



Natural Resources
Canada

Ressources naturelles
Canada

CASE STUDY: BUILDING CLIMATE RESILIENCE IN CANADA'S MINING SECTOR



**The Mining Association of Canada's
Guide on Climate Change Adaptation
for the Mining Sector**



The Mining Association of Canada

Canada

Highlights

- The **Mining Association of Canada** (MAC), with support from Natural Resources Canada (NRCan), developed a guide to help Canada's mining sector prepare for and adapt to the impacts of climate change.
- The *Guide on Climate Change Adaptation for the Mining Sector* was published in 2021. It has been used by more than 60 mining companies across Canada that are implementing MAC's Towards Sustainable Mining (TSM) Climate Change Protocol.
- Canada's mining sector continues to take meaningful action by understanding climate risks, building adaptive capacity, supporting scientific research, and implementing strategies to prepare for climate impacts.

>> About this case study

Canada's mining sector is facing both risks and opportunities because of climate change. To help the industry prepare for and adapt to changing conditions, [MAC](#), with support from [NRCan](#), developed the [Guide on Climate Change Adaptation for the Mining Sector](#) (adaptation guide). The adaptation guide helps mining companies better understand climate impacts and take steps to manage them.

Through this work, Canada's mining industry is laying the foundation for a more sustainable, competitive, and climate-ready future that supports economic growth while safeguarding communities, ecosystems, and critical infrastructure.

This case study:

- Summarizes the climate impacts on the mining sector
- Outlines the key features of MAC's adaptation guide
- Highlights lessons learned while developing the adaptation guide
- Provides an overview of MAC's ongoing and future work

Did you know?



In 2024, the mining sector was responsible for **\$156 billion** or 5% of Canada's GDP.



Valued at **\$153 billion** in 2024, domestic mineral exports accounted for 21% of Canada's total domestic exports.



In 2024, the mining sector directly and indirectly employed **724,000 people**, including over **17,300 Indigenous employees**.¹

¹ [10 key facts on Canada's minerals sector](#), Natural Resources Canada (2025; PDF, 3.96 MB)

>> Climate change and Canada's mining sector

Canada is a trusted supplier of natural resources and a global leader in the supply of critical minerals. The changing climate presents **opportunities** for Canada's mining sector, including longer shipping periods through Arctic waters because of reduced ice packs.

The sector also faces many **risks** across its value chain because of climate variability and extreme weather events. For example, **increasing air temperature** can significantly increase risks for surface operations, including the health and safety of miners working in open pits and other roles that require working outdoors.

Droughts can affect water availability and mine operations and increase the risk of wildfires, thereby endangering workers, damaging infrastructure, and interrupting the power supply. **Extreme rain events** can cause localized or downstream flooding and road washouts, damaging infrastructure and disrupting operations and supply chains. **Degrading permafrost** can cause land instability, thereby affecting tailings facilities, water management infrastructure, access roads, haul roads, building and plant foundations, and subsurface structures. **Sea-level rise, coastal erosion** and **saltwater intrusion** may damage transportation and other infrastructure in the near-shore environment, affecting port facilities, operations and supply chains ².

What is adaptation?

Climate change adaptation refers to actions that either reduce the negative impacts of climate change or take advantage of potential new opportunities, thereby increasing resilience to a changing climate. Adaptation incorporates **future climate projections** to better prepare for what is ahead instead of relying only on historical data to guide operations and planning.



Glencore's Sudbury Integrated Nickel Operations was an early adapter, starting their work on a climate change plan in 2009. [Click here to learn more.](#)

The mining sector in Canada is investing in **climate change adaptation** to build sector resilience and reduce future costs associated with climate change. These actions support goals to maintain operational continuity, safeguard environmental values and communities, and secure long-term economic certainty. Across economic sectors, every dollar spent on adaptation can save \$13 to \$15 in the long run, providing a clear business case for companies to take proactive measures in the face of increasing climate-related risks ³.

² [Guide on Climate Change Adaptation for the Mining Sector](#), Mining Association of Canada (2021). For more information on climate risks to Canada's mining sector, see NRCan's [National Issues Report](#).

³ [Damage Control: Reducing Climate Impacts](#), Canadian Climate Institute (2022)

MAC's *Towards Sustainable Mining*® (TSM) is a globally recognized program that provides a rigorous sustainability standard that is verified by a third party. The standard supports mining companies in managing key environmental and social risks. The TSM program is mandatory for all MAC members and their Canadian operations and has been adopted by countries around the world, **demonstrating Canada's leadership and commitment to sustainable mining practices**. The TSM program has nine protocols. The Climate Change Protocol includes requirements to understand and manage risks posed by climate change through adaptation and to reduce emissions.

