which can lead to a lack of drinking water for livestock (**consequence**) and for irrigation (**consequence**).

Spring flooding (**hazard**) may cause soil erosion (**impact**), which can lead to topsoil loss (**consequence**) and turbid water (**consequence**).

For each climate hazard (both existing and new), systematically identify the subsequent impact(s) and consequence(s). As shown in Table 4, this can be completed by asking a series of "if, then" questions, with examples of potential answers.

Table 4. Key questions and possible answers to identify impacts and consequences with the "if, then" approach

Some key "if, then" questions to identify impacts and consequences	Examples of possible answers
If the projected change in the climate hazards occurs, then what are the potential impact(s)?	If heavy rainfall events (hazard) are predicted to be more frequent and with greater amounts of precipitation, the watershed may see an increase in the frequency of overland flooding (impact).
If this impact occurs, then what are the potential ecological, economic, or social consequences?	An increase in overland flooding (impact) may lead to crop loss (economic consequence), road washouts (social consequence), and soil erosion (ecological consequence).

Source: Authors.

Tip: How will climate change impact the prairies?

Canada in a Changing Climate: Regional Perspectives provides insight into how climate change will impact communities, the environment, and the economy across the country. Chapter 4: Prairie Provinces describes how and why the climate has changed and the hazards we can expect in the future.

A Snapshot of the Changing Prairie Climate describes how changes in the characteristics of forest fires, drought, floods, and extreme weather, such as heat waves, will affect life on the Prairies. It looks how these changing climate hazards will affect seven sectors, including agriculture, ecosystems and wildlife, Indigenous communities, and urban and rural communities.

Later in the process, the hazards, impacts, and consequences will be considered as climate risk. Climate risk is the potential for negative consequences from the impacts of climate change hazards (see Section 4.4.2).

Appendix E has information and tools to support the project management team and watershed planner to learn about hazards, impacts, and consequences. Table E1 includes a list of single-event and slow-onset hazards that may be relevant to the watershed. Table E2 provides two examples of hazards (spring flooding and drought) with subsequent impacts and consequences that could be relevant to the watershed. Refer to these tables and begin to fill in Table E3 to identify hazards, impacts, and consequences specific to the watershed.

Further guidance:

Appendix E. A General List of Hazards, Impacts, and Consequences

4.3 Learn About Climate-Resilient Actions to Address Climate Risks and Review Traditional Actions

Who is responsible:
Watershed planner and project management team

Many different climate-resilient actions are available to build resilience to the hazards, impacts, and consequences (i.e., climate risks), such as

- conserve and restore wetlands
- prevent stream bank erosion with riparian restoration
- plant and maintain shelterbelts.

Tip: A reminder about actions

To help distinguish existing BMPs and programs that do not consider climate risk from new or updated actions that do consider climate risk, the guidebook uses the following terms:

- Traditional actions include the programs and BMPs that the watershed districts currently promote and implement but that do not explicitly consider climate risk.
- Climate-resilient actions include both existing and new BMPs or programs that explicitly consider climate risk and are implemented to provide adaptation benefits.

IWMPs include actions to address various watershed priorities, and each priority area has specific goals to coordinate action on the ground and to achieve the goals. Some of the actions will be familiar, as existing BMPs and programs in the watershed (traditional actions) can also increase resilience to climate change. There might also be some new, innovative solutions to consider. Whether traditional or new, these actions will now be deliberately implemented to reduce the risk of climate change, with the bonus that they still provide all the other benefits that originally motivated their implementation.

Appendix F provides a "menu" of climate-resilient actions that the project management team and watershed planner can review as options to increase the watershed's resilience to climate risks and to share during public engagement sessions. With input from watershed residents, the project management team and watershed planner will create an initial list of actions (see Section 4.4.3) that will be later evaluated to develop a finalized list to ensure a climate-resilient IWMP (see Section 4.5).

Tip: Considering climate change in traditional actions

While a range of traditional actions have been used in the past to reduce the risk of environmental impact and climate hazards, such as flooding and drought, it cannot be assumed that these actions will continue to provide the same benefits in the future. Without considering how climate change will influence future hazards within the watershed, implementing these traditional actions may, in fact, increase vulnerability to future climate risks.

When considering the climate projections for the watershed (see Section 4.1), the project management team and watershed planner can apply a future climate lens to ensure that traditional actions remain effective as climate conditions change. Table 6 provides questions

that may help to apply a climate lens to traditional actions from past IWMPs, with examples of potential answers.

Table 5. Key questions and possible answers to apply a future lens to traditional actions

Some key questions to apply and future lens to traditional actions	Examples of possible answers
What type of climate hazards have impacted this action in the past?	This action (shelterbelts) has been exposed to drought in the past.
Is the action in an area that might be especially exposed to these climate hazards?	Yes, as drought is experienced across the watershed
Are the hazards that the action has been exposed to in the past expected to become more intense, frequent, or change in some other manner?	Yes, as drought is anticipated to become more frequent and prolonged across the watershed.
Do you think the action will remain effective considering these changes, or does it need to be modified or removed from the IWMP?	Shelterbelts are an important action to keep but could be more climate resilient by considering species or varieties that are drought tolerant. Additionally, budgeting for regular watering or irrigation when the trees are first planted and during early establishment will support robust, healthy trees.

Source: Authors.

Additionally, the project management team and the watershed planner should review all the traditional actions planned for implementation to ensure that they truly increase climate resilience and that none are maladaptive. Some hypothetical examples of maladaptation include the following:

- A streambank is badly eroded due to years of regular cattle access and heavy grazing. To stabilize the streambank and prevent further erosion, the watershed district and landowner install rock armour or rip rap. The increased severity of flooding leads to an increased volume and velocity of water flows. Unfortunately, the rock armour does not help to slow the velocity of water or support absorption, and the erosion continues to worsen over time and exacerbates flooding. Using native vegetation, either on its own or in combination with rock armour, provides better erosion protection, as the plant roots bind the soil and strengthen the streambank, and the vegetation slows the flow of water, additionally providing shade and wildlife habitat.
- Shelterbelts are planted in the watershed using a single species of tree (e.g., green ash). Unfortunately, with warmer winters, an invasive species (e.g., emerald ash borer) has an additional reproductive cycle in the year. All the newly planted green ash trees are susceptible to this invasive insect and die, leaving the land more exposed to drought and erosion. The shelterbelt and surrounding watershed would be more resilient to climate change by planting a diverse variety of trees (rather than a monoculture), reducing the susceptibility to disease and insects.

- A water retention project is built on a beef producer's land to capture spring runoff and moderate the timing of peak flows and runoff velocity. This is intended to reduce the likelihood of road washouts downstream and store water in case of drought during the summer. Unfortunately, the design and construction of the water retention structure did not consider increases in precipitation under future climate projections, and the footprint of the retention pond has grown, unintendedly flooding adjacent pasture and reducing grazable acres.

If some of the traditional actions seem like they will be less effective or maladaptive with climate change, consider adjusting them to remain effective or remove them from the plan, if necessary.

Further guidance:

Appendix F. Menu of Climate-Resilient Actions

List of climate lens questions and considerations about maladaptation in Section 4.3

4.4 Include Climate Change Considerations at Public Engagement Sessions

As outlined in the Water Protection Act (2005), public engagement is integral to the development of the IWMP and is completed through various approaches, including online surveys, in-person meetings at different communities across the watershed, and webinars or virtual meetings. This participatory approach is a great entry point to present some information about climate change, share the anticipated projections for the watershed, prioritize climate risks, and identify climate-resilient actions.

4.4.1 Share Information About Climate Change

Who is responsible:
Watershed planner

During public engagement, the project management team and watershed planner should spend some time introducing the topic of climate change and the anticipated impacts on the watershed. Include the climate change projection information and hazards, impacts, and consequences collected for the watershed (see Sections 4.1 and 4.2). Additionally, provide an overview of the various actions that are available to support resilience or how some traditional actions may need to be adjusted to become climate-resilient actions. With this information, watershed residents can provide their experiences and input into prioritized climate risks and potential actions.

The Federation of Canadian Municipalities has developed *Talking It Through: A Discussion Guide for Local Government Staff on Climate Adaptation* to help discuss the impacts of climate change and adaptation options with senior decision-makers and elected officials. In support, they also offer a *Talking It Through: A Discussion Guide for Local Government Staff on Climate Adaptation* PowerPoint Tool that can be downloaded and customized to address the unique situation of the watershed.

Public engagement sessions provide an opportunity to learn about how climate change is understood and experienced by watershed residents. Watershed residents can provide valuable local knowledge of how hazards have historically impacted the watershed and any observed changes over time. This input can be collected during in-person or virtual meetings or added to the online survey process. Appendix G includes some questions that the watershed planner can include in the meetings or survey.

Further guidance:

Communication tips and online guidance in Section 4.1

Appendix G. Suggested Questions for Engagement With Watershed Residents

4.4.2 Prioritize the Climate Risks of Greatest Concern and List Potential Climate-Resilient Actions

Who is responsible:
Watershed planner

Through the previous steps of the information gathering stage, the project management team and watershed planner will have gained a greater understanding of how the climate of the watershed is anticipated to change in the coming decades and potential hazards, impacts, and consequences. In doing so, the project management team and watershed planner may have already noticed that some of these changes in climate hazards will have greater implications for the health and well-being of the watershed than others, either because of the potential severity or because of capacity to manage the anticipated change.

There is likely a long list of potential climate hazards, impacts, and consequences. Prioritization will aid the project management team and watershed planner in determining which climate hazards pose the greatest threat to the watershed and therefore should be actively managed for.

The prioritization process can be completed by looking at

- **the likelihood** of a climate-related hazard occurring
- **the potential severity** of the consequence of a hazard if it occurs.

Tip: Framing the climate change conversation differently

While the scientific evidence around climate change is clear, some remain skeptical. If this is the case in the watershed of interest, consider framing the conversation a bit differently to avoid alienating the skeptics. Discuss hazards and weather events in ways that are relevant to residents.

Avoid terms like "mitigation," "resilience," and "climate change." A term like "risk management," not linked specifically to climate change, may resonate more, as many rural residents, municipalities, and farmers are already accustomed to managing risk.

"Water management" is another term that resonates with rural residents, municipalities, and farmers who prepare for and respond to drought, erosion, heavy precipitation, and flooding.

Celebrate all the good work and positive efforts that rural residents, municipalities, and farmers contribute to their watershed and local environment rather than fixating too much on the uncertain future and "bad news stories" that can vilify the agricultural industry and rural communities.

Examples of alternative ways to discuss hazards and weather events:

- Instead of "Climate change will likely increase the frequency and severity of drought. What are some climate-resilient actions to mitigate risk?" try:

  "In recent years, the watershed has regularly experienced drought, causing feed and water shortages and crop loss. What can the watershed do to better prepare for drought in the coming years?"
- Instead of "Climate change will likely make spring flooding more regular. What are some climate-resilient actions to mitigate risk?" try:

  "The watershed has recently seen spring flooding, which damages buildings, washes out roads, and delays seeding. What can the watershed do to better prepare for spring flooding in the coming years?"

