Ontario Provincial Climate Change Impact Assessment

Adaptation Best Practices Summary Report

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This report was prepared for the Ontario Ministry of the Environment, Conservation and Parks by the Climate Risk Institute in collaboration with Dillon Consulting Limited.

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Ontario Ministry of Agriculture, Food and Rural Affairs

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Ontario Ministry of Health

Ontario Ministry of Infrastructure

Ontario Ministry of Labour, Immigration, Training and Skills Development

Ontario Ministry of Mines

Ontario Ministry of Municipal Affairs and Housing

Ontario Ministry of Natural Resources and Forestry

Ontario Ministry of Northern Development

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Key Terms, Definitions and Acronyms

– A –

Adaptation: Process of adjustment to actual or expected climate hazards and its effects.

Adaptive Capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

APGO: Association of Professional Geoscientists of Ontario

Area of Focus: The five Areas of Focus defined by the Ontario Ministry of the Environment, Conservation and Parks for the PCCIA are: Business and Economy; Food and Agriculture; Infrastructure; Natural Environment; and People and Communities.

ASP: Adaptive Social Protection

– B –

BOMA: Building Owners and Managers Association

– C –

Climate Change: Refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Climate Hazard: Changes in climate (events or stressors) that have the potential to cause harm or benefit.

Consequence: (In the PCCIA context) the severity of an impact, assessed as a consequence in one of four criteria (human health and safety, environmental damage, financial loss, disruption to services).

CRI: Climate Risk Institute

Critical Infrastructure: Critical infrastructure is defined as interdependent, interactive, interconnected networks of institutions, services, systems and processes that meet vital human needs, sustain the economy, protect public health, safety and security, and maintain continuity of and confidence in government.

Cross-Sectoral Impacts: Climate change impacts that span multiple Areas of Focus. For the purposes of Ontario's PCCIA, cross-sectoral impacts are characterized based upon five themes: 1) food security, 2) water security, 3) energy security, 4) human health, 5) community function; human health, safety and well-being ((4) and (5) are linked together in this report due to the common themes between them).

CSA: Canadian Standards Association

CSIRO: Commonwealth Science and Industrial Research Organisation

CVC: Credit Valley Conservation

– D –

Direct Impact: Effects of changes in climate that in and of themselves cause an impact. Also referred to as primary effects of climate change. In the context of Ontario's PCCIA, direct impacts are those resulting from climate hazards on the Areas of Focus, which has been quantified.

– E –

EPA: United States Environmental Protection Agency

Equity Lens: Within the context of the PCCIA, this is a term specifically used as part of cross-sectoral analysis (Section 7.6). An equity lens has been applied to every cross-sectoral theme, which identifies unique factors or populations that may be disproportionately impacted associated with the cross-sectoral theme.

ESSCO: Engineering Student Societies' Council of Ontario

Event: Occurrence or change of a particular set of circumstances.

Expert [evidence, experience]**:** Expert refers to the subject matter expertise held by the Consulting team consultants, all of whom have significant experience and knowledge of their respective Areas of Focus. This can also refer to external expertise in the form of engaged Stakeholders.

– F –

Frequency: The number of occurrences of a repeating climate variable per unit of time (e.g., a flood event that is reasonably expected to occur 1 time in a 100 year time span has a frequency = 1/100 yrs. = 1 x 10-2 or is sometimes called "Annual Frequency"). Using this example, "1 time in a 100 year time span" is expressed as 1:100 year, which is called a "Return Period".

– G –

GBON: Global Basic Monitoring Network

GHG: Greenhouse gas

GLWQA: Great Lakes Water Quality Agreement

– H –

HIRA: Hazard Identification Risk Assessments

– I –

ICLR: Institute for Catastrophic Loss Reduction

IESO: Independent Electricity System Operator

Impact: Effect on natural and human systems.

Indirect impacts: Effects of changes in climate that occur as a secondary result. These impacts result from changes in one or multiple climate hazards. Also referred to as secondary and tertiary effects of climate change.

Information: Within the Methodology Framework, information means knowledge, facts, and data that is qualitative or quantitative in nature. Information will be collected through a variety of sources such as: stakeholder input, expert experience, literature review, climate models, geospatial data, and numerical data.

Interaction: The pairing of an asset or service or operation with a climate hazard that has the potential to impact the asset or service or operation.

IRENA: International Renewable Energy Agency

IPCC: Intergovernmental Panel on Climate Change

– L –

LIDAR: Light Detection and Ranging

Likelihood: (In the PCCIA context) the likelihood, as an annual probability, that a near worst-case scenario will occur.

– M –

MECP: Ministry of Environment, Conservation and Parks

MoE: Ministry of Energy

MINES: Ministry of Mines

MMAH: Ministry of Municipal Affairs and Housing

MND: Ministry of Northern Development

MNRF: Ministry of Natural Resources and Forestry

– N –

Nature-Based Solutions (NBS): Nature-based Solutions are actions and policies to protect, sustainably manage, protect and restore natural and modified ecosystems. They address societal challenges, like climate change, effectively and adaptively, simultaneously benefiting people and nature.

NCC: National Construction Code

NERC: North American Electric Reliability Corporation

NRCan: Natural Resources Canada

– O –

OFA: Ontario Federation of Agriculture

Ofwat: Water Services Regulation Authority (United Kingdom non-ministerial government department)

OMAFRA: Ontario Ministry of Agriculture, Food and Rural Affairs

ONEIA: Ontario Environmental Industry Association

OSPE: Ontario Society of Professional Engineers

– P –

PCCIA: Provincial Climate Change Impact Assessment

Peer Review Panel (PRP): The PRP is made up of ten subject matter experts from across Ontario, and from a variety of organizations (including Cambium Indigenous Professional Services, Association of Municipalities of Ontario, Council of the Great Lakes Region, Intact Centre on Climate Adaptation, Conservation Ontario, Ontario Association for Impact Assessment, Real Property Association of Canada, Institute for Catastrophic Loss Reduction, Ontario Federation of Agriculture, and Ontario Soil and Crop Improvement Association). The PRP review draft PCCIA products and provide commentary on the utility of PCCIA products for decision-making support and communication among their stakeholder/membership base. The PRP did not provide technical peer review, rather their feedback was used to improve a) clarity, and b) the ability of draft products to meet the needs of Ontario stakeholders and Indigenous peoples such as communicating relevant risks or adaptation actions for implementation. Feedback received from the PRP was reviewed and used to revise drafts. These edits were made prior to draft products being submitted to Ministry staff for their review periods as per the work plan.

PEO: Professional Engineers Ontario

PIEVC: Public Infrastructure Engineering Vulnerability Committee

– R –

Resiliency: The ability of systems and structures to absorb the shocks of climate change related events and impacts, and return to normal functioning without major delays.

Rights holder: Indigenous Peoples; holding constitutionally protected rights.

Risk: The positive or negative level of uncertainty of an event. In the context of the PCCIA, risk is measured as the product of frequency (of climate hazard), likelihood (of impact) and consequence (of impact).

Risk Analysis: Process of understanding the nature of risk and its characteristics including likelihood and consequence.

Risk Assessment: Process used to identify, analyze, and evaluate risk.

Risk Criteria: Criteria to evaluate the significance of risk.

Risk Evaluation: Process of comparing the risk results with the risk tolerance criteria and determining where further actions are required.

Risk Identification: Process of finding, recognizing, and describing risks.

– S –

SOFF: Systematic Observations Financing Facility, a financing mechanism to allow for the improvement of "surface-based observational" climate data worldwide

Stakeholder: Individuals engaged throughout the PCCIA process; these individuals contribute to the information gathering and provide their Area of Focus expertise.

– T –

TEK: Traditional Ecological Knowledge

TRCA: Toronto and Region Conservation Authority, one of 36 Conservation Authorities in Ontario, created to safeguard and enhance the health and well-being of watershed communities through the protection and restoration of the natural environment and the ecological services the environment provides.

– U –

UK: United Kingdom

UNFCCC: United Nations Framework Convention of Climate Change

– V –

Vector-borne Diseases: Human illnesses caused by parasites, viruses, and bacteria that are transmitted by mosquitoes, sandflies, triatomine bugs, blackflies, ticks, tsetse flies, mites, snails, and lice.

Climate change adaptation is defined as adjustments to ecological, social, or economic systems, in response to actual or expected climatic effects or impacts. In plain language, this means understanding risks and impacts related to the changing climate, and then making changes to managed systems in order to reduce impacts.

Climate change adaptation is increasingly being recognized as a core component of both current and long range planning exercises, bolstered by the evident need to reduce damage and loss as well as human health and wellbeing impacts from climate change. As the IPCC 6th Assessment Report (AR6) Summary for Policymakers (2021) notes, "It is unequivocal that human influence has warmed the atmosphere, ocean and land…Human-induced climate change is already affecting many weather and climate extremes in every region across the globe".

The call to action on adaptation is urgent – as the IPCC (2022) lays out, the window for meaningful action is now: "Climate Resilient Development is already challenging at current warming levels. It will become more limited if global warming exceeds 1.5°C (2.7°F). In some regions it will be impossible if global warming exceeds 2°C (3.6°F). **This key finding underlines the urgency for climate action, focusing on equity and justice. Adequate funding, technology transfer, political commitment and partnership lead to more effective climate change adaptation and emissions reductions**."