When combined, an analysis of both the likelihood of a hazard and the severity of the consequences can help identify the key climate-related risks to be managed, as follows:

- Hazards with a high likelihood of occurring and that have the potential for significant or severe consequences can be considered high-risk events where adaptation actions might be required.
- In contrast, hazards with a low likelihood of occurring and low severity of consequences may be considered low-risk events that are less of a priority.

Appendix H provides a step-by-step description of how the watershed planner can lead a climate risk matrix exercise to develop a prioritized list of climate risks, gathering input during the public engagement sessions. Appendix H also includes sample worksheets and tables for rating likelihood and severity and for plotting these on a risk matrix to determine the climate risks of greatest concern.

The list of prioritized climate risks will be used to select potential climate-resilient actions and will be included in the "Watershed Characterization" and "Implementation Plan" sections of the IWMP (see Section 5.0).

Further guidance:

Appendix H. Climate Risk Matrix Exercise

4.4.3 List Climate-Resilient Actions to Address the Prioritized Climate Risks

Who is responsible:
Watershed planner

The watershed planner will work with watershed residents to identify potential climate-resilient actions for each of the prioritized climate risks.

When identifying potential climate-resilient actions, it is useful to initially create a long list of options. These could

- be traditional actions (reviewed through the climate lens);
- be short-, medium-, and long-term options;
- be low-, medium-, and high-cost options;
- provide climate mitigation or other co-benefits, such as improved water quality or biodiversity;
- consider the utilization or enhancement of natural ecosystems, such as wetlands and riparian areas;

- build knowledge, such as increasing awareness within the watershed of climate change and climate-resilient actions;
- be physical interventions, such as building water retention ponds; or
- focus on the operation and maintenance of programs, such as allocating time and money to water trees during the establishment of shelterbelts.

Creating a long list of potential actions and then classifying these actions into different categories can be advantageous when completing future steps in the adaptation planning process, as shown in Table 7.

Tip: Include different organizations from across the watershed

In addition to building an initial list of climate-resilient actions during public engagement sessions, the watershed planner may want to host meetings with specific groups responsible for the management of different parts of the watershed (e.g., municipalities, commodity groups, or provincial government departments).

Table 6. Example of categorized climate-resilient actions for prioritized climate risks

Hazard: Increasing temperature and decreasing precipitation causing more frequent and prolonged drought

Prioritized risk	Potential climate-resilient action
Drought	Promote water retention projects to help store water for use during drought; consider design to increase storage capacity or to build a series of smaller ponds
Water supply	Enhance water conservation education and communications programs amongst watershed residents, partnering municipalities, and local businesses
New pests	Training so watershed staff are aware of pests and invasive species, working with the provincial invasive species monitoring team to identify and report occurrences during fieldwork and site visits

Source: Authors.

Appendix I provides a description of content that the watershed planner can include when collecting potential climate-resilient actions to include in the IWMP, including a fillable table.

Further guidance:

Appendix I. Build an Initial List of Climate-Resilient Actions

4.5 Include Climate Change Adaptation Expertise on the Watershed Team

Who is responsible:
Project management team and watershed planner

The watershed team is a large team with diverse expertise in scientific, traditional, and local knowledge that provides technical information and advice to inform the development of the plan. Developed by the project management team and watershed planner, the watershed team may provide an overview of existing information to support public engagement and the understanding of the watershed, as well as identify assets and issues, assess options, and provide recommendations for specific watershed issues.

Watershed team members may be from the following (Souris River Watershed District, 2020):

- project management team
- local municipalities
- provincial government
- federal government
- Indigenous communities
- planning districts
- non-profit environmental groups

When building the watershed team, include members with climate change expertise who can share their knowledge and help integrate climate change considerations across the IWMP process, throughout the suggested entry points and wherever the project management team and watershed planner need help and advice.

Here is a list of skills and knowledge to be considered when identifying potential watershed team members:

- understanding of the relevant concepts and impacts of climate change on the Canadian Prairies, as well as relevant issues and policies;
- experience accessing, understanding, and summarizing climate projections and potential climate change impacts on the watershed;
- experience conducting climate risk and/or climate vulnerability assessments to identify potential future climate hazards and support the prioritization and implementation of appropriate, place-based climate-resilient actions;
- understanding of sustainable agriculture practices and approaches, including climate-resilient agriculture;
- knowledge of the role of ecosystems for climate adaptation, nature conservation, nature-based solutions, and green infrastructure;

- existing relationship with different levels of government, research agencies, and the private sector to support the understanding, funding, and implementation of climate-resilient actions;
- experience leading public and stakeholder engagement around climate adaptation planning or other participatory processes.

Tip: List of organizations with expertise in climate change

There are many organizations with resources and expertise on climate change adaptation available to help identify potential members for the Watershed Team:

- ClimateWest is a regional hub for climate services across Manitoba, Saskatchewan, and Alberta. It provides access to regionally relevant climate information and support to use it effectively in planning and decision making. ClimateWest offers a help desk to assist communities, businesses, and others with locating the most relevant climate data and connecting with climate specialists, as well as how to integrate climate change into decision making.
- PCC, affiliated with the University of Winnipeg and host of the Climate Atlas of Canada, supports Canadians in moving from risk to resilience, using maps, videos, research reports, training, and outreach.
- The Centre for Indigenous Environmental Resources (CIER) enables Indigenous People and communities to be leaders in positive environmental change. CIER developed a comprehensive Indigenous Climate Change Adaptation Planning Toolkit, which includes easy-to-understand tools and resources for all stages of the adaptation planning process.
- The Prairie Adaptation Research Collaborative, affiliated with the University of Regina, translates scientific research into practical and regionally relevant climate data, information, and knowledge, as well as support for professional development.
- The All One Sky Foundation supports education, research, and community-led programs to build climate resilience, having facilitated the adaptation planning process for groups across the Prairies, including Manitoba.

4.6 Evaluate the List of Potential Climate-Resilient Actions

Who is responsible:
Watershed planner and project management team

Once the initial list of potential climate-resilient actions is prepared (Section 4.4.3), an evaluation table can provide a structure for the project management team and watershed planner to review, critique, and evaluate the actions. The evaluation results will help select the final list of actions to address the prioritized climate risks and will be added to the Key Solutions section of the implementation plan. Appendix J includes a fillable evaluation table and an example of the table completed for water retention structures.

Further guidance:

Appendix J. Evaluation of Climate-Resilient Actions

5.0
Plan Drafting

Plan drafting

During the plan drafting stage, the project management team and watershed planner begin to draft the plan, using the compiled information, technical expertise from the watershed team, and public input.

5.1 Add a Climate Change Subsection to the Existing "Watershed Characteristics" Section

Who is responsible:
Watershed planner and project management team

When drafting the IWMP, the project management team and watershed planner should add a Climate Change subsection to the "Watershed Characteristics" section, with the following information:

- a brief description of climate change and why watershed districts need to integrate adaptation planning into the IWMP process;
- the climate change projections collected for the watershed, including one of the following options:
    - the simple approach with a summary of projections for Manitoba from Appendix C, or
    - the intermediate approach with projections for the watershed region that includes the variables summarized in Appendix D, or
    - the highly detailed projections completed by a climate change expert.
- the list of prioritized of climate risks (hazards, impacts, and consequences) identified during the risk matrix exercise (Appendix H). This list will influence the identification of key challenges in the "Implementation Plan" section.

Further guidance:

Content from Appendix C or D (if used) and Appendix H

5.2 Include Climate-Resilient Actions in the "Implementation Plan" Section

Who is responsible:
Watershed planner and project management team

After the evaluation of potential climate-resilient actions (see Section 4.5 and Appendix J), the project management team and watershed planner will incorporate the selected climate-resilient actions into the "Management Actions" table in the IWMP, which includes a brief description of the action, partner organizations, and the measure of success. Additional information about selecting measures of success is shared in the MEL section of the guidebook (see Section 7.2). The final list of climate-resilient actions can also be included and summarized in the "Key Solutions" section of the implementation plan, where appropriate.

Further guidance:

Content from Appendix J

6.0
Plan Review and Plan Approval

Plan review

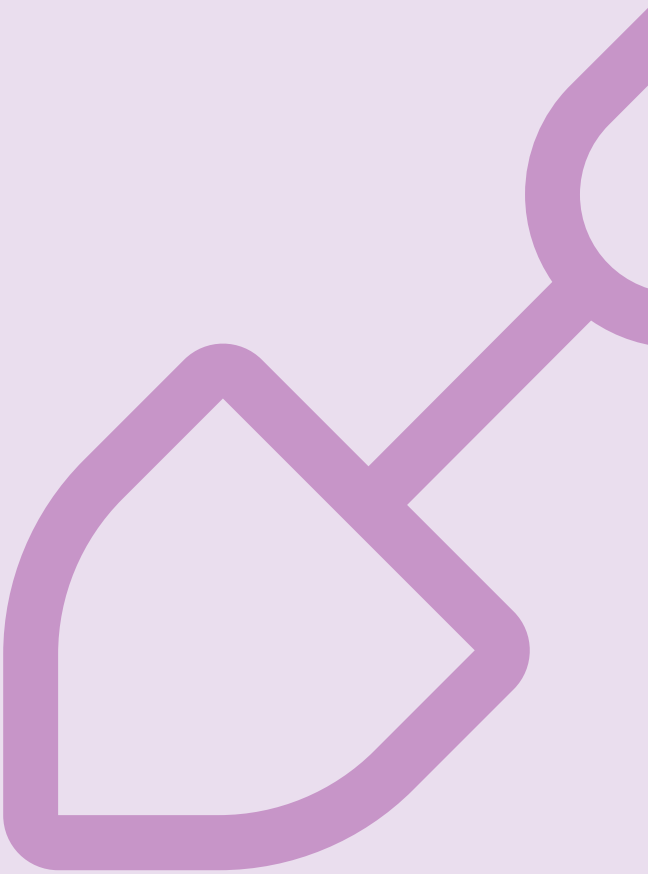
During the plan review stage, the project management team and watershed team review the draft, and the watershed planner coordinates the provincial branch and departmental review.

Plan approval

During the plan approval stage, the IWMP is submitted to the Minister of Environment and Climate Change for approval.

Who is responsible:
Watershed planner, project management team, and watershed team

When reviewing the draft IWMP prior to submitting it for departmental review and ministerial approval by the designated expert advisory council, the project management team can review it to ensure the entry points have been considered throughout the development of the IWMP. Recall that participatory adaptation planning must be integrated within the IWMP process and will be less effective as an afterthought.



7.0
Implement

Implement

During the implementation stage, the watershed district will begin to work with the partners to establish a budget to implement the suggested actions. Over the 10-year implementation cycle, the project management team should monitor the implementation of the actions annually, with the measures of success included in the IWMP and adjusted as necessary.

7.1 Implementation

Who is responsible:
Water planning authority (i.e., watershed district)

The climate-resilient actions will be implemented in the same manner as the rest of the IWMP. As such, it is expected that they will be managed by the partner organizations listed for each action in the IWMP, such as the watershed district, provincial and federal government departments, municipalities, landowners, industry groups, and conservation organizations. Ideally, both the traditional and climate-resilient actions will be included in their operation activities like annual budget planning, landowner programs, and asset management and maintenance.