The global climate is changing. In Canada, the rate of rapid warming is happening two times faster than the global average, creating increased vulnerability and urgency to adapt to a changing climate even with an ongoing effort to curb greenhouse gas (GHG) emissions (Environment and Climate Change Canada, 2022).

Impacts from climate change have already affected Ontarians. Climate change impacts already affecting Ontarians include recent events such as flooding, heat waves, and unusually high climate variability and extremes. In 2021 alone, insured catastrophic losses across the country reached $2.1 billion dollars (Insurance Bureau of Canada, 2022), and Ontario has not been immune to these trends.

The social and health costs of not adapting to climate change would be catastrophic. Estimates of insured catastrophic losses do not consider the social costs of climate change. These can be significant and include impacts such as service loss due to damaged infrastructure, forced migration, cultural losses, harms to mental health and community wellbeing, and more. In addition, the loss of life and wellbeing impacts (particularly for people who are more vulnerable) are often not well considered in economic evaluations of climate change (Boyd and Markandya, 2021).

Indigenous knowledge should be integrated and prioritized in developing adaptation responses. It is critical to heed Indigenous voices on climate change, privileging Traditional Ecological Knowledge and bridging Indigenous knowledge and Western science. Indigenous Peoples and local communities have wisdom and values oriented towards nature, and amassed through generations. First Nations, Inuit and Métis Peoples in Ontario and across Canada face unique and disproportionate risks to their health, due to their interlinked ways of being with the environment and nature (National Collaborating Centre for Indigenous Health, 2022).

There are regional differences in adaptation priorities and urgency of adaptation in different sectors.

It is crucial to consider the relative differences for Northern Ontario communities, particularly with respect to infrastructure and investment in securing the necessities of life such as medical care, clean drinking water, and secure, climate adapted housing. Understanding these differences is crucial to identifying the appropriate responses in the context of cascading impacts to the wellbeing of people and communities from inadequate transportation infrastructure, housing, or energy supply (Canadian Climate Institute, 2022).

Adaptation has a number of co-benefits – it is more fiscally responsible to invest in adaptation, compared to recovery from climate induced disasters.

Estimates indicate that the ratio of benefits to costs from investing in climate adaptation is in the order of 6 to 1 (Green Analytics Corp., 2020). The sooner investments are made, the greater the benefits will be. For every $1 spent on adaptation measures today, future indirect and direct benefits amount to $13-$15.

As a global community, in Canada, and in Ontario – immediate action against climate change needs to be taken.

The impacts of climate change will continue to be felt, regardless of emissions reductions. Strong action is needed to reduce the impacts resulting from climate change – to adapt to the changing climate – in order to protect critical infrastructure, systems and communities from experiencing catastrophic failures and losses.

Adaptation should fully involve all components and aspects in society, incorporating Indigenous knowledge and experience alongside other data; and should involve the development and implementation of policies and programs, capital and operational expenditures, research and technological development – all with the goal of reducing impact from the changing climate.

1.0 Introduction

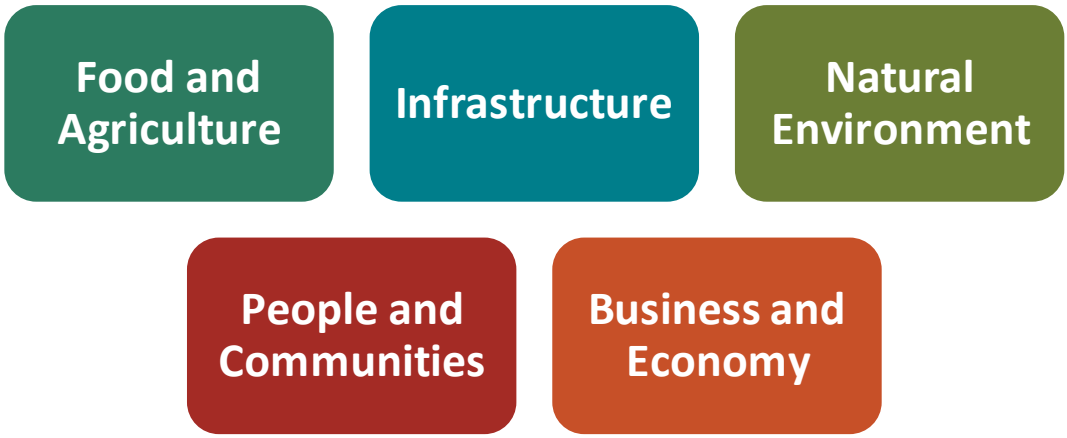
1.1 Provincial Climate Change Impact Assessment Overview

Ontario's climate is changing, and there is an urgent need to both understand the nature of the change and future impacts, as well as to invest in the capacity of the people, communities, industries, and governance organizations to adapt.

To this end, the Province of Ontario through the Ministry of Environment, Conservation and Parks (MECP) commissioned the Provincial Climate Change Impact Assessment (PCCIA) in 2020, to undertake a scientifically based assessment of risks, opportunities, and Adaptive Capacity for key sectors of Ontario.

The PCCIA focused on Areas of Focus and Cross-Sectoral Themes for analysis. Each of these sectors and systems broadly represent the diversity of ecological, social, and business systems in Ontario.

Figure 1-1 Areas of Focus in The Ontario Provincial Climate Change Impact Assessment



In each Area of Focus, a series of categories called 'Level 1' and 'Level 2' were used to guide and develop risk scenarios for evaluation. Each Level 1 category represents a primary branch of the Area of Focus, similar to how a sector is defined under the North American Industrial Classification System (NAICS). Level 2 categories are primary branches of a Level 1 category and provide additional details, similar to how subsectors and industries form the hierarchy for each sector in NAICS.

Figure 1-2 Structure of The Assessment of Impacts in The Ontario Provincial Climate Change Impact Assessment

To represent the inherent connectedness and complex interactions between Areas of Focus, cross-sectoral analyses were conducted. For the purposes of Ontario's PCCIA, cross-sectoral impacts were qualitatively characterized based upon five themes:

1. Water Security
2. Energy Security
3. Food Security
4. Community Function; and,
5. Human Health, Safety and Well-Being.

Community Function and Human Health, Safety and Well-Being are linked together in this report due to the common themes between them. An equity lens was applied to every cross-sectoral theme, identifying unique factors or populations that may be disproportionately impacted.

Figure 1-3 Cross Sectoral Themes in the Assessment of Impacts

This Adaptation Best Practices Summary is a companion document to the PCCIA Technical Summary Report, and the larger Adaptation Best Practices Report. The following sections provide an overview of the process and approach to developing a library of Adaptation Best Practices. For each of the Cross-sectoral and Areas of Focus, this summary highlights some of

the included actions from the larger Adaptation Best Practices Report to support policy-makers and decision-makers in the identification and consideration of adaptation measures that can build Adaptive Capacity in the businesses, communities, infrastructure, and natural systems of Ontario, with the ultimate goal of reducing the potential for catastrophic losses across the Province. In addition, the adaptation actions identified also include suggestions on improving interprovincial and international negotiations and coordination across transboundary issues such as floods (where rivers cross borders), as well as societal and economic issues.

1.2 Ontario's Capacity to Adapt

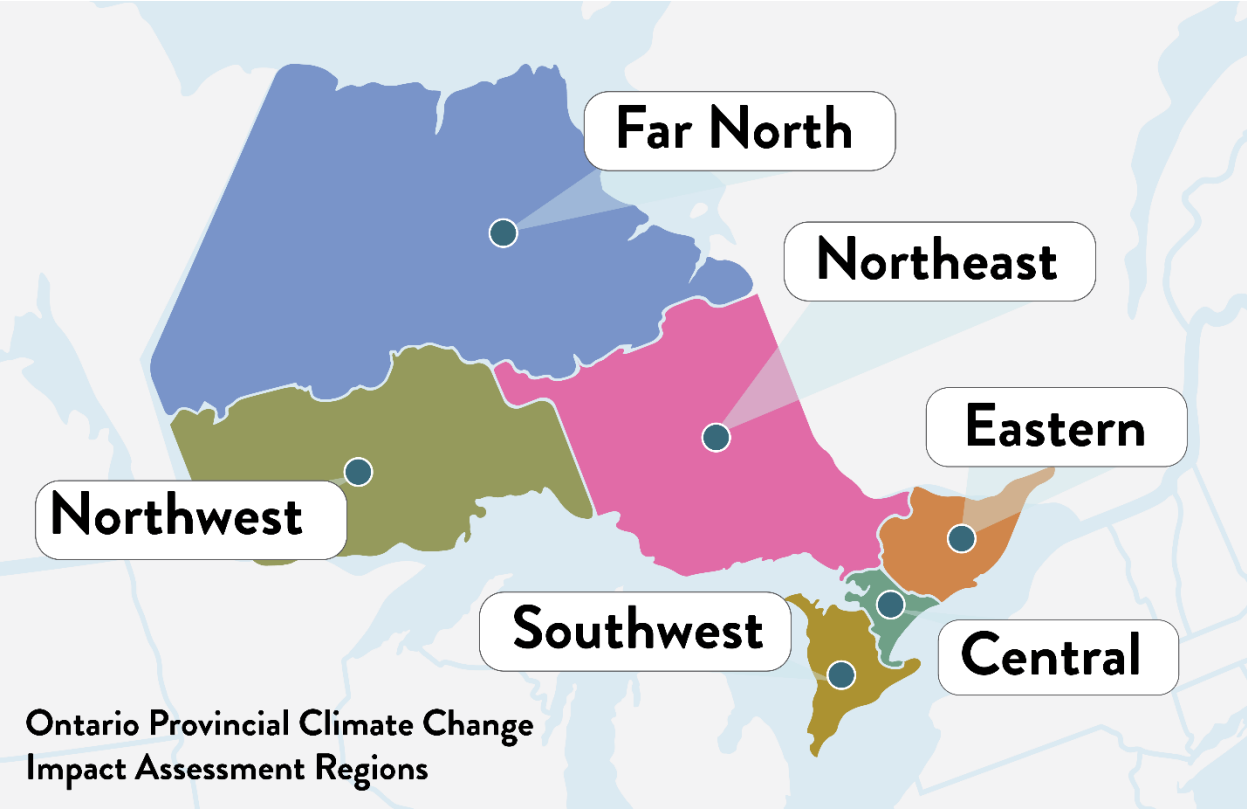
Within the framework of the PCCIA, the capacity to adapt to current and projected climate risks was explored through an Adaptive Capacity assessment. **Adaptive Capacity** is a way to measure inherent adaptability in a system, organization, or industry. It can be defined as "**the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences**".