Tip: Example of increased cost when adjusting to a climate-resilient action

A traditional action could be seeding an area of land to perennial forages, specifically alfalfa. The climate lens shows greater resilience with the use of a new variety of drought-tolerant alfalfa. A bag of the drought-tolerant seeds costs more as compared to a bag of the older variety. Thus, the cost of this action will increase.

Additional financial resources may be required to account for extra costs to increase the climate resilience of a traditional action. Funding for new actions specifically designed to increase climate resilience will also need to be secured. These funds could come from the Watershed District's existing budget by reallocating resources or secured through external grants and funding opportunities. Budgets should consider costs beyond just the action itself (e.g., engineering design, construction, and materials for a water retention structure) to include costs that consider the success of the action more broadly, like training for staff and

key actors, long-term operation and maintenance, communication and outreach activities, and MEL.

If climate-resilient actions are planned that are new to the watershed, consider piloting them on a smaller scale and explicitly considering scaling up during the pilot. This can help you learn about the best approach for implementation, address potential challenges, and understand the impact of the climate-resilient action. Additionally, pilot projects can provide stakeholders, watershed residents, and adjacent neighbours with an opportunity to see and learn about the climate-resilient action, helping to build political and community support for further implementation on a larger scale across the watershed (Local Governments for Sustainability. [ICLEI], 2019).

7.2 Monitoring, Evaluation, and Learning

Who is responsible:
Water planning authority (i.e., watershed district)

The implementation stage of the IWMP process includes monitoring and evaluation of progress toward achieving its objectives. Similarly, adaptation planning aims to monitor and evaluate progress but also places emphasis on the need to learn from experience and incorporating these insights into future actions. MEL can help the project management team and watershed planner understand what aspects of the IWMP are working, what needs adjustment to improve results, and how these insights can be shared. Monitoring of adaptation efforts can be included in the typical process that the IWMP follows (both annual reports and the 5-year progress report), although the following highlights some additional considerations.

Ultimately, the MEL process is looking to answer the following questions specific to climate change:

- Is the IWMP, including its climate-resilient actions, being implemented as expected? Are its goals and objectives being achieved?
- Are the climate-resilient actions leading to a reduction in climate risk? Would the implementation of other actions lead to better outcomes?
- What has worked well? Where can we improve? Can the information gathered through this process also support future efforts to update the IWMP, including ongoing efforts to adapt to current and future climate change?

Monitoring

To monitor or measure the success of the climate-resilient actions, the project management team and watershed planner will need to identify and select indicators that are specific to the watershed region and the implemented actions. These indicators can be output or outcome focused:

- Output indicators reflect the success of implementation of the planned actions. For example, the number or area of wetlands restored in the watershed. Output indicators ask, "Was the action successfully implemented?"
- Outcome indicators measure the extent to which the expected result or goal of the action has been achieved, for example, the change in flood-related loss, such as crop yield, due to wetland restoration activities. Outcome indicators ask, "Was the action effective?"

As a result, outcome indicators generally require a longer time horizon to monitor because project outcomes, particularly greater resilience to climate change, cannot be determined for many years. Both output and outcome indicators are needed to measure the success of climate-resilient actions in the short- and long-term, respectively.

Manitoba's Water Management Strategy, released in 2022, and the associated Action Plan, released in 2023, have committed to developing performance indicators to measure progress. Some of the suggested indicators might be relevant and align with the IWMP.

Tip: Select indicators for the IWMP

Introducing Indicators: A First Look at Using Indicators to Measure Adaptation Progress, from ICLEI Canada, describes why indicators are so important, including different types, how to select them, and the benefits and challenges of doing so.

The following questions may assist the project management team and watershed planner when selecting indicators to monitor the actions included in the IWMP (including traditional and climate-resilient actions):

- What indicators are currently being used to monitor and evaluate the progress of the IWMP?
- Do the existing indicators currently track the extent to which climate-resilient actions are advancing climate adaptation efforts? Do they need to be revised, or are additional indicators for measuring climate resilience needed?
- For a revised or new indicator:
    - Does the watershed district have the capacity and resources to monitor this indicator?

    - Can the watershed district monitor the indicator themselves, or can they access the necessary data from a partner organization or different monitoring program?
    - What are the costs associated with monitoring this indicator?
- Does the watershed district have the capacity to analyze or process the data?
- Can the watershed district align with existing monitoring systems? For example, they could consider leveraging data already collected as part of existing long-term watershed monitoring networks.

Tip: Existing data sources that may be useful for MEL

Government of Canada

- Weather and drought conditions
- Water quantity
- Water sustainability indicators
- Freshwater quality monitoring
- Agri-environmental indicators
- Weather, climate, and hazards
- Water Survey of Canada

Province of Manitoba

- Agri-Maps
- Weather Reports
- Manitoba River Conditions and Forecasts Web Map

Other

- Lake Winnipeg Community-Based Monitoring Network
- Lake Winnipeg DataStream

Here are some examples of indicators, both output (➪) and outcome (➜), that could be used to monitor climate-resilient actions:

➪ number of projects implemented

➪ number of acres conserved, restored, and/or constructed

➪ number of trees planted

➪ annual change in wetland area

- annual change in grassland area
- annual change in forested areas
- annual number or repair cost of municipal road washouts (from local municipality)
- number of calls to watershed district about issues (define issues, such as washouts, water shortages, severe erosion, etc.)

Evaluation

Once data has been collected for the selected indicators, the project management team and watershed planner will evaluate whether the implemented actions have contributed or will contribute to the goals of the IWMP. The following list of questions may assist in evaluating the outcomes of the IWMP implementation process:

- Did the indicators meet your objectives and priorities as outlined?
- Did you meet the number of projects/actions you intended on implementing?
- Has the action addressed climate risk/did you record outcome indicator results?
    - If yes, do the results show that the action has resulted in your expected outcome, such as reduced flooding or fewer insurance claims?
    - If no, does the output indicator suggest potential benefit in the future?

Learning

The adaptation planning process is an iterative process and, like the IWMP process, needs to be reviewed and adjusted on a regular basis to make sure it includes the most up-to-date information available. The next revision of the IWMP will provide an opportunity for "learning." The project management team and watershed planner can review the knowledge obtained from the monitoring and evaluation process to inform the next round of adaptation-friendly actions and programs in the updated IWMP. Learning about the adaptation process, as well as the implementation of climate-resilient actions, can lead to greater success in achieving the watershed management goals.

References

Alberta Agriculture and Forestry. (2018). *Beneficial management practices: Environmental manual for Alberta farmsteads*. https://open.alberta.ca/dataset/3a9c15b4-11cc-45bd-9554-182dfde134e2/resource/588ebfff-e78b-4110-a100-9912519bda03/download/af-environmental-manual-for-alberta-farmsteads-2019-11.pdf

Bush, E. & Lemmen, E. S. (Eds.). (2019). *Canada's changing climate report.* Government of Canada. https://changingclimate.ca/CCCR2019/

Canadian Council of Ministers of the Environment. (2015). *Implementation framework for climate change adaptation planning at a watershed scale*. https://publications.gc.ca/collections/collection_2016/ccme/En108-4-39-2015-eng.pdf

Canadian Council of Ministers of the Environment. (2021). *Guidance on good practices in climate change risk assessment.* https://ccme.ca/en/res/riskassessmentguidancesecured.pdf

Dickson, I. M., Butchart, S. H. M., Dauncey, V., Hughes, J., Jefferson, R., Merriman, J. C., Munroe, R., Pearce-Higgins, J. P., Stephenson, P. J., Sutherland, W. J., Thomas, D. H. L., & Trevelyan, R. (2017). *PRISM: Toolkit for evaluating the outcomes and impacts of small/medium sized conservation projects.* https://conservationstandards.org/library-item/prism-toolkit-for-evaluating-outcomes-and-impacts/

Goertzen, S. (2019). *Local climate change adaptation planning in Manitoba.* International Institute of Sustainable Development. https://www.iisd.org/system/files/publications/climate-change-adaptation-planning-manitoba.pdf

Government of Manitoba. (n.d.). *Integrated watershed management planning.* https://www.gov.mb.ca/sd/pubs/water/iwmp_handout.pdf

Government of Manitoba. (2005). *The Water Protection Act.* https://web2.gov.mb.ca/laws/statutes/2005/c02605e.php

Local Governments for Sustainability. (2019). *Changing climate, changing communities: Guide and workbook for municipal climate adaptation.* https://icleicanada.org/wp-content/uploads/2019/07/Guide.pdf

Intergovernmental Panel on Climate Change. (2014). *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White [Eds.]). Cambridge University Press. https://www.ipcc.ch/report/ar5/wg2/

International Union for the Conservation of Nature. (2022). *Ecosystem based adaptation: Building on no regret adaptation measures.* https://www.iucn.org/sites/default/files/2022-07/iucn-eba-technical-paper-no-regret-actions-20-lima.pdf

Janowiak, M., Dostie, D., Wilson, M., Kucera, M., Howard Skinner, R., Hatfield, J., Hollinger, D., & Swanston, C. (2016). *Adaptation resources for agriculture: Responding to climate variability and change in the Midwest and Northeast* (Technical Bulletin 1944). United States Department of Agriculture.

Manitoba Habitat Conservancy. (n.d.). *Glossary of terms.* https://mbhabitat.ca/glossary-of-terms/

Méthot, J., Rawluk, A., Roy, D., Saleh, T., & Kroft, E. (2023). *The state of play of natural infrastructure on the Canadian Prairies.* International Institute for Sustainable Development. https://www.iisd.org/publications/report/state-of-play-natural-infrastructure-canadian-prairies

Möller, V., van Diemen, R., Matthews, J. B. R., Méndez, C., Semenov, S., Fuglestvedt, J. S., & Reisinger, A. (Eds.). (2022). *Glossary.* Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Annex-II.pdf

Prairie Climate Centre. (n.d.). *Manitoba and climate change*. https://climateatlas.ca/sites/default/files/Manitoba-Report_FINAL_EN.pdf

Prairie Climate Centre. (2018). *Climate atlas guidebook*. https://climateatlas.ca/sites/default/files/ClimateAtlas-Guidebook_V1_Nov2018.pdf

Prairie Climate Centre. (2019). *Climate atlas of Canada*, version 2 (July 10, 2019). https://climateatlas.ca

Prairie Climate Centre. (2022). *Manitoba's changing climate*. https://climatewest.ca/wp-content/uploads/2022/06/Slide-deck_MB-Changing-Climate.pdf

Resilience Institute & All One Sky (2018). *Climate change adaptation planning and creation of a local early action plan.* https://resilienceinstitute.ca/wp-content/uploads/2019/11/Adaptation-Guide-Oct2018-1-1.pdf

Sauchyn, D., Davidson, D., & Johnston, M. (2020). Prairie provinces. In F. J. Warren, N. Lulham, & D. S. Lemmon (Eds.), *Canada in a changing climate: Regional perspectives report*. Government of Canada. https://changingclimate.ca/regional-perspectives/chapter/4-0/

Souris River Watershed District. (2020). *Souris River Integrated Watershed Management Plan: Terms of reference*. Government of Manitoba.