This Provincial Climate Change Impact Assessment analyzed five main categories of Adaptive Capacity:

1. **Technology**: the availability of technological resources that can build resilience into the systems being assessed, including hard technologies, practices and planning, lessons learned databases, best practices implementation, and capacity to innovate.
2. **Resource Availability**: an organization, industry, or system's capacity to apply and/or redistribute resources where and when needed, including financial, human, and natural resources.
3. **Equity**: the presence of equally distributed opportunities such as access to healthcare, employment opportunities, distribution of income, and social cohesion. This component was applied only to the People and Communities Area of Focus.
4. **Governance**: how an organization/industry is prepared to adapt for, and respond to, climate change hazards and shocks, including implemented policies, programs, and recognition of climate change.
5. **Complexity:** the number of stakeholders or decision-makers present in a sector or at a regional level. The capacity to make decisions and change course at the sector or regional level can be inversely correlated to the number of decision-makers/stakeholders.

This provincial-scale impact assessment assessed Adaptive Capacity within each of the five Areas of Focus and across each of the six regions (presented in **Figure 1-4**). The characterization involved evaluating one or more of the five Adaptive Capacity themes, assigning a score of Low, Medium, or High based on literature and expert judgment for each Level 1 categories. It should be noted that the Adaptive Capacity rating scale was the inverse of the Risk rating scale, with High Adaptive Capacity indicating a strong potential for adaptation across the five categories listed above, and Low Adaptive Capacity indicating a concern due to deficits or challenges in some or all of the five categories.

Figure 1-4. Ontario Provincial Climate Change Impact Assessment Regions



The Adaptive Capacity results were used to help guide the identification of areas of research for adaptation best practices. The results are summarized for each Area of Focus in the respective sections of this report, and explained in greater detail in the PCCIA Technical Summary Report.

1.3 Adaptation Best Practices Overview

Adaptation to climate change requires education, cross-sectoral and cross-jurisdictional collaborations, and implementation of measures, strategies, and policies and programs designed to reduce climate risk and resulting impacts.

The term "best practice" often refers to practices that have been shown by research and/or experience to produce optimal results. These practices are suitable for widespread adoption, with appropriate adaptation for local contexts. Climate change is a slow, multi-decadal process, which means that adaptation is a constant journey. Indigenous communities have been adapting to a changing climate for thousands of years; by contrast, climate change adaptation planning in a non-Indigenous context is still considered a young science. The overarching practices in this report therefore highlight the need to integrate Indigenous knowledge and expertise into planning for adaptation, while also developing monitoring and reporting mechanisms to track progress and gather data to enable future evaluation exercises and improvements.

While many adaptation interventions that are designed for North American application are therefore quite recent, there is a significant amount of research, reporting, and adaptation mapping from Canada and internationally that can be capitalized on to mobilize towards action.

For purposes of this report, the included best practices are intended to be considered as a starting point for closer investigation to select locally and contextually appropriate measures to address climate risks, which vary significantly across the Province. It is critical to integrate an equity lens into the selection and design of adaptation actions, taking into account the needs and circumstances of vulnerable populations, and considering intersecting factors such as access to affordable, secure housing community accessibility for people with disabilities, language barriers, state of infrastructure, food and energy security, and disaster preparation for future pandemics or other large-scale challenges.

1.4 Report Methodology

Adaptation best practices were developed through a variety of data capture and review methodologies, including:

- Engagement with subject matter experts with each of the Areas of Focus and Ontario government representatives, through a series of workshops dedicated to each Area of Focus.
- Research and literature review conducted by the consulting team, focusing on adaptation practices that have been implemented, and/or have been researched and peer-reviewed, and drawing on the results of the Adaptive Capacity assessment for each Area of Focus as described in Section 1.3. The full reference list is provided at the end of the full ABP Report document, with over 400 documents cited. These references include peer reviewed journals; government documents; Indigenous Community reports and research papers; and non-government and professional association reports, databases, and websites.
- Inclusion of low-risk, high-reward practices identified by subject matter experts for each Area of Focus.
- Review and assimilation of findings from the literature review and workshop feedback, by the consulting team's subject matter experts for each Area of Focus, who have extensive experience in adaptation planning for communities, organizations, governments, and Indigenous Communities. The literature review supported the development of recommended adaptation best practices.
- Peer review of the utility of the report and gaps content by the Peer Review Panel (PRP). A description of the PRP can be found in the Key Terms, Definitions and Acronyms section above.

1.5 How to Read and Interpret this Summary Report

This summary report provides an overview of the approach to developing the Adaptation Best Practices Report, and highlights the identified adaptation best practices (ABP) as measures that have been implemented (either in Ontario or in other jurisdictions), researched and peer-reviewed, and/or identified by subject matter experts (both through consultation with external participants, and in collaboration with internal consulting team specialists). The lists of adaptation best practices presented in this report were developed based on the resources available, and within the time constraints of the project. Efforts were made to compile as many practices as possible; however, the lists presented herein should not be considered exhaustive.

Intended to be read in conjunction with the Technical Summary Report (Ontario Provincial Climate Change Impact Assessment Summary Report) prepared for the PCCIA, this ABP Summary as well as the larger ABP Report serve as a compendium of adaptation actions, and as a starting point to consider potential avenues to address the highest risks highlighted through the technical work and risk assessment.

The intended audiences of this report are policy-makers, decision-makers, and technical climate change adaptation practitioners within Ontario. These audiences are positioned to take appropriate action where possible, and to transfer adaptation information to relevant public and private stakeholders, as needed, in support of climate change adaptation in key sectors of the Province (as identified and prioritized in the PCCIA summary reports).

Additionally, the adaptation best practices presented in this report are not specifically recommended for implementation by the Government of Ontario; rather, the lists of best practices are meant as a compendium, or scan of options that practitioners, government organizations, and decision-makers can choose from. Identifying implementation priorities and mechanisms would fall to a more geographically scoped review that includes consultation with affected communities, underlined by local risks and the needs of vulnerable populations.

1.5.1 Presentation of Adaptation Best Practices

Adaptation best practices (ABPs) have been identified by Area of Focus, using the main Level 1 Category of assessment to organize and group the best practices. This report is laid out as follows:

- **Section 3.0** presents overarching ABPs, which present opportunities to address multiple risks across multiple Areas of Focus, and/or Cross-Sectoral Themes. This section also documents ABPs related to each of the five Cross-Sectoral Themes that emerged from the PCCIA: Water Security; Energy Security; Food Security; and Community Function, Human Health, Safety and Wellbeing.
- **Sections 4.0 to Section 8.0** of this report document ABPs for each of the Areas of Focus: Food and Agriculture; Infrastructure; Natural Environment; People and Communities; and Business and Economy. Readers may find relevant ABPs within the overarching and cross-sectoral sections, and then additional, more specific ABPs within their Area of Focus sections of interest.

Within each section, ABP tables identified as "overarching" include ABPs that are relevant to most/all Level 1 categories of that Area of Focus. Area of Focus sections contain tables of ABPs grouped by category, and may include specific reference to sub- categories.

The ABPs are documented in tabular format. The elements described for each Adaptation Best Practice are presented in **Table 1-1**.

Table 1-1. Description of information contained in ABP tables

Type of Adaptation Best Practice	Description of Adaptation Best Practice	Implementation Timeline	Implementation Responsibility and Partners	Reference
Categorization of the ABP, using the following categories: **Policy and Regulation** **Investment and Incentives** **Research and Development** **Projects or Programs**	The adaptation best practice description, including information for report user review and consideration. There may be hyperlinked to resources and references contained within this content, for access to additional information.	Timeline for implementation: • Short (Less than 5 years) • Medium (5-10 years) • Long Term (More than 10 years). Timelines have been determined based on urgency of action needed, as well as high level feasibility of implementation. For example, an action may be recommended to be implemented in the short term; however, it may not be feasible to implement within 5 years; in this case, it will be identified as medium term implementation. In addition, some items identified as 'short term' may be partially in effect in Ontario.	Description of the decision maker and/or partners that would most likely lead the implementation of the associated ABP, and would be responsible for undertaking the measures identified in the Ontario context. **Provincial Government** includes ministries and departments within the government. **Agencies** includes Conservation Authorities, other Provincial bodies, Canadian Federal agencies, and other government entities, for example cross-border authorities in the United States. **Communities** includes municipal governments and Indigenous Communities. **Associations and Non-government** includes non-ministerial regulatory and governing bodies, professional associations, and service providers (e.g., conservation authorities, utility companies, etc.), as well as non-governmental community based groups. **Private Sector or Individual** includes companies and individual citizens. **Academia** refers to academic institutions.	Additional references. These are references that are not linked to the text in the description of the ABP. The references are provided in a numbered list at the end of this document. While all actions incorporate refinements from Subject Matter Experts, the notation [SME] indicates an action specifically recommended by a Subject Matter Expert as part of the PCCIA project process.

The types of ABPs are further described below. Despite the ABP categorization into one of these four categories, many ABPs can be categorized into several of these groups, and ABPs that fall within these groups are broad and wide-ranging. There is no "one size fits all" solution to climate change adaptation.

- Policy and Regulation: A set of policies, regulations or plans used to support decision-making and/or operational regulations.
- Investment and Incentives: Investment into existing or new programs, and development of incentive programs and opportunities.
- Research, Development and Capacity Building: Primarily focused on expanding knowledge through research and development. These are science-based opportunities and may lead to program development, investments and incentives, or projects.
- Projects or Programs: Projects or longer-term programs that support Ontario stakeholders and rights holders in adoption of adaptation measures.

1.6 Implementation and Action Planning Recommendations

The contents of the ABP Report provide a range of actions to support the development of area-specific or sector-specific action plans. Action plans that are timely as well as informed by consultation with affected communities, developed in conjunction with up-to-date data, allow for the allocation of funds towards the adaptation interventions that will most directly address specific risks at a given point in time.

The process of identifying what specific actions should be undertaken is essentially the 'narrowing' of the space between the broader universe of potential options/opportunities, constrained by what is possible based on available resources and technology, and guided by the need to mitigate climate risk and impacts to the most vulnerable areas and communities (Chambwera et al., 2014).

There may be situations in which full adaptation is not possible, due to technology or resource constraints. In such situations, it is important to consider the 'residual impacts' of climate change and identify ways to address these through integrated approaches with the community and those affected (Chambwera et al., 2014).

Key Steps in Developing an Implementation Plan

The following are the key steps in developing an adaptation implementation or action plan:

1. **Assess and build institutional Adaptive Capacity**: Work with regional and local agencies, as well as Indigenous rights holders and stakeholders to understand where capacity shortfalls might exist (related to resources, technology, etc.), and develop ways to address these in advance or in tandem with developing an action plan.
2. **Engage with Indigenous rights-holders, community members and groups, and stakeholders**: Build relationships and recognize work that has already been done, engage those taking action and who have built up networks and foundations in climate action, and meaningfully integrate Indigenous traditional knowledge.
3. **Map and prioritize climate risks based on the local context**: Leverage data to visualize how climate hazards will impact various areas in a community, consider where key infrastructure, community assets, and vulnerable populations are located geographically relative to their exposure to climate risks such as flooding, areas with increased heat island effect, etc.
4. **Define targeted actions with a specific timeframe for implementation**: Utilize economic and social analysis tools to define the extent to which prioritized climate risks can be mitigated through adaptation, mapping these out with clear allocation of roles and responsibilities of government and all involved groups.
5. **Implement the identified actions**: Implement adaptation actions and interventions, putting in place processes to collect data on the effectiveness of the actions.
6. **Monitor and report on progress, continually assess emerging priorities**: Recognize that adaptation is a dynamic process that needs to respond on an ongoing basis to emerging priorities and changing conditions, and develop mechanisms to monitor and report on progress using the data collected in the implementation phase, and through clear indicators for success.
7. **Share knowledge and lessons learned**: Throughout the implementation process, seek and leverage ways to share knowledge, engage in storytelling, and allow for the integration of lessons learned to inform future steps.

2.0 Adaptation Best Practices: Overarching Principles

Effective action on climate change adaptation is complex, and requires coordinated efforts across governments, individuals, and businesses. The World Bank's Guide for Designing Strategies for Climate Change Adaptation and Resilience (Hallegatte et al., 2020) offers a high-level perspective of climate change adaptation and universal guiding principles that can direct adaptation practice. The guide's six guiding principles for climate change adaptation, corresponding to common policy domains, include:

- Ensure resilient foundations through rapid and inclusive development.
- Facilitate the adaptation of businesses and people.
- Adapt land use patterns and protect critical public assets and services.
- Increase people's capacity to cope with and recover from shocks.
- Anticipate and manage macroeconomic and fiscal risks.
- Ensure effective implementation through prioritization and continuous monitoring.

Similarly, the United Nations Convention on Climate Change (UNFCCC) developed guiding principles on the basis of national-level adaptation planning, which can be scaled to Provincial-level planning as well:

- Follow a gender-sensitive, participatory and fully transparent approach, taking into consideration vulnerable groups, communities and ecosystems.
- Be based on and guided by the best available science and traditional and Indigenous knowledge.
- Not be prescriptive, nor result in the duplication of efforts.

Additional guidance can be drawn from the mission of the Ready2Respond emergency preparedness document from the World Bank (2017), including:

- Protect public safety, a core responsibility of government, including through sound emergency preparedness and response planning.
- Build institutional capacity, through information sharing within and across governments, private sector, and others.

Climate change disproportionately impacts specific populations, such as people with disabilities, older adults and young children, those engaged in outdoor occupations, unhoused or inadequately housed populations, and low-income populations. Many significant social and health costs of climate change can be difficult to measure. While the adaptation practices identified in this report cover a broad range of sectors, it is important to integrate an equity lens into adaptation planning. The PCCIA recognizes that unequal effects of climate change and the potential impacts of any implementation action on vulnerable populations must be central to decision-making.

Lastly, it is important to consider the implications of maladaptation when developing adaptation plans. According to the IPCC, maladaptation an unintended consequence of adaptation, referring to actions that may lead to increased risk of adverse climate-related outcomes (such as increased GHG emissions); increased or shifted vulnerability to climate change; exacerbated inequity; and/or diminished welfare, now or in the future.

The concept of maladaptation has thus far received little attention in the literature, and generally accepted mechanisms to avoid maladaptation are undeveloped. However, a recent study published in Environmental Sociology (Bertana et al., 2022), identifies four key structural challenges that contribute to maladaptation that, if understood, can be used to avoid it. The challenges faced by adaptation practitioners that can cause maladaptation include:

- Focus on technological fixes versus holistic approaches;
- Difficulty of distinguishing the difference between adaptation and development;
- Difficult in quantifying unquantifiable metrics and thus using inaccurate indicators to measure success; and
- Competing challenges that lead to adaptation not being prioritized.

Consideration of maladaptation demonstrates that when adaptation is implemented to address only the impacts of climate change, rather than the underlying drivers of what makes people vulnerable to climate change in the first place (e.g., gender inequity, marginalization, and other power inequalities), it may not be effective (Schipper, 2022).

The following section (Section 3.0) presents a series of Overarching and Cross-Sectoral Adaptation Best Practices that can support broad climate resiliency across multiple areas of action in Ontario. The sections that follow (Sections 4.0 through Section 8.0) present adaptation actions for consideration organized based on the five Areas of Focus in the PCCIA.

3.0 Overarching and Cross-Sectoral Adaptation Practices

Climate change impacts occur against the backdrop of complex and dynamic social and ecological systems, and can cause cascading and compounding effects, depending on the exposure and Adaptive Capacity of systems. Adaptation actions that cover overarching and cross-sectoral themes have the capacity to address a wider range of potential risks, and can align the Province with a greater capacity to adapt to climate change.

3.1 Overarching Adaptation Best Practices

The following overarching adaptation best practices were selected to highlight key areas for action that cover a wide range of potential risks and are relevant to multiple Areas of Focus.

Table 3-1. Areas for Overarching Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Facilitate access to relevant climate and hydrological data • Review and implement flood risk strategies in high-risk areas • Adopt Nature Based Solutions • Develop a suite of decision-support tools for climate change adaptation
Research and Development	• Integrate monitoring and evaluation of adaptation planning • Leverage larger city-based resiliency networks in Canada and internationally
Investment and Incentives	• Develop programs and enhance policies that support Nature-Based Solutions and increase protection of green spaces and green infrastructure
Policy and Regulation	• Apply a climate lens to government decision-making • Embed climate risk in land use planning and policy • Apply an equity lens to all climate change adaptation planning • Apply an Indigenous lens to all climate change adaptation planning

3.2 Cross-sectoral Adaptation Best Practices

Within the context of the PCCIA, cross-sectoral impacts are defined as climate change impacts that span multiple Areas of Focus. The five Cross-Sectoral Themes identified within the PCCIA are:

- Water Security
- Energy Security
- Food Security
- Community Function, Human Health, Safety and Well-being

Adaptation best practices are presented in the sections below, for each of the cross-sectoral themes.