Appendix A. Example of Written Content to Include in the Terms of Reference

The following paragraph can be used or modified when the water planning authority and watershed planner develop the terms of reference during the preplanning stage of the integrated watershed management plan (IWMP) process, by clearly identifying and including terms like "climate change," "climate risk," "resilience," and/or "adaptation." This demonstrates commitment to incorporating climate change adaptation early in the IWMP process.

> "Climate change has implications for the ecosystem health and the management of the (**insert name of relevant**) watershed. To enhance the resilience of the watershed and its residents, climate change risks and adaptation considerations will be included in the IWMP process. The watershed planner, water planning authority, project management team, and watershed team will learn about how the anticipated impacts of climate change will affect the watershed and include actions that will reduce the risk of these impacts as part of the implementation plan. Participatory and collaborative engagement with residents, Indigenous Peoples, stakeholders, and government representatives, already part of the IWMP process, will help to ensure the climate change risks and climate-resilient actions accurately represent the goals, issues, and priorities of the watershed."

Appendix B. Summary of Climate Projections for the Province of Manitoba

The Prairie Climate Centre (PCC) put it best: Manitoba's future climate is projected to be "hotter, drier, wetter, *weirder*," shifting from the predictable weather patterns Manitobans are used to" (PCC, 2022). Extreme weather events and reoccurring drought are not new to the Prairies, but, unfortunately, climate change will make it worse.

The following list summarizes key points from the Manitoba and Climate Change report by PCC[1], keeping in mind that there will be differences based on the location of the watershed within the province (Table B1).

Hotter summer temperatures, with an increase in the average summer temperature, more days above 30°C, and more tropical nights (≥20°C), contributing to the following:

- drier conditions, with higher risk of forest fires over a longer season
- more heat waves, with increased health risk for vulnerable people
- northern migration of the plant hardiness zone, introducing new species and pests
- hot and dry conditions causing stress to crops and livestock.

Warmer, shorter winters, with an increase in the average winter temperature, fewer winter days (≤15°C) and icing days (≤0°C), and more variable weather events, contributing to the following:

- loss of permafrost
- more freeze/thaw cycles which damage roads and infrastructure
- loss of insulating snow layer for perennial plants
- shorter ice road season
- greater risk of out-of-season storms.

Overall increase in precipitation, with a higher yearly average, although more in April (wetter springs) and less in August (drier summers); the variability in precipitation will contribute to the following:

- wetter springs and drier summers could lead to flooding and drought in the same year;
- increase in the frequency of extreme weather events and heavy rainfall, but little soil moisture recharge;
- greater risk of drought;
- greater risk of overland flooding.

[1] The Manitoba and Climate Change report by PCC provides a summary of temperature projections that can provide a broad understanding of climate change impacts for the province of Manitoba.

Table B1. How different variables are projected to change under low- (less climate change) and high- (more climate change) carbon scenarios climate change for cities and towns in Manitoba

		Winnipeg	Brandon	Morden	Dauphin	Gimli	Flin Flon	Thompson	Churchill
Average hottest temperature of the year (°C)		34.5	34.8	35.1	34	32.8	32.5	31.8	29.4
		37.8	37.7	38.5	36.6	35.8	35	33.9	31.5
		39.3	39.3	40.1	38	37.3	36.5	35.4	33.1
Average coldest temperature of the year (°C)		-36	-37.9	-34.1	-37.4	-37.5	-39	-43.3	-40.7
		-31.5	-33.2	-29.6	-33.5	-33.2	-35.3	-38.6	-35
		-29.8	-31.5	-27.9	-31.8	-31.3	-33.2	-36.3	-32.3
Average number of days per year above 25 °C		55	57	57	48	41	28	22	7
		87	88	90	79	73	52	41	13
		98	100	102	91	85	66	53	18
Average number of below-zero days per year		189	196	186	196	194	205	225	242
		161	170	158	168	164	177	198	216
		149	157	145	156	152	164	185	204
Average length of the frost-free season		127	117	130	118	124	124	94	97
		149	140	153	141	146	147	118	118
		161	150	184	148	156	158	134	132

Note: Recent past; Low-carbon future; High-carbon future.
Source: PCC, n.d.

Appendix C. The Climate Atlas of Canada for Accessing and Interpreting Climate Data

The Climate Atlas of Canada is user friendly and a suggested source for watershed-level initiatives. The Climate Atlas Guidebook provides advice on how to find the different types of information available on the Atlas and what this might mean for the watershed district (PCC, 2018). ClimateWest hosts a two-part series of webinars, where the first episode demonstrates how to use the Climate Atlas of Canada, including a case study from a prairie municipality.

Tip: The Climate Atlas of Canada

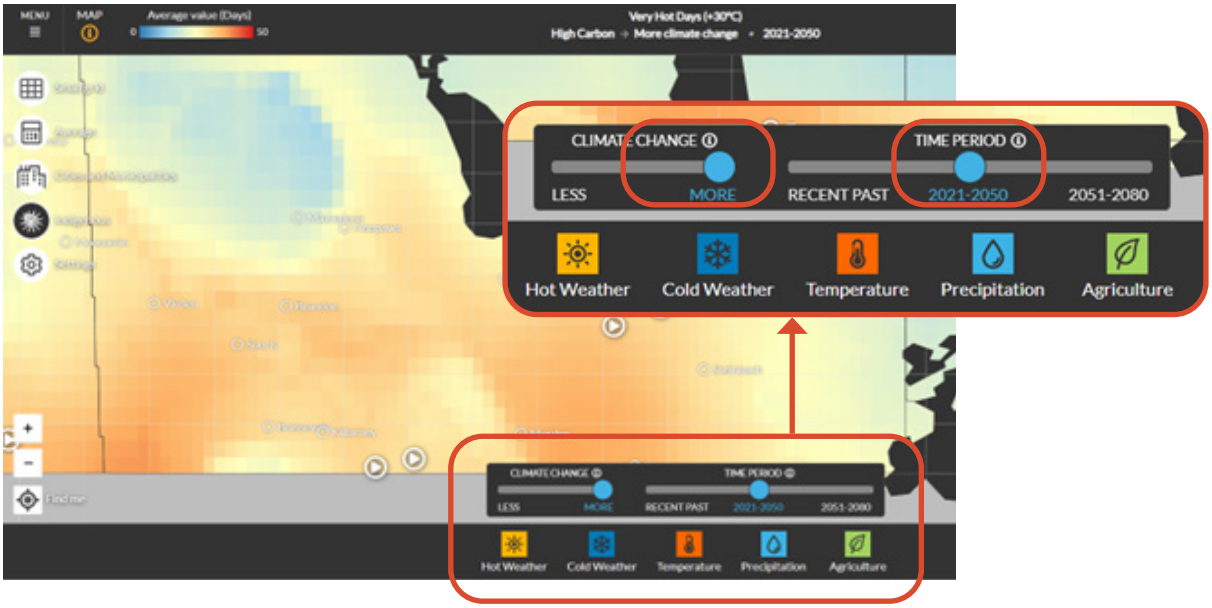
The Climate Atlas of Canada has 39 variables that can be explored, such as

- average length of heat waves
- number of heat waves
- wet days
- corn heat units
- frost days

The variables are described in detail here.

When gathering information on climate projections, the project management team and watershed planner must decide on the time period(s) and emission scenario(s) of interest. When considering how climate hazards will change in the future, most communities choose an immediate-term time period (up to 2050) and worst-case emissions scenario (RCP8.5) where GHG emissions are high, resulting in more severe climate change (Figure C1). The project management team and watershed planner may want to use the same parameters, as the near-term time period is likely most relevant to watershed district's planning horizon and the worst-case scenario lets the watershed district be prepared for the worst, while hoping for the best. Table C1 provides an example of a variable filled in using data from the Climate Atlas of Canada.

Figure C1. Example of mapping feature and climate projections from the Climate Atlas of Canada, with selection options for the amount of climate change (less or more) and the time period (recent past, 2021–2050, and 2051–2080)



Source: Climate Atlas of Canada, 2019.

Tip: What are the representative concentration pathways?

The representative concentration pathways (RCPs) help address the challenge of uncertain future emissions by defining different scenarios that lead to a higher or lower concentration of GHGs. The user can decide which to use in their planning. Although four different RCPs do exist, the Climate Atlas of Canada uses two scenarios (PCC, 2018):

- RCP8.5 results in more warming (high carbon; GHGs continue to increase at current rates until the end of the century, or business as usual).
- RCP4.5 results in less warming (low carbon; GHGs increase until about 2050 and then rapidly decline).

Unfortunately, some degree of climate change is inevitable. Under both RCPs, the impacts of climate change are anticipated to become more intense over time. The Climate Atlas has three time periods where users can compare the recent past (1976–2005), the immediate future (2021–2050), and the near future (2051–2080).

Table C1. An example of the mean temperature variable with data from the Climate Atlas of Canada, comparing the averages for the recent past (1976–2005) with the near-term time-period (up to 2050) in a worst-case emissions scenario (RCP8.5)

Variable	Period	Recent Past: 1976–2005	Near-term period: 2021–2050	Change (+/-)
Mean temperature (°C)[a]	**Annual**	**3**	**5.3**	**+2.3**
	Spring	3.1	5.2	+2.1
	Summer	18.1	20.2	+2.1
	Fall	4.4	6.6	+2.2
	Winter	-13.9	-11.2	+2.7

Note: [a] The projections for the mean temperature variable are filled in, using data from the Town of Virden as an example.

Source: PCC, 2019.

Appendix D. Suggested Climate Variables Relevant to Watershed Management

Table D1 includes a fillable table with projections for suggested climate variables that are particularly important to watershed management, comparing the averages for the recent past (1976–2005) with the near-term time period (up to 2050) in a worst-case emissions scenario (RCP8.5). Using the Climate Atlas of Canada (see Appendix B), fill in the following table. Considering adding other climate variables that may be relevant to the watershed.

Table D1. Fillable table with select variables that are key to watershed management and can be used to gather information for the watershed

Variable	Period	Recent Past: 1976–2005	Near-term period: 2021–2050	Change (+/-)
Mean temperature (°C)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
Number of very cold (-30°C) days	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			

Variable	Period	Recent Past: 1976–2005	Near-term period: 2021–2050	Change (+/-)
Number of very hot (+30°C) days	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
Growing degree days (Base 5°C)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
Length of the frost-free season (days)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			

Variable	Period	Recent Past: 1976–2005	Near-term period: 2021–2050	Change (+/-)
Freeze–thaw cycles (days when the temperature fluctuates between freezing and non-freezing)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
Precipitation (mm)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
Number of heavy precipitation days (where > 20mm of rain or frozen precipitation falls)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			

Variable	Period	Recent Past: 1976–2005	Near-term period: 2021–2050	Change (+/-)
Maximum annual 1-day precipitation (% change)	**Annual**			
	Spring			
	Summer			
	Fall			
	Winter			
	Annual			
	Spring			
	Summer			
	Fall			
	Winter			
	Annual			
	Spring			
	Summer			
	Fall			
	Winter			

Appendix E. A General List of Hazards, Impacts, and Consequences

The following appendix will help understand and identify climate hazards, impacts, and consequences within the watershed. Climate hazards are the result of the project changes to the climate, where Table E1 provides a list of single event and slow onset climate hazards. For example, if your watershed is projected to see an increase in the number days above 30°C, the climate hazards could be dry periods, extremely hot days, and heat waves. These hazards will be used to identify subsequent impacts and consequences of climate change.