3.3 Water Security

Ensuring access to adequate quantities and acceptable quality of water is key for sustaining human well-being and socio-economic development, ensuring protection against water-borne pollution and water-related disasters. Preserving the functionality of natural ecosystems plays a vital role in maintaining water security. The impacts of climate change on water resources will manifest within each of the Areas of Focus as disruptions and changes in:

- Water transmission: The transport of water from water body sources to municipal storage facilities and/or to distribution networks to the point of use, which takes place through water transmission pipelines.
- Water treatment: Any process that involves physical, chemical, physicochemical, and/or biological operations to eliminate and/or reduce contamination or non-desirable characteristics of water to make it appropriate for a specific end-use.
- Water storage: Holding water in a contained natural or artificial area for a period of time for later use for a variety of purposes.
- Water distribution: Provision of uninterrupted supply of water from a central location to a location of end-use.
- Water use: Public and private use of water, including withdrawn water for a variety of household, commercial, and industrial purposes/activities without returning it to the source.
- Source Water quality: Protection of raw drinking water sources and management of any contamination sources, including through stormwater management infrastructure, waste management, and other activities, for instance road salt impacts which have knock-on effects for aquatic life and ecosystems and human health. The Clean Water Act, 2006 recognizes/defines the drinking water quality risks of road salt activities and requires policies to manage their significant risks in the local source protection plans.

The following table lists adaptation best practices applicable to water security in Ontario.

Table 3-2. Areas for Water Security and Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Collaborate and simplify water data capture and sharing among jurisdictions in Ontario (and beyond) • Further develop a provincial monitoring program for drought impacts across the Province • Develop and implement an integrated water management framework/strategy for the Province • Create a provincial governing body to represent water management in Ontario • Implement Policy Changes laid out in the Update of Ontario's Water Quantity Management Framework.
Research and Development	• Explore and apply recommended practices for managed aquifer recharge
Investment and Incentives	• Develop water storage investment programs
Policy and Regulation	• Develop a collaborative approach to water policy development across borders

3.4 Energy Security

Energy security includes many elements, but can be characterized as the degree to which Ontarians have consistent access to sufficient quantities of reliable, affordable energy. Factors influencing energy security include both inputs (e.g., energy sources and generation) and outputs (e.g., distribution and consumption) in line with economic development and environmental needs. At its simplest, energy security is associated with securing reliable energy supply, including consideration of energy infrastructure, intensity, diversification, market transparency, and links with the environment and political decisions. Energy systems underpin energy security, and are comprised of the following activities that span across all Areas of Focus:

- Energy supply: Various energy resources that comprise Ontario's energy mix, including nuclear, hydroelectricity, wind, solar, natural gas, biomass, etc.
- Energy generation: The process of generating power and electricity from sources of primary energy, including various generation facilities and their supporting energy infrastructure.
- Energy transmission and distribution: Any distribution technology and infrastructure, such as transmission and distribution lines, pipelines, freight, and other forms of energy transport.

- Energy use: Supporting infrastructure to bring energy products to market and the end use of energy in any technology, service, manufacturing, transportation, or any other form relying on energy such as inhabiting a building.

The following table lists adaptation best practices applicable to energy security in Ontario.

Table 3-3. Areas for Energy Security and Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Build capacity for energy resiliency planning • Practice procedures to recover from energy failures after extreme weather events • Review C40 recommendations, and identify interdependencies and collaboration opportunities
Research and Development	• Convene subject matter experts to focus on critical infrastructure interdependence
Investment and Incentives	• Develop programs to support capacity building and energy transition in remote areas • Invest in and encourage energy diversification
Policy and Regulation	• Apply an equity lens to policy decisions in the energy sector • Develop policies and/or regulations to embed climate change resiliency in long-term infrastructure and energy planning • Develop regulatory mechanisms for climate adaptation funding

3.5 Food Security

Food security is one of the most crucial challenges facing Ontario communities today, and is set to become more challenging in the years to come. Food security is achieved when "individuals have access to sufficient, safe, nutritious, and culturally appropriate food that meets their dietary needs" (Ministry of Children, Community and Social Services, 2017). It is a multi-dimensional concept that can be influenced by various sectors and is affected by impacts that cascade through food systems.

Food systems underpin food security, and are comprised of the following activities, which span across all Areas of Focus:

- Food production: Encompasses commercial and non-commercial agriculture, livestock, fisheries, and aquaculture production, as well as the hunting, fishing, and harvesting of traditional Indigenous foods.
- Food processing: The transformation of raw food inputs into retailed food products (e.g., washing, sanitizing and packaging).

- Food distribution: The transportation of food products to users (e.g., grocery stores, restaurants, etc.) through transportation networks including rail, road, plane, shipping, etc.
- Food preparation and consumption: Preparation and consumption of food by the consumer.

The following table lists adaptation best practices applicable to food security in Ontario.

Table 3-4. Areas for Food Security and Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Reduce food waste through modified storage and processing practices and policies • Promote local and urban food production and circular economy principles
Research and Development	• Consider impacts from COVID-19 in development of policies related to Ontario's food system
Investment and Incentives	• Support labour skills development and supply of domestic labour • Provide financial incentives for preservation of farmland and water quality
Policy and Regulation	• Prioritize farmland protection and sustainable growth

3.6 Community Function, Human Health, Safety and Well-Being

A community is comprised of different parts that represent specialized functions, activities, or interests, each operating within specific boundaries to meet community needs. For the community to function well, each part has to effectively carry out its role, and disruptions caused by climate change can significantly undermine this. Key elements of community function that can be impacted by the changing climate are:

- Social support and inclusion: The strengthening of supports available to individual community members through social ties to other individuals, groups, and the larger community, and the process of improving the terms on which individuals and groups take part in society.
- Access and infrastructure redundancy: Available backup alternatives when other components are disrupted (e.g., due to flooding, landslides, etc.).
- Economic stability: The absence of excessive fluctuations in economy meaning that people have the resources essential to a healthy life.
- Emergency response management: The management of resources and responsibilities and organization of measures and actions for dealing with the consequences of emergencies (e.g., flooding, power failure, etc.) to ensure safety and security of communities and minimize damage to infrastructure and disruptions to essential services.

- Ecological stewardship: Responsible use and protection of the natural environment through conservation and sustainable practices.
- Land use planning and development: The process of regulating the use of land to promote desirable social and environmental outcomes and efficient use of resources.

Climate risks to health, safety, and well-being are complex and mediated by a range of determinants of health and other situational, behavioural, and organizational factors, including health and safety-related infrastructure. The management of climate risks and projected impacts to health, safety, and well-being requires close partnerships with officials within and outside the health sector. Climate change can impact the health, safety, and well-being of Ontarians both directly, through different climate hazards (e.g., extreme heat), and indirectly through a range of environmental, built, and economic pathways. Key impacts for Ontarians include the following:

- Spread of disease vectors and pathogens.
- Water quality and food safety concerns.
- Mental health and well-being concerns.
- Declining air quality.
- Public safety and emergency response challenges.
- Extreme temperature exposure challenges.

The following table lists adaptation best practices applicable to community function and to human health, safety and well-being in Ontario.

Table 3-5. Areas for Community Function, Human Health, Safety and Well-being, and Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Support the development of community information networks • Undertake timely research in the wake of critical supply chain disruptions • Provide consistently available and up-to-date emergency planning guidance to communities • Improve communications on climate change to the general public • Encourage integration of climate change education in post-secondary education programs • Develop and employ citizen juries to support climate change engagement
Research and Development	• Continue using wastewater surveillance to track occurrences of infectious diseases

Adaptation Category	Examples of Adaptation Measures
Investment and Incentives	• Reduce barriers to accessing power outage emergency kits • Develop programs to support innovation in communities • Build 'safety nets' to protect vulnerable populations and retain community function
Policy and Regulation	• Develop guidelines to support community services and businesses adapt to virtual service delivery in the event of climate disruptions • Include a wide breadth of stakeholders and rights holders in public policy decision making • Protect and preserve green spaces in urban environments • Integrate emergency and community planning standards into community and infrastructure plans

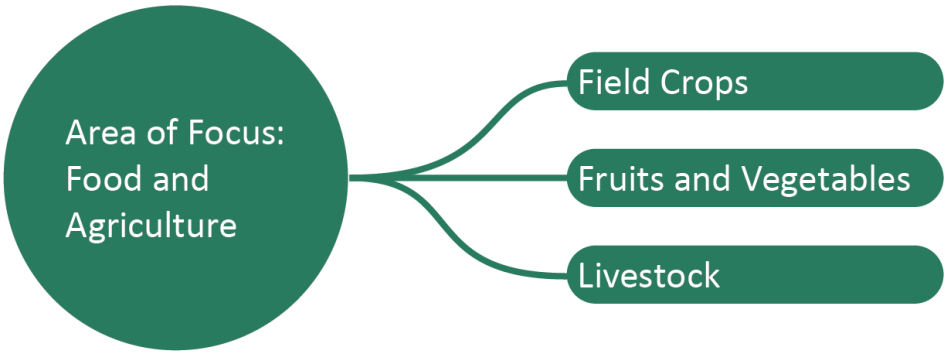
4.0 Food and Agriculture Adaptation Practices

Ontario's food and agriculture sector plays a crucial role in the province's economy, landscape, and society, with over 700,000 employed (approximately 10.3% of provincial employment) and approximately $45 billion in annual revenue (6.4% of total provincial GDP). The sector is multi-faceted and inextricably linked to systems within and outside of the sector, including infrastructure, economic and natural systems.

Changing climate conditions could present opportunities for agriculture in Ontario (e.g., longer growing and grazing seasons), but such benefits could be offset by negative impacts, resulting in declining productivity, crop failure, and livestock fatalities. Several commodities (e.g., cereals, corn, soybeans, apples, berries and grapes) are expected to face very high climate risks by the end of the century.

The Food and Agriculture Area of Focus has been broken down into the following Level 1 categories:

Figure 4-1. Food and Agriculture Area of Focus Level 1 Categories



All Level 1 and Level 2 industries as part of Food and Agriculture have been assessed to have a medium Adaptive Capacity, indicating some potential to undertake appropriate adaptation actions as highlighted in **Table 4-1** and **Table 4-2**.

Table 4-1. Current Food and Agriculture Adaptation Priorities by Level 2 Category

Current Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Corn	Central, Northeast	**High**	**Medium**
Soybeans	Central, Northeast	**High**	**Medium**
Apples	Central	**High**	**Medium**
Berries	Central, Northeast, Northwest	**High**	**Medium**
Field Vegetables	Central	**High**	**Medium**
Tender Fruit	Central	**High**	**Medium**

Table 4-2. Emerging Food and Agriculture Adaptation Priorities by Mid-Century (2050s) by Level 2 Category (RCP8.5)

Emerging Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Cereals	Central, Northeast, Northwest	**High**	**Medium**
Canola	Central, Northeast	**High**	**Medium**
Forages	Central, Northeast, Northwest	**High**	**Medium**
Greenhouse Vegetables	Central	**High**	**Medium**
Beef	Central	**High**	**Medium**
Dairy	Central	**High**	**Medium**
Poultry and eggs	Central	**High**	**Medium**
Swine	Central	**High**	**Medium**

The ABP Report provides a range of potential best practices for Food and Agriculture, as summarized in **Table 4-3.**

Table 4-3. Areas for Food and Agriculture Climate Adaptation

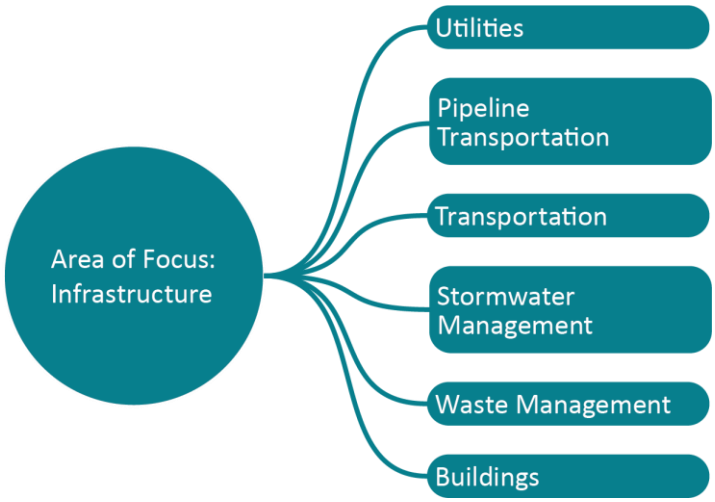
Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Strengthen monitoring and surveillance programs for pest and disease management. • Expand decision support tools for on-farm water, soil and nutrient management. • Enable demand-driven knowledge transformation and transfer through collaboration between researchers and farmers.
Research and Development	• Support and advance research on agricultural expansion opportunities under a changing climate. • Research and development on new and climate-resilient varieties/breeds and livestock nutrition regimes. • Support technological research and advancements on precision agriculture, advance drainage and irrigation systems.
Investment and Incentives	• Support and advance research on agricultural expansion opportunities under a changing climate. • Research and development on new and climate-resilient varieties/breeds and livestock nutrition regimes. • Support technological research and advancements on precision agriculture, advance drainage and irrigation systems.
Policy and Regulation	• Apply a climate lens to government decision-making, and ensure integration of Indigenous perspectives. • Invest and strengthen coordination and integration of water management

5.0 Infrastructure Adaptation Best Practices

The Infrastructure Area of Focus broadly encompasses assets that have been built, and that will be designed and constructed in the future in the province. Infrastructure is the backbone of the economy, of service delivery, and of community function. Generally, the amount of built infrastructure tends to be located where Ontarians live, with greater concentration in the most populous regions of Southwest, Central, and Eastern Ontario. Farther north, infrastructure is less concentrated but remains critically important for rural, remote and Indigenous communities in these regions.

The Infrastructure Area of Focus has been broken down into the following Level 1 categories:

Figure 5-1. Infrastructure Area of Focus Level 1 Categories



Climate impacts on infrastructure were assessed for every region of Ontario. For each Level 1/Level 2 category, various interactions of how climate hazards could lead to impacts were documented and used to quantify how likely it would be to occur and how severe the consequences would be if it did. Consequences such as the level of disruption to services and extent of financial loss were used to inform risk profiles. This portion of the assessment only analyzed the direct impacts on Infrastructure. Indirect and cascading impacts of infrastructure disruption and damages are covered under other Areas of Focus (e.g., Business and Economy, People and Communities etc.) and under the Cross-Sectoral Theme section.

All Level 1 and Level 2 industries as part of Infrastructure have been assessed to have a medium Adaptive Capacity level compared against significant risks to a range of sectors, indicating some potential to undertake appropriate adaptation actions across regions and types of infrastructure as highlighted in **Table 5-1** and **Table 5-2**.

Table 5-1. Current Infrastructure Adaptation Priorities by Level 2 Category

Current Priorities	Region	Risk Score	Adaptive Capacity
Electrical Power Generation	Central, Northeast, Northwest, Far North	**High**	**Medium**
Flood Mitigation Infrastructure	Central, Northeast, Northwest, Far North	**High**	**Medium**
Urban and Rural Stormwater Management Systems	Central, Northeast, Northwest, Far North	**High**	**Medium**

Table 5-2. Emerging Infrastructure Adaptation Priorities by Mid-Century (2050s by Level 2 Category (RCP8.5)

Emerging Priorities	Region	Risk Score	Adaptive Capacity
Air Transportation	Central, Northeast, Northwest	**High**	**Medium**
Electrical Transmission, Control and Distribution	Central, Northeast, Northwest, Far North	**High**	**Medium**
Housing	Far North	**High**	**Medium**
Other Buildings	Far North	**High**	**Medium**
Public Buildings	Far North	**High**	**Medium**
Rail	Central, Northeast, Northwest, Far North	**High**	**Medium**

The Adaptation Best Practices presented in this section provide a range of opportunities for action, as summarized in **Table 5-3.**

Table 5-3. Areas for Infrastructure Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Incorporate climate change into asset management, and specifically develop technical guidance on how to do so and at what level of detail. • Develop programs to support communities of practice focused on each of the major infrastructure asset categories. • Fast-track the deployment of green infrastructure by incorporating green infrastructure into designs and renewed development.
Research and Development	• Support and encourage the release of quantitative datasets that can be used to assess risk and inform infrastructure design. • Require that new research and modeling should factor in climate change scenarios where they inform infrastructure planning and design, such as floodplain mapping. • Conduct further research on international impacts, integrating potential climate impacts into a broader study of future global markets for key waste products • Develop climate resiliency design guidelines with technical specificity.
Investment and Incentives	• Increase and mobilize funding for partnership research among industry, institutions, governments and Indigenous communities. • Increase funding to support infrastructure upgrades that explicitly factor in future climate conditions and enhance climate change adaptation.
Policy and Regulation	• Increase the frequency of maintenance and monitoring and develop extreme weather response plans. • Develop policies to adopt climate risk frameworks to build sustainability and resilience principles into infrastructure projects. • Undertake vulnerability assessments and implement standards for risk management and hazard mitigation

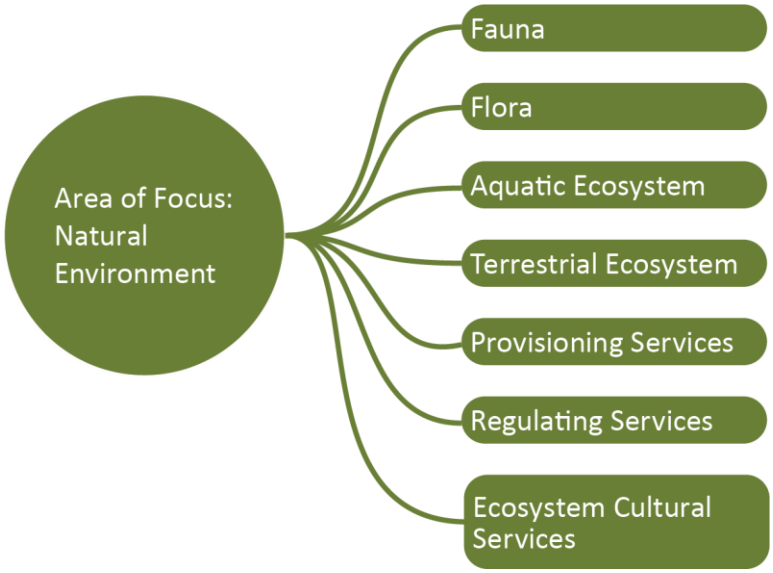
6.0 Natural Environment Adaptation Practices

Ontario's natural environment consists of three distinct ecozones, based on ecology, climate and geology: Hudson Bay Lowlands, Ontario Shield, and Mixedwood Plains. Each region has unique ecosystems and pressures posed to the natural environment. For example, Southwest Ontario is the in the Mixedwood Plains ecozone, has high human population density while containing one-third of the rare, threatened, and endangered species found in all of Canada.