Table E1. Examples of climate hazards

Single-event climate hazards			
Winds (strong)	Freezing rain	Wildfire/grassfire	Hail
Heavy snowfall	Extended snowpack	Tornado	Fog
Extremely hot days	Heat wave	Blizzards	Heavy rainfall
Lightning	Thunderstorms	Floods	Multi-year drought
Icy roads	Cold periods	Dry periods	
Slow-onset climate hazards			
Length of frost-free period	Length of growing season	Changes to stream flows	Freeze–thaw cycles
Warming winter, Loss of extreme cold			

Source: Authors, adapted from The Resilience Institute & All One Sky Foundation, 2019.

Climate impacts are the result of the climate hazard. Consider potential impacts by asking the following questions:

- If [climate hazard] happens, what would happen to the watershed's [residents, infrastructure, water supply, natural environment, crop producers, livestock producers, resource extraction, biodiversity, etc.]?
- What assets are most likely exposed to the [climate hazard]?
- How exposed is the watershed to the impacts of climate change?

Consequences are the expected outcomes of a climate impact, which is triggered by a climate hazard. For example, one possible climate hazard is spring flooding, which can have the impact of soil erosion, with many consequences, such as topsoil loss and turbid water. A climate hazard triggers multiple climate impacts, each potentially having multiple consequences. Table E2 provides some examples of potential impacts and consequences from two climate hazards: spring flooding and drought.

Tip: Hazard, impact, and consequence

Remember the differences between hazard, impact, and consequence with the following example.

Drought (hazard) may cause limited precipitation (impact), which can lead to a lack of drinking water for livestock (consequence) and for irrigation (consequence).

Spring flooding (hazard) may cause soil erosion (impact), which can lead to topsoil loss (consequence) and turbid water (consequence).

Table E2. List of hazards, impacts, and consequences that might be a useful reference for the project management team and watershed planner

Hazard	Impact	Consequence
Spring flooding	Soil erosion in areas with bare soil or shallow-rooted vegetation	• Turbid water • Topsoil loss • Sediment deposition
	Inundated land	• Damage to homes and buildings • Delayed seeding, or none at all • Evacuations • Surface water and water well contamination • Loss of seeded acres or hay and pastureland
	High-velocity water flows	• Road washouts and closures • Eroded and unstable river and stream banks
Drought	Little precipitation	• Limited water supply for irrigation • Decreased surface water supply for humans and livestock • Decreased groundwater supply for humans and livestock • Lower water levels in rivers, lakes, and wetlands • Potential conflict over water rights • Water use limitations
	Low soil moisture and dry/stressed/dying vegetation	• Increased risk of wildfire • Wind erosion • Water contamination • Delayed seeding, or none at all • Reduced crop yields • Feed shortages for livestock • Loss of seeded acres or hay and pasture land

One way to identify hazards, impacts, and consequences is with a visual approach, as shown in Figure E1. The hazard is identified at the centre of the map, with the impact(s), each with multiple consequences, branching from the hazard. This can be a useful approach to use at public engagement sessions, allowing participants to contribute to a project board with hand-written notes.

An alternative approach is to fill in Table E3, which will provide the same outcome.

Figure E1. An example of a mapping exercise, with an example of spring flooding as the climate hazard, and the associated impacts and consequences

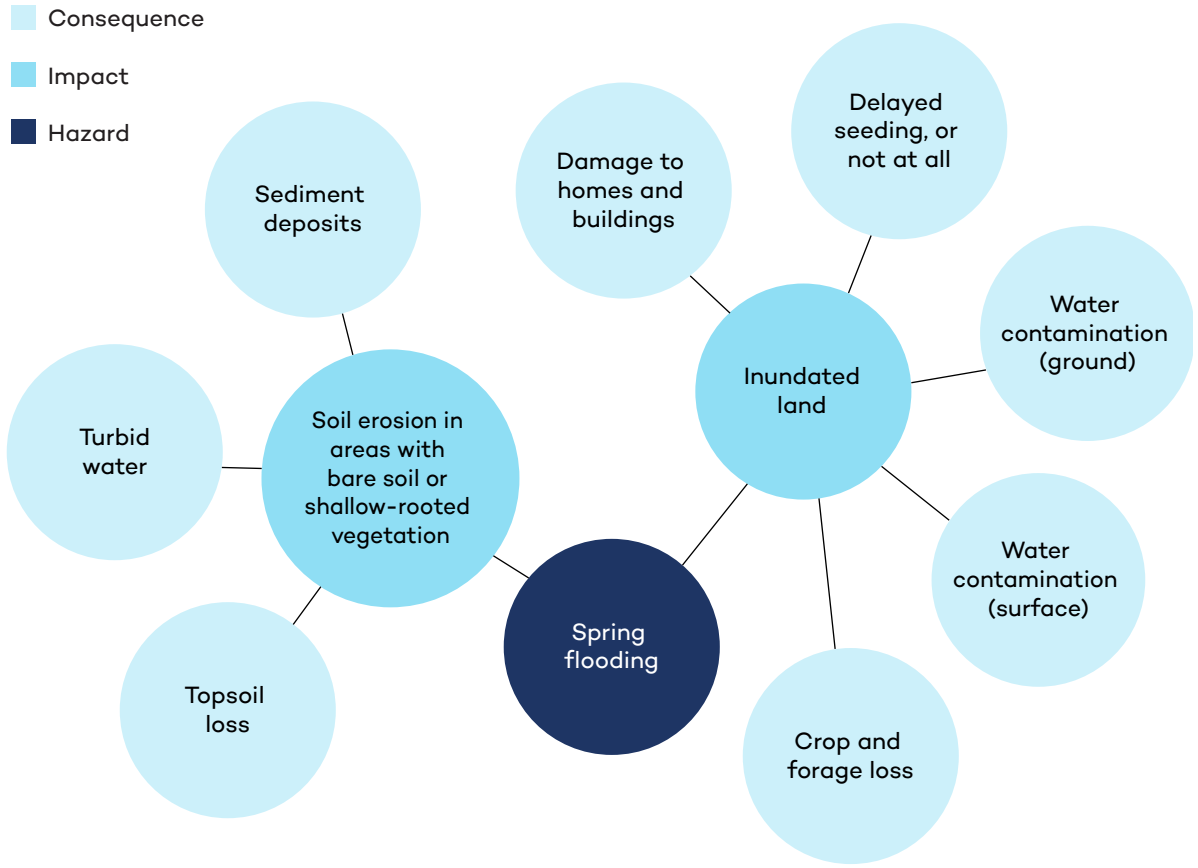


Table E3. Fillable table to record hazards and the impacts and consequences of each

Climate hazard
Impacts:
Consequences:
Climate hazard
Impacts:
Consequences:
Climate hazard
Impacts:
Consequences:
Climate hazard
Impacts:
Consequences:
Climate hazard
Impacts:
Consequences:

Appendix F. Menu of Climate-Resilient Actions

While many climate-resilient actions may not appear to be that much different from traditional watershed management practices and programs, it is the choice of actions specifically to address previously identified climate hazards and risks that distinguishes the former from the latter.

The following list of climate-resilient actions includes the climate risk(s) that the action will help to address, a description of the adaptation action, adaptation benefits, and useful resources. These include actions that the watershed districts can implement themselves (e.g., construction of enhanced water retention projects in strategic locations) or actions that watershed districts can promote through program delivery on privately owned land to watershed residents and farmers (plant and conserve shelterbelts).

Capture Runoff From Existing Farm Drainage Networks

Climate risk: Flood; wet springs; drought

Description: On-farm drainage networks (surface and sub-surface drainage) exist in some regions of watersheds, especially for annual crop production. While helpful to make fields accessible earlier in the spring, drainage can exacerbate hazards. During spring melt, drainage increases the velocity and volume of water, potentially inundating downstream neighbours and infrastructure. If conditions are dry later during the summer, there is less moisture retained on the land and in the soil, putting crops at great risk of heat stress. Building water retention or constructed wetlands at strategic locations can capture and store drainage water within the region or watershed, instead of moving it off site as quickly as possible.

Note: All on-farm drainage must be licensed as per the Water Act.

Adaptation benefits: The ability to capture and store drainage water will hold water back and reduce the severity of downstream flooding. Additionally, the ability to retain water within the region and watershed will maintain the availability of water during hot weather and drought. Water quality may also improve, as sediments can settle out of the runoff, and if a constructed wetland, wetland vegetation can filter nutrients.

Resources:

- Prairie Agricultural Machinery Institute: Constructed Wetlands
- Prairie Agricultural Machinery Institute: Tile Water Recycling
- BC Farm Practices & Climate Change Adaptation: Water Storage; pp. 16/17 for Captured Field Drainage and Irrigation Water Storage

Grazing Management and Grassland Conservation/ Restoration

Climate risks: Drought; heavy rain

Description: Implement the four key grazing principles (balance, distribution, timing, and rest) to prevent overgrazing, making management decisions based on the understanding of vegetation, soil, climate, livestock, and the capability of the specific pasture or region to improve ecosystem function, plant vigour, and soil health. The ongoing conversion of tame and native grasslands to annual cropland degrades the ecological services that grasslands provide.

Adaptation benefits: Careful grazing management (i.e., not permitting overgrazing) increases resilience, particularly to drought, as it supports the water cycle. More plants and decreased bare ground allow more precipitation to infiltrate into the soil. Additionally, the improved soil health, organic matter, and nutrient cycling makes soil "spongy," increasing moisture retention. During heavy rainfall, grassland plants prevent soil erosion and slow runoff. Moisture retention helps ensure forage availability during drought, particularly if the grassland includes drought resistant, native species.

Resources:

- Government of Manitoba: Grow Guide 2021 – Upland area conservation, enhancement, or restoration on p. 22
- BC Farm Practices & Climate Change Adaptation: Management-Intensive Grazing
- ALUS: Success with ALUS Enhanced Grazing Projects
- USDA: Managing Grazing to Improve Climate Resilience
- USDA: Drought and Rangelands – Effects and Management Responses
- Cows and Fish: Caring for the Green Zone – Riparian Areas and Grazing Management

Riparian Area Management

Climate risks: Flood; drought; extreme heat

Description: Riparian areas border lakes, wetlands, rivers, and streams. They have unique vegetation thanks to the presence of water and its influence on soil. Riparian areas are negatively affected when overgrazed by livestock, cleared for infrastructure development, agriculture, or logging, or channelized to accelerate the movement of water. To maintain or restore riparian function, consider adjusting grazing management (fencing, off-stream watering systems, temporary exclusion) and reestablishing riparian vegetation.

Adaptation benefits: During floods, riparian vegetation slows the flow of water and prevents bank erosion, allowing water to access the floodplain and seep into the water table. These benefits help alleviate downstream flooding while recharging the groundwater table so water is more likely to remain available during drought. Riparian areas in poor condition do not have the same groundwater storage capability and risk low or intermittent stream flow. Riparian vegetation also shades the water, reducing its temperature, which is especially important as increased average temperatures and extreme heat become more common. Warmer water exacerbates water quality issues and changes habitat conditions for aquatic species.

These adaptation benefits are greater when riparian management is implemented across a watershed, as opposed to on an individual basis.

Resources:

- Government of Manitoba: Grow Guide 2023 – Riparian area management on p. 19
- BC Climate Change Adaptation Program: Economic, Social, and Environmental Benefits of Riparian Rehabilitation as a Climate Change Adaptation Strategy for Agriculture
- Cows and Fish: Caring for the Green Zone – Riparian Areas and Grazing Management
- Cows and Fish: Caring for the Green Zone – Riparian Areas: A User's Guide to Health
- Cows and Fish: Growing Restoration – Natural Fixes to Fortify Streambanks
- Cows and Fish: Invasive and Disturbance-caused Plants Fact Sheet
- Cows and Fish: Protection Shorelines & Streambanks – Naturally
- Cows and Fish: Looking at My Streambank
- Agroforestry & Woodlot Extension Society: Manual for Riparian Forest Buffer Establishment in Alberta

Plant and Conserve Shelterbelts

Climate risks: High winds; extreme heat; drought

Description: Shelterbelts are rows or areas of adapted species of trees or shrubs that are planted to help reduce the impacts of climate change within fields, pastures, and farmyards. In addition to planting shelterbelts, landowners can allow natural plant communities to establish by protecting selected areas from grazing or cropping.

Adaptation benefits: The frequency and intensity of wind are anticipated to increase with climate change, so properly designed shelterbelts can offer protection, reducing wind speed and turbulence. Shelterbelts provide shade during hot weather, changing the air and soil temperature. Additionally, they can affect how snow accumulates and melts, contribute to soil and water conservation, prevent erosion, and provide habitat for wildlife and beneficial insects, all while sequestering carbon.

Resources:

- BC Farm Practices & Climate Change Adaptation: Shelterbelts
- Government of Manitoba: Grow Guide 2023 – Buffer establishment – shelterbelts, multi-species buffer strips on p. 21
- Manitoba Department of Agriculture: Shelterbelt Guidelines for Manitoba Pig Producers
- ALUS: Success with ALUS Tree & Shrub Projects
- Foothills Forage and Grazing Association: Everything Shelterbelts
- USDA: Considering Climate Change in Tree Planting
- Agroforestry & Woodlot Extension Society: The Practical Guide to Establishing an Eco-Buffer

Plan for Extreme Weather Events

Climate risks: Flood; drought; wildfires

Description: Assess and create a plan to protect assets, livestock, and residents on farms to understand and identify the steps to take in case of extreme weather events like floods, droughts, and wildfires. In Manitoba, all owners and operators of premises with livestock and poultry must have a Premises Identification Number, which helps to prepare for and track animals in the event of an emergency, like disease or flood.

Adaptation benefits: In the event of an extreme weather event, like a flood, drought, or wildfire, having specific plans will help the farm be better prepared to take effective action during the disaster. Examples of planning content include:

- Wildfire plans can help identify risk reduction measures (e.g., remove fuel or set up sprinklers), communicate the plan with family, staff, neighbours, and wildfire responders, and facilitate an evacuation plan for residents and livestock.
- Flood plans can help understand the potential risks and areas that are most vulnerable to flooding, where to implement temporary and permanent flood protection measures, and facilitate an evacuation plan for residents and livestock.
- Drought-management strategies will help guide grazing decisions, when to destock, and how or where to access supplemental feed and water.

Resources:

- BC FireSmart: Farm and Ranch Wildfire Preparedness
- BC Climate Change Adaptation Program: Farm & ranch wildfire preparedness plan – guide & workbook
- BC Climate Change Adaptation Program: Farm Flood Readiness Toolkit
- Beef Cattle Research Council: Drought Management Strategies
- Canadian Cattlemen: Do you have a drought management strategy?
- Protect Your Farm Assets video

Include Water Retention Structures

Climate risks: Flood; drought; heavy rain

Description: The construction of small dams, water retention basins, and temporary back floods, or the addition of infrastructure, like berms and gated culverts, to store surface water runoff. Keeping beavers on the landscape can provide similar benefits.

Adaptation benefits: Greater water storage capacity helps reduce the timing of peak flows and runoff velocity to reduce downstream flooding. The greater water storage also helps hold water on the landscape, recharging the groundwater aquifer and increasing the likelihood of water storage in case of drought. Additionally, water retention can improve water quality by capturing nutrients, sediments, and pesticides.

Resources:

- BC Farm Practices & Climate Change Adaptation: Water Storage
- Government of Manitoba: Grow Guide 2023 - Water Retention on p. 14
- IISD: How to Best Manage Water Retention Sites to Protect Manitoba's Environment
- Cows and Fish: Caring for the Green Zone – Beaver Our Watershed Partner
- Cows and Fish: Beavers and Fish
- Cows and Fish: Beaver Coexistence Tools
- IISD: A Strategic Vision for Enhancing Naturalized Water Retention in Manitoba

Conserve, Enhance, or Restore Wetlands

Climate risks: Flood; drought; heavy rain

Description: Wetlands can be conserved to prevent drainage, particularly Class 1 and 2 wetlands, which are vulnerable to drainage and/or filling. Enhancement can include actions that improve the health of wetlands, like fencing to restrict livestock access or seeding a perennial buffer around the wetland. Restoration includes plugging surface drains or reestablishing natural contours to restore the water-holding capacity of the basin.

Adaptation benefits: Wetlands provide many benefits that enhance resilience, like flood prevention, groundwater recharge, and base flow maintenance, especially during drought. Additionally, wetlands improve water quality, reduce erosion, support biodiversity, and provide wildlife habitat.

Resources:

- Manitoba Prairie Wetland Classification Guide
- Government of Manitoba: Grow Guide 2023 – Wetland Conservation, Enhancement, or Restoration on p. 16
- Ducks Unlimited Canada: Investigating the Role of Wetlands in Climate Change mitigation and Adaptation
- ALUS: Success With ALUS Wetland Projects
- Canadian Institute for Climate Choices: Wetlands Can Be Infrastructure, Too
- USDA: Climate Adaptation Strategies and Approaches for Conservation and Management of Non-Forested Wetlands

Change Management Approach on Marginal or Idle Land

Climate risks: Flood; heavy rain

Description: The cause of marginal land must be determined. There are many different reasons, including poor or waterlogged soil, salinity, difficulty in accessing with machinery, or steep slopes, to name a few. These issues often make the land unproductive for annual crop production. Depending on the cause, some areas of land should be removed from annual crop production and seeded to perennial vegetation.

Idle land may include areas that are not used to produce crops or livestock, like field edges, ditches, or watercourses. They may be naturalized ecosystems but are often degraded, with opportunity to make changes to restore their function and contribute to landscape connectivity.

Adaptation benefits: Depending on the area, marginal lands can store water during spring melt, heavy rain, or floods to help reduce the timing of peak flows and runoff velocity to reduce downstream flooding or inundated cropland. The greater water storage also helps hold water on the landscape, recharging the groundwater aquifer and increasing the likelihood of water storage in case of drought. The perennial vegetation will protect the soil from erosion while also improving water quality by capturing nutrients, sediments, and pesticides. Farmers may see financial benefits as marginal lands tend to have poor yields, making less profit than it costs to produce a crop. Efforts on idle land, including riparian, grassland, and wetland restoration and the addition of more native species, help improve the delivery of ecosystem services under a changing climate.

Resources:

- The Western Producer: Marginal land must be managed properly
- Ontario Ministry of Agriculture, Food, and Rural Affairs: Cropland Retirement
- USDA: Adaptation Resources for Agriculture on p. 27

Support and Maintain the Fundamental Functions of Soil and Water Across the Watershed and on Farms

Climate risks: Flood; drought; extreme weather

Description: With increasing flood and drought, climate change has the potential to disrupt the basic functions of soil and water that are key to supporting ecosystems and agricultural production.

Adaptation benefits: A variety of climate-resilient actions can contribute to soil health and water quality, including

- increase soil organic matter by minimizing tillage and soil disturbance, maintaining ground cover with perennial vegetation or residue, or adding compost, crop or livestock residue, biochar or other amendments to help buffer against both dry and wet extremes; greater soil organic matter can improve water infiltration and reduce nutrient loss during heavy rainfall, while also retaining soil moisture during drought;
- reassess nutrient and pesticide applications to ensure they match crop needs in a changing climate and avoid runoff of these inputs during heavy rainfall.

Resources:

- U.S. Department of Agriculture: Adaptation Resources for Agriculture on p. 21

Appendix G. Suggested Questions for Engagement With Watershed Residents

Participatory engagement is a central element of both the IWMP and climate change adaptation processes. Insights about changes in climatic conditions that watershed residents have already experienced, and their concerns for the future, may be gained during the public engagement process. Questions should be framed around how climate change is impacting residents and what they are doing to prepare for a changing climate. These answers will help inform about watershed priorities when contemplating the impacts of climate change and how receptive the watershed residents are to take the required steps to prepare for climate change.

Public Engagement

The following questions may be useful to include in public engagement or as part of a facilitated discussion:

- Are you concerned about climate change and its impact on your watershed?
- What climate-related changes have you observed in the watershed?
    - What do you see as the most significant consequence of these changes?
- What actions have been taken in the past in response to these historical events or changes?
    - Did these actions work?
    - If not, why not? What happened?
    - How can these strategies be strengthened/improved?
- What other actions are you aware of that might be appropriate to your watershed?

Online Survey

The watershed planner can include some questions about climate change in the online surveys that are often a part of public engagement. The following questions may be useful:

- How worried are you about climate change?
    - very worried
    - somewhat worried
    - not very worried
    - not at all worried

- How worried are you that the following hazards might impact the watershed? Repeat these choices for each hazard (flooding, wildfires, drought, severe storms, heat waves, etc.)
    - very worried
    - somewhat worried
    - not very worried
    - not at all worried
- How well do you think the following actions will work to reduce the impacts of climate change? Repeat these choices for each action (water retention structures, grassland conservation and restoration, riparian area management, plant shelterbelts, etc.)
    - very worried
    - somewhat worried
    - not very worried
    - not at all worried
- Please list other actions to reduce the impacts of climate change that might be appropriate to your watershed.

Appendix H. Climate Risk Matrix Exercise

The watershed planner can lead a climate risk matrix exercise during public engagement sessions to help prioritize which climate-related hazards are of greatest concern and require actions to reduce the watersheds' vulnerability to these risks.