Each of the regions across Ontario faces unique threats and challenges from the effects of climate change. Species and habitats are irreplaceable, and the services that ecosystems provide to Ontario communities are challenging and costly to replicate via engineered or technical solutions, if possible at all. A healthy and resilient natural environment, therefore, is essential to adapt to a changing climate.

The Natural Environment is broken down into the following seven Level 1 categories, defined to cover the intrinsic value of nature and biodiversity, natural resources, and values important to humans.

Figure 6-1. Natural Environment Area of Focus Level 1 Categories



All Level 1 and Level 2 industries as part of Natural Environment have been assessed to have a medium Adaptive Capacity level, indicating some potential to undertake appropriate adaptation actions across industries as highlighted in **Table 6-1** and **Table 6-2**.

Table 6-1. Current Natural Environment Adaptation Priorities By Level 2 Category

Current Level 2 Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Fish	Central, Far North	**High**	**Medium**
Waterfowl	Central	**High**	**Medium**
Bogs	Northeast, Northwest, Far North	**High**	**Medium**
Mudflats	Far North	**High**	**Medium**
Carbon Storage	Northeast, Far North	**High**	**Medium**

Table 6-2. Emerging Natural Environment Adaptation Priorities by Mid-Century (2050s) by Level 2 Category (RCP8.5)

Emerging Level 2 Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Birds	Central, Northeast, Northwest	**High**	**Medium**
Insect/Spider	Central, Northeast	**High**	**Medium**
Mammals	Central, Northeast, Northwest, Far North	**High**	**Medium**
Migratory songbirds	Central, Northeast, Northwest, Far North	**High**	**Medium**
Reptile	Northeast	**High**	**Medium**
Lichen	Northwest	**High**	**Medium**
Vascular plant	Central, Northeast, Northwest	**High**	**Medium**
Marsh	Central, Northeast, Far North	**High**	**Medium**
Coniferous Forest	Northeast, Northwest, Far North	**High**	**Medium**
Deciduous Forest	Central, Northeast, Northwest	**High**	**Medium**
Sand Barren and Dune	Central	**High**	**Medium**
Tallgrass Savannah	Central	**High**	**Medium**

Emerging Level 2 Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Freshwater Provision	Central, Northeast, Northwest, Far North	**High**	**Medium**
Wood Supplies	Central	**High**	**Medium**
Carbon Storage	Central, Northwest	**High**	**Medium**
Pollination	Central	**Very High**	**Medium**
Water Flow Regulation	Central	**High**	**Medium**
Coniferous Forest	Northeast, Northwest, Far North	**High**	**Medium**
Deciduous Forest	Central, Northeast, Northwest	**High**	**Medium**
Sand Barren and Dune	Central	**High**	**Medium**
Tallgrass Savannah	Central	**High**	**Medium**
Nature-Based Recreation	Central, Northeast, Northwest	**High**	**Medium**
Recreational Fishing (Angling)	Central, Northeast, Northwest, Far North	**High**	**Medium**

The ABP Report provides a range of potential best practices for Natural Environment, as summarized in **Table 6-3**.

Table 6-3. Areas for Natural Environment Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Fill governance gaps across Ontario's regions and develop formal partnerships, with funding, to manage natural ecosystems. • Ensure Indigenous Knowledge informs new and enhanced regulations and management practices. • Develop a provincial framework to study variation in species demographics rates to track trends and conservation goals. • Develop a policy to manage and monitor changing species ranges. • Restore and manage ecosystems to recover biodiversity and ecosystem services, and enhance resilience. • Develop collaborations among communities and support Indigenous-led conservation.
Research and Development	• Develop education resources for forest and urban forest managers.
Investment and Incentives	• Invest in research and Indigenous-led community-based monitoring and research programs. • Prioritize ecosystem restoration, and the protection and preservation of intact or high functioning ecosystems. • De-risk green infrastructure implementation and invest in education.
Policy and Regulation	• Protect and strengthen the Conservation Authorities Act (CAA) and Environmental Assessment Act (EAA). • Protect riparian zones along water bodies, wetlands and stream corridors. • Develop a policy for climate refugia protection and management. • Maintain, promote and enhance ecosystem connectivity. • Protect and conserve peatlands and other carbon-dense ecosystems as intact ecosystems. • Develop provincial policy for landscape management to support assisted migration and re-establishment.

7.0 People and Communities Adaptation Practices

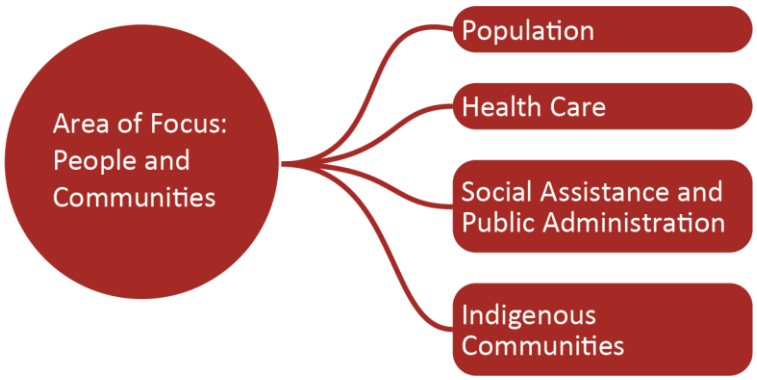
Climate change and related impacts will increase risks to Ontario's people and communities. Ontario's rapidly changing climate threatens the health and well-being, livelihoods, service access, and cultural practices of Ontarians and their communities in a myriad of ways, both direct and indirect. While the physical impacts to property and infrastructure often receive the greatest focus and have consequential impacts for people, the impacts on human health and the systems that people across the province rely on for their well-being have also been significant.

Vulnerability is not distributed evenly across Ontario, with climate change disproportionately impacting individuals and communities facing systemic inequities, such as marginalized and racialized groups. It is therefore critical to apply an equity lens when analysing climate impacts on Ontario's people and communities. Socially vulnerable people, and women and people with disabilities in particular, are disproportionately affected by global climate change because of their geographic location and gendered socioeconomic roles, yet they are least equipped to deal with its impacts due to their disadvantaged economic and political position. Unhoused populations experience impacts from climate events more so than most of the general population, both due to a lack of adequate shelter and a higher likelihood of compromised physical and/or mental health. Resulting impacts from climate hazards for unhoused populations include illness, injury, and death with the greatest impacts felt by those most marginalized.

A key way to build Adaptive Capacity among marginalized groups is to understand the interconnections between climate change risk and other social and economic issues, including access to housing, disability rights, poverty, immigration status, language or cultural barriers, and environmental justice more broadly, and work in tandem across levels of government and society to build Adaptive Capacity through access to resources.

The People and Communities Area of Focus is broken down into the following Level 1 categories, developed based on an understanding of the need to parse climate change impacts and not overlap with the considerations and analysis of the other Areas of Focus.

Figure 7-1. People and Communities Area of Focus Level 1 Categories



All Level 1 and Level 2 industries as part of Infrastructure have been assessed to have a low or medium Adaptive Capacity level, indicating several areas challenged by shortfalls in technology, resource availability, or governance, along with significant sector complexity as highlighted in **Table 7-1** and **Table 7-2**.

Table 7-1 Current People and Communities Adaptation Priorities

Current Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Health Care	Central	High	Medium
Unhoused Population	Central, Far North, Northeast, Northwest	High	Lower
	Eastern, Southwest,	High	Medium
Indigenous Population	Northeast	High	Lower
	Eastern, Southwest	High	Medium
Indigenous Cultural Services	Central, Far North, Northeast, Northwest	High	Lower
	Eastern, Southwest	High	Medium
Indigenous Health Care	Central, Northeast, Northwest	High	Lower
	Eastern, Southwest	High	Medium

Table 7-2. Emerging People and Communities Adaptation Priorities by Mid-Century (2050s) (RCP8.5)

Emerging Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
General Population	Central, Northeast, Northwest	High	Lower
	Eastern, Southwest	High	Medium
Health Care	Northeast, Northwest, Far North	High	Medium
Social Assistance and Public Administration	Central, Northeast, Northwest, Far North	High	Lower
	Eastern, Southwest	High	Medium
Indigenous Population	Central, Northwest, Far North	High	Lower
Indigenous Social Assistance	Eastern, Southwest	Very High	Medium
	Central	Very High	Lower
	Northeast, Northwest, Far North	High	Lower

The ABP Report provides a range of potential avenues for building climate resiliency among People and Communities in Ontario, as summarized in **Table 7-3**.