Prioritization is typically done by looking at

- the **likelihood** (or probable frequency) of a climate-related hazard happening
- the **severity** of the impact(s) and consequence(s) of the climate-related hazard if it happens.

Looking at likelihood and severity together helps prioritize and identify the climate risks that should be managed, using drought as an example.

Example: Spring flooding (hazard) may cause soil erosion (impact) which can lead to topsoil loss (consequence).

Likelihood

The watershed planner and project management team will first agree upon definitions of "likelihood." Examples of how "very low" to "very high" likelihood could be defined are provided in Table H1.

Table H1. Potential definitions for likelihood

Rare (1)	Event not expected to occur, but possible
Unlikely (2)	Event unlikely to occur, but not negligible
Possible (3)	Event less likely than not, but still appreciable chance of occurring
Likely (4)	Event more likely to occur than not
Almost Certain (5)	Event highly likely to occur

Following this, assign a likelihood to each identified impact and consequence for the climate hazard (Appendix E), using the agreed-upon definitions. For each, provide a sentence or two that documents why that likelihood was assigned to the climate hazard. Although technical approaches can be used, local knowledge of the watershed and climate projections, as well as expertise from the watershed team (Appendix B or C), will provide useful insight into likelihood.

Example: The likelihood of spring flooding (hazard) is likely because

- it is projected that the watershed will regularly see more precipitation in the winter and spring
- ongoing wetland and grassland loss reduces the water-holding capacity of the watershed.

Severity

The next step is to estimate the severity of the impacts and consequences of a climate-related hazard where, similar to likelihood, the watershed planner and project management team will agree upon definitions of "severity" (Table H2).

Table H2. Potential definitions for severity of consequences

Insignificant (1)	No impact or very minor impacts that do not change the aspects of the watershed.
Minor (2)	No significant impact observed on the watershed. Any impact observed can be handled through business-as-usual practices.
Reasonable (3)	Moderate impacts at the local and regional scale to the watershed, can be addressed through low-cost or no-regret climate-resilient actions.
Major (4)	Major impacts at the local and regional scale that are of high importance to one or more aspects of the watershed, requiring strategic climate-resilient actions to avoid consequences.
Catastrophic (5)	Extreme impacts at the local and regional scale. Consequences can result in irreparable damage to many aspects of the watershed.

Now, for each of the impacts and/or consequences for the climate hazards used in the likelihood assessment and using the agreed definitions for "very low" to "very high," score the potential severity and document why that severity rating was assigned.

Example: The severity of soil erosion (impact), which can lead to topsoil loss (consequence), is minor:

- It may impact crop production, but there is low risk to human and animal well-being.
- The risk can be reduced with existing practices, like no-till or reduced tillage, and by promoting practices like grassed waterways and riparian buffers.

Risk Matrix

Use the scores assigned to the impacts and consequences of the climate hazards and plot them on a risk matrix template (Figure H2). This will provide relative rankings of risk levels for the impacts and consequences of each climate hazard. This will help to decide which risks are prioritized and will benefit from climate-resilient actions. The threshold for action will be different for each watershed (e.g., some watersheds will want to implement actions for both moderate and high risks, while others may implement for just high risks). The following might help to decide:

- High risk: These risks are high priority and require immediate action.
- Moderate risk: These risks are a lower priority and require action in the short to medium term.
- Low risk: These risks are a low priority and can be monitored for changes to the climate hazard or to the watershed (residents, economy, ecosystem).

Again, documenting the rationale for developing the risk matrix can support the development of the current IWMP and assist future efforts to update it.

As shown in Table H2, based on the likelihood of spring flooding being likely (4) and the severity of soil erosion and topsoil loss is minor (2). The risk is moderate.

Figure H1. Example of risk matrix for spring flooding

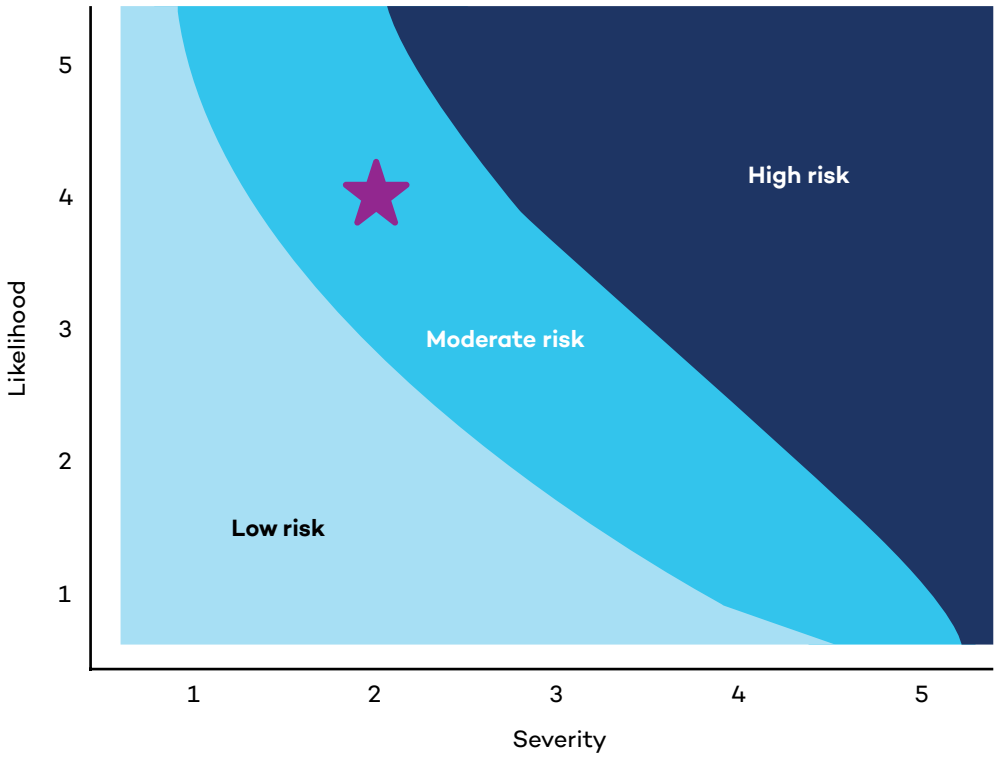
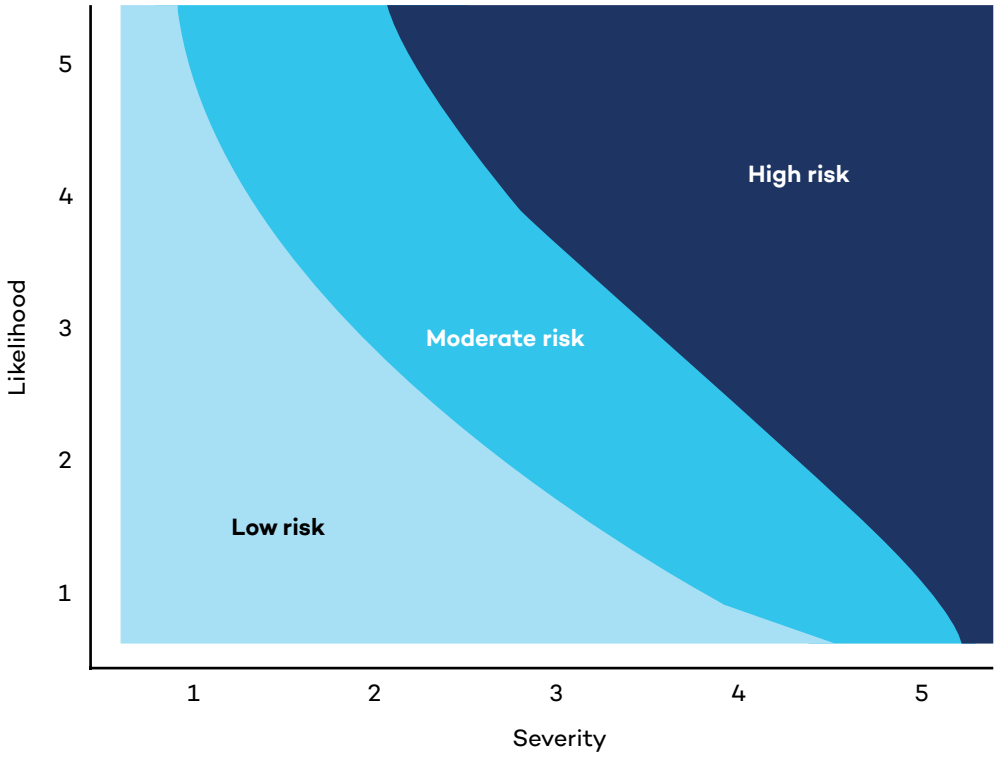


Figure H2. Risk matrix



Note: The risk matrix will be repeated for each climate-related hazard, so there may be multiple risk matrix diagrams.

Source: Authors' diagram.

Appendix I. Build an Initial List of Climate-Resilient Actions

Referring to the list in Appendix F, the watershed planner and project management team will begin to build a list with a broad range of climate-resilient actions for the prioritized risks without immediately considering possible constraints, such as time, money, or expertise; this can be assessed during a later evaluation (Appendix J). The list should include a variety of actions, including

- short-, medium-, and long-term strategies
- low-, medium-, and high-cost strategies
- climate-resilient actions that have mitigation and other co-benefits, such as improved water quality or biodiversity
- actions with the flexibility to be adjusted or changed as required
- considering the utilization or enhancement of natural assets, such as wetlands and riparian areas.

Remember that different climate-resilient actions may address the same risk. Similarly, one climate-resilient action may help address many different risks.

Example:

Climate hazard: Spring flooding

Prioritized risk	Potential climate-resilient action
Soil erosion and topsoil loss (moderate)	• Plant shelterbelts • Change management of marginal land
Inundated land and delayed seeding *(risk not determined)*	• Change management of marginal land • Wetland restoration • Water retention

Fill in Table I1 with the climate hazard, the prioritized risk, and potential climate-resilient action. Complete one worksheet for each climate hazard.

Table I1. Identify potential climate-resilient actions for each hazard

Climate hazard:

Prioritized risk	Potential climate-resilient action

Appendix J. Evaluation of Climate-Resilient Actions

Once an initial list of climate-resilient actions is selected to address the prioritized risks, Table J1 can be used to evaluate each action and create a final list of actions to include in the "Implementation Plan" (adapted from Janowiak et al., 2016).

The following information will help fill in the evaluation table.

Climate-resilient action: List the climate-resilient actions selected from Appendix I.

Climate risk: List the climate risk(s) that the climate-resilient actions will address.

Benefits: List the adaptation benefits that these climate-resilient actions will provide. Note if it addresses a primary risk or challenge, addresses multiple challenges, or has co-benefits (e.g., pollinator habitat).

Time frame: List the approximate time frame for implementing the climate-resilient action. Some may be implemented in the short term and/or seasonally (< 1 year), while others may not be implemented for many years (>10 years).

Cost: Include an estimated cost for the action, which may be a range. The cost range will be unique to each watershed district and its operating budget, but an example is

- **low**: <CAD 25,000
- **medium**: CAD 25,000 to CAD 50,000
- **high**: >CAD 50,000

Drawbacks and barriers: List any drawbacks that could arise, like reduction of cropland acres, or barriers to the action, like legal, financial, political, social, or physical.

Effectiveness and feasibility: An adaptation action is best if it is both effective (i.e., it will have the desired impact) and feasible (i.e., it is realistic to implement). Consider the benefits, drawbacks, and barriers to determine the potential success of that adaptation action in increasing resilience. The following categories may be used:

- **high**: The action will likely be both effective and feasible. The benefits are clearly greater than any potential drawbacks and barriers.
- **moderate**: There are some drawbacks or barriers that may reduce the effectiveness or feasibility of this action, but still be worth exploring as different approaches might help overcome the drawbacks or barriers.
- **low**: The action does not seem effective or feasible. The drawbacks and barriers are too large, or the benefits are too small relative to the required effort.

Partners: Consider other groups in the watershed that may be interested in this action and can lead or help lead its implementation.

Implement: The team can consider the benefits, timeframe, cost, drawbacks and barriers, and effectiveness and feasibility to select the actions to include. Select actions that will help overcome or avoid climate risks, are highly practical, or have major benefits. Identify if an action should be listed in the implementation plan section of the IWMP:

- **yes**: The action will be helpful in increasing resilience and should be included in the IWMP. Note anything that will be useful to consider in its implementation.
- **no**: This action is not effective or feasible and will not be included in the IWMP.

Example:

Climate-resilient Action	Climate Risk(s)	Benefits	Time frame	Cost	Drawbacks and Barriers	Effectiveness and Feasibility	Partners	Implement
Water Retention	Flood Drought	Water storage to decrease impact of flooding (both volume and velocity of water) Stores water and recharges groundwater to alleviate water/feed shortages during drought	<1 years	Low	Takes land out of production Reluctance from some landowners to participate Eventually will run out of potential sites and willing landowners	Already well understood (performance, cost, design) Existing program with watershed districts Many different funding opportunities		Yes

Table J1. A fillable table to evaluate potential climate-resilient actions to include in the Implementation Plan section of the IWMP

Climate-resilient Action	Climate Risk(s)	Benefits	Time frame	Cost	Drawbacks and Barriers	Effectiveness and Feasibility	Partners	Implement

Climate-resilient Action	Climate Risk(s)	Benefits	Time frame	Cost	Drawbacks and Barriers	Effectiveness and Feasibility	Partners	Implement

Appendix K. Resources

The following resources are useful to support entry points, presented by the stages of the IWMP. Those resources that are bulleted with ( ) are included within the document, while additional, new resources are bulleted with a ( ).

Preplanning

Organizations With Expertise on Climate Change Adaptation

- https://climatewest.ca/ClimateWest is a regional hub for climate services serving the provinces of Manitoba, Saskatchewan, and Alberta. It provides access to regionally relevant climate information and support to use it effectively in planning and decision making. ClimateWest offers a help desk to assist communities, businesses, and others with locating the most relevant climate data and connect with climate specialists, as well as how to integrate climate change into decision making.
- The Prairie Climate Centre (PCC), affiliated with the University of Winnipeg, supports Canadians in moving from risk to resilience, using maps, videos, research reports, training, and outreach. PCC also hosts the Climate Atlas of Canada and the Indigenous Climate Atlas, an interactive map that explores how climate variables are projected to change as well as a summary of Indigenous-focused data, knowledge, resources and climate solution.
- The Centre for Indigenous Environmental Resources (CIER) enables Indigenous People and communities to be leaders in positive environmental change. CIER developed a comprehensive Indigenous Climate Change Adaptation Planning Toolkit, which includes easy-to-understand tools and resources for all stages of the adaptation planning process.
- The Prairie Adaptation Research Collaborative, affiliated with the University of Regina, translates scientific research into practical and regionally relevant climate data, information, and knowledge, as well as support for professional development.
- The All One Sky Foundation supports education, research, and community-led programs to build climate resilience, having facilitated the adaptation planning process for groups across the prairies, including Manitoba.

General Information on Climate Change

- The Climate Atlas of Canada has a variety of articles and short videos, with the option to filter by "climate science", with additional content about health, Indigenous Knowledge, cities, and more.
- The Prairie Climate Centre has prepared a report, Manitoba and Climate Change, that summarizes the expected impacts of climate change for Manitoba.

- Manitoba Climate Resilience Training provides training to access, use, and apply knowledge and tools on climate change adaptation. It includes presentations (and associated slide decks) on
  - Foundational training
  - Nature-based Infrastructure Solutions to Enhance Resilience
  - Indigenous modules
  - A Path Forward (includes the integration of IWMPs)
- Climate Change Connection explains the science behind climate change, focused on Manitoba
- Up North on Climate's Adaptation Framework: Pages 9-19 explain climate change, the greenhouse effect, and projections in an easy-to-understand format, accompanied by fun illustrations.
- The World Wildlife Fund's article explains the difference between climate change mitigation and adaptation and how both can be used to address climate change.
- The Climate Change Adaptation Quick Guide uses illustrations to show how climate change impacts the land and communities. It also includes examples of actions that can be used to adapt to drought, flooding and wildfires, amongst others.
- Natural Resources Canada's Adapting to Climate Change: An Introduction for Canadian Municipalities: Chapter 1 covers what climate adaptation is and why it is important in Canada. Chapter 2 highlights key components of successful adaptation planning processes.
- CIER has developed a Climate Change Adaptation Planning Toolkit; Guidebook 1: Starting the Planning Process helps communities learn about climate change and assemble a leader and team, while sharing community examples.
- Climate Science, Risk & Solutions: Climate Knowledge for Everyone, developed by the Massachusetts Institute of Technology, is an interactive online tool that walks visitors through the science behind climate change and GHGs, climate predictions and risk, and different solutions.

Gather Information

Climate Data and Projections

- The Prairie Climate Centre publishes a summary of anticipated changes for communities across Manitoba, as well as a description of how these changes will impact economic sectors and residents.
- The Climate Atlas of Canada hosts climate model data through an interactive map. Users can explore their current modelled climate and projected future climates using a number of temperature and precipitation variables and indices. The Climate Atlas allows users to view and download data specific to their location through tables, graphs, and reports.

- ClimateData.ca provides high-resolution climate data for a number of climate variables and indices that can be explored for locations throughout Canada. It provides access to modelled data, observed climate normal, and observed station data.
- ClimateWest's A Guide to Finding Climate Information & Data provides a user-friendly overview of the free sources of climate data and information available to Canadian municipalities and others.
- The Government of Manitoba hosts a webpage detailing the province's flood events and damage since 1950. There is another page where users can access fire mapping data from 2010-2019.
- The Manitoba Drought Monitor includes information on precipitation, river and lake levels, groundwater levels, and reservoir supply levels across the province.

Learn About Hazards, Impacts, and Consequences

- Canada in a Changing Climate: Regional Perspectives provides insight into how climate change will impact communities, the environment, and the economy across the country. Chapter 4: Prairie Provinces describes how and why the climate has changed and the hazards we can expect in the future.
- A Snapshot of the Changing Prairie Climate describes three climate hazards (forest fire, drought and flood, and extreme weather) that will affect life on the Prairies across seven sectors, including agriculture, ecosystems and wildlife, Indigenous communities, and urban and rural communities.

Public Engagement

- The Federation of Canadian Municipalities' *Talking it Through: A Discussion Guide for Local Government Staff on Climate Adaptation* provides a useful resource to inform planned discussions with decision-makers on the impacts of climate change and adaptation options. There is also a useful customizable PowerPoint template that is editable to address the unique situation of the watershed (visit this page to download the template).
- CIER has developed a Climate Change Adaptation Planning Toolkit. Guidebook 2: Climate Change Impacts in the Community includes activities to start to engage community members about local climate change impacts, while sharing stories of communities that have already suffered from climate change.

Prioritize Climate Risk

- CIER has developed a Climate Change Adaptation Planning Toolkit. Guidebook 3: Identifying Community Sustainability and Climate Change Vulnerabilities works with community members to explore the concept of community sustainability versus community vulnerability to climate change.

- The Canadian Council of Ministers of the Environment provides Guidance on Good Practices in Climate Change Risk Assessment. The guidance document explains the fundamental elements of climate risk assessment and includes six case studies highlighting good practice in Canada.

Plan Drafting

- Appendix H. Menu of climate-resilient actions includes lists of resources for each of the 10 climate-resilient actions.
- CIER has developed a Climate Change Adaptation Planning Toolkit; Guidebook 4: Identifying Solutions works with community members to list and prioritize climate-resilient actions.

Implementation

- To help build the case for investing in climate-resilient actions, ICLEI Canada has prepared the Cost of Doing Nothing toolkit. It outlines the rationale for assessing the costs versus benefits of acting to reduce climate risks and provides a template and tool to collect, track, and present data to make the business case for investing in adaptation measures.
- An additional financial resource is the Inventory of Innovative Financial Instruments for Climate Adaptation online tool developed by IISD.

Monitoring, Evaluation, and Learning

- ICLEI Canada released Introducing Indicators: A First Look at Using Indicators to Measure Adaptation Success to provide a starting point for identifying potential indicators to assess a community's preparedness for climate change and includes over 70 possible indicators that could be used.
- Are We There Yet?, from ICLEI Canada and the Clean Air Partnership, looks specifically at how existing sustainability indicators used by communities may be adapted for use in measuring adaptation progress.
- The Guidebook on Monitoring and Evaluation of Adaptation at National and Sub-national Levels developed by IISD and the German Technical Cooperation Agency is intended to help users align their monitoring and evaluation system with its purpose and context as well as determine its content, how it will be put into place, and what will be its outputs.

Additional Adaptation Planning Guidebooks

- The Canadian Council for Ministers of the Environment published the Implementation Framework for Climate Change Adaptation Planning at a Watershed Scale, which details a seven-step process to build resiliency across the watershed.

- All One Sky Foundation's Climate Resilience Express Adaptation Planning Guide provides an overview of the necessary steps to take in the development of a locally driven climate adaptation plan. This guide supports their workshop-based process for adaptation planning.
- The U.S. Department of Agriculture developed the Adaptation Resources for Agriculture guidebook for the U.S. Midwest and Northeast that outlines a five-step process that producers can undertake, including worksheets to evaluate potential climate-resilient actions, identify implementation tactics, and monitor the effectiveness of their actions. It also provides case studies of farms that have created adaptation plans.
- Climate Change Adaptation Planning and Creation of a Local Early Action Plan: A Guide for Facilitating a Co-Created Adaptation Planning Process in Indigenous Communities by the Resilience Institute and All One Sky Foundation describe how Western science and Indigenous Knowledge can be woven together to co-create local early action plans and climate adaptation plans in Indigenous communities.
- ICLEI's 2019 Changing Climate, Changing Communities Guide and Workbook is a milestone-based framework to assist local governments in the creation of adaptation plans to address the climate change impacts relevant to their communities.

©2024 The International Institute for Sustainable Development
Published by the International Institute for Sustainable Development

Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Website: www.iisd.org
Twitter: @IISD_news

IISD

iisd.org