Table 7-3. Areas for People and Communities Climate Adaptation

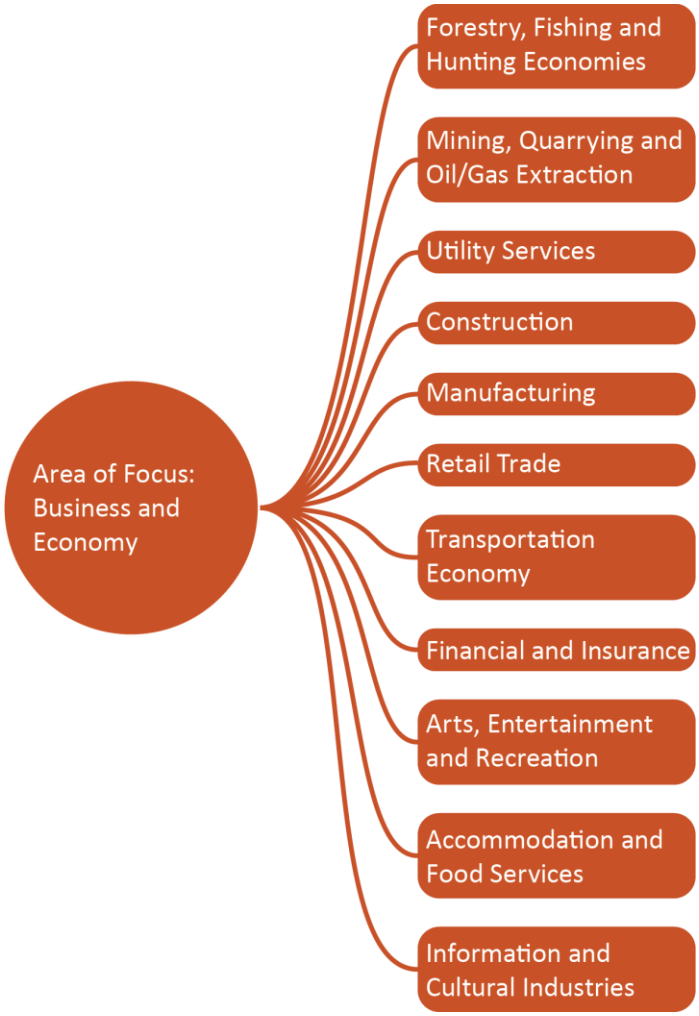
Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Provide funding and programming support for development of heat event response planning for municipalities. • Promote Indigenous-led adaptation projects and programs. • Provide consistently available and up-to-date emergency planning guidance to communities. • Encourage the use of innovative technology to increase capacity to respond to climate-related health crises (e.g. emergency response planning scenarios).
Research and Development	• Advance research to fill remaining knowledge gaps on climate changes impacts to people and communities in Ontario.
Investment and Incentives	• Invest in early warning systems for climate hazard events. • Invest in the establishment and enhancement of extreme heat impact reduction strategies. • Adapt food resource management in the face of climate change and provide funding for resurfacing of Traditional Ecological Knowledge.
Policy and Regulation	• Develop policies and tools to support respectful and meaningful incorporation of Indigenous knowledge systems into adaptation planning and decision-making. • Reframe adaptation policies to be culturally appropriate for Indigenous communities. • Include a wide breadth of rights holders and stakeholders in public policy development and decision-making.

8.0 Business & Economy Adaptation Practices

Ontario's businesses and their economic contribution is significant, contributing almost 39% of Canada's overall gross domestic product (GDP) in 2021 (Government of Ontario, 2022). Climate change impacts are fueling more extreme weather, impacting local economies, driving up costs and challenging economic growth. Climate impacts, and the associated economic shocks and the ability to recover from these impacts, will not be uniform across Ontario. Now is the time for to build strong local, resilient economies that support in reducing greenhouse gas emissions as well as fostering innovative business practices. A resilient Ontario economy has a competitive advantage and can enable businesses at all scales and across industries to thrive in the face of an uncertain and extreme future.

The Business and Economy Area of Focus is broken down into the following Level 1 categories:

Figure 8-1. Business and Economy Area of Focus Level 1 categories



As Ontario's Financial Accountability Office reports, following the sharp job loss caused by the COVID-19 pandemic shutdowns, Ontario employment rebounded strongly in 2021, with jobs increasing by 4.9 per cent rise compared to 2020 (FAO, 2022). The province's annual unemployment rate declined to 8.0% in 2021, down from 9.6% in 2020. It currently sits at 5.1% as of November 2022 (Ontario Ministry of Labour, Immigration, Training and Skills Development, 2022). Despite this progress, the unemployment rate in 2021 was well above the pre-pandemic rate, as a larger number of job seekers entered the labour market looking for work. While some sectors saw job growth, others have seen an increase in demand for workers with a shortage of workers. These trends can be attributed to a range of factors, including an aging workforce and a reduction in the female working population (Greenspon, 2022).

Adaptation planning across the spectrum of business and economic sectors in Ontario therefore requires an understanding of how climate change is interconnected with other ongoing stresses, and the ways in which climate resiliency is intertwined with broader social and economic trends and pressures.

The benefits of taking action to address climate risk via planned adaptation generally outweigh the costs, over the medium to long term. The areas for building climate resilience comprise both actions that can be undertaken at the industry and firm-level, as well as actions that can be implemented by government to establish enabling conditions/incentives for adaptation.

The PCCIA Adaptation Best Practices Report categorizes adaptation options for industries within the Business and Economy Area of Focus. Ontario has the solutions and knowledge to act and lessen or avoid many climate risks that industries face, with industry-specific adaptation options available.

All Level 1 and Level 2 industries as part of Business and Economy have been assessed to have a medium or high Adaptive Capacity (see Section 1.3 for an explanation of the assessment). In other words, no industry is considered to have a low Adaptive Capacity based upon technology, resource availability, governance, and sector complexity. Thus, climate adaptation priorities for current and future timeframes can be considered a reflection of those with the highest risk profiles (see **Table 8-1** and **Table 8-2**).

Table 8-1. Current Business and Economy Priorities

Current Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Arts, Entertainment and Recreation	Central	**High**	**Medium**
Fishing, Hunting and Trapping	Central, Northeast, Northwest, Far North	**High**	**Medium**
Forestry and Logging	Central, Northeast, Northwest, Far North	**High**	**Medium**
Deep Sea, Coastal and Great Lakes	Central, Northeast, Northwest, Far North	**High**	**Medium**

Table 8-2. Emerging Business and Economy Priorities by Mid-Century (2050s) (RCP8.5)

Emerging Adaptation Priorities	Region	Risk Score	Combined Adaptive Capacity Rating
Arts, Entertainment and Recreation	Northeast, Northwest, Far North	**High**	**Medium**
Rail	Central, Northeast, Northwest	**High**	**Medium**

A high-level summary of potential actions is provided in **Table 8-3**

Table 8-3. Areas for Business and Economy Climate Adaptation

Adaptation Category	Examples of Adaptation Measures
Projects or Programs	• Develop a suite of decision-support tools for climate change adaptation. • Integrate climate change into financial valuation, natural environment impacts, and business continuity planning. • Facilitate development of knowledge sharing networks, and encourage participation in the United Nations Office for Disaster Risk Reduction (UNDRR) ARISE program. • Support the use of public-private partnerships to reduce climate risk impacts to businesses.
Research and Development	• Review and mobilize case studies across businesses, such as Environment and Climate Change Canada's map of adaptation actions. • Undertake industry-specific climate change risk assessments that factor in interdependencies and supply chain impacts. • Support innovative research at the industry-specific level that achieves low carbon resilience in operations and business activities.
Investment and Incentives	• Develop financial instruments to promote investment in climate resilience. • Develop a grant or loan program to support industry-specific activities that support regional economic employment (e.g., resource-based recreation and tourism industries).
Policy and Regulation	• Develop financial instruments to promote investment in climate resilience. • Develop a grant or loan program to support industry-specific activities that support regional economic employment (e.g., resource-based recreation and tourism industries).

9.0 Closure

The PCCIA focused on identifying climate impacts and Adaptive Capacity across five Areas of Focus, namely Food and Agriculture, Infrastructure, Natural Environment, People and Communities, and Business and Economy. In addition, five cross sectoral areas were identified, namely Water Security, Energy Security, Food Security, Community Function, and Human Health, Safety and Well-being. The last two areas are linked together in this report due to the common themes between them.

The report presents a series of adaptation practices that are overarching across the province, for each Cross Sectoral theme, and for each Area of Focus studied within the PCCIA, and identifies practices that may reduce risks and build Adaptive Capacity.

The identified practices are measures that have been implemented (either in Ontario or in other jurisdictions), researched and peer-reviewed, and/or recommended by subject matter experts (both through consultation with external participants, and in collaboration with internal consulting team specialists). This report is intended to provide a starting point for discussion, and support the development of targeted climate change adaptation action and implementation plans across Ontario.

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