» About the project

From 2018 to 2021, MAC partnered with Golder Associates (now WSP) and Lorax Environmental Services to develop guidance that mining companies could use to assess and mitigate the risks from climate impacts.

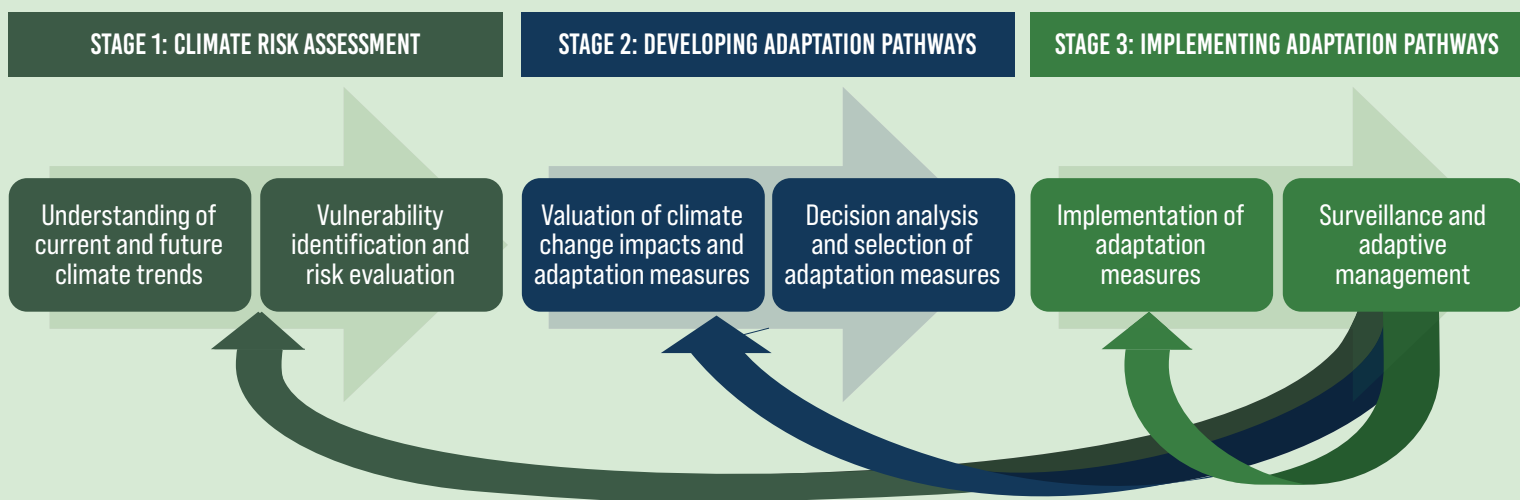
NRCan's [Climate Change Adaptation Program](#) provided funding and access to adaptation experts from across Canada. MAC established a Climate Change Adaptation Steering Group that provided overall direction on behalf of MAC members and participated in workshops and meetings throughout the process. A final draft of the guidance document was distributed for comment to more than 300 MAC representatives and associate members.

The success of this collaborative, multi-stakeholder approach emphasizes the importance of shared responsibility and public-private cooperation in addressing climate adaptation challenges.

» About the guide

The [Guide on Climate Change Adaptation for the Mining Sector](#) provides a three-stage process that companies can use to implement the Towards Sustainable Mining® (TSM) program's Climate Change Protocol and incorporate climate change adaptation into decision-making. This process can be applied to the planning and design of new mine sites or to existing sites in the operations, closure, and post-closure phases.

This general process could also be used by other industries, businesses, or jurisdictions to reduce the long-term costs associated with climate and other environmental risks. It uses an adaptation pathways approach that is widely recognized as best practice. The various pathways offer flexibility to respond to both short- and long-term uncertainties and can be adjusted to various future conditions.



The MAC Guide on Climate Change Adaptation includes a three-stage iterative process (image adapted from the adaptation guide)

The process has three stages:

Stage 1. Conduct a Climate Change Risk Assessment.

This stage involves:

- collecting and analyzing both historical and projected climate data for a specific site
- identifying infrastructure and operations that may be vulnerable to climate change
- evaluating the associated risks
- identifying any potential opportunities based on expectations of future climate change and resulting landscape conditions

Stage 2. Develop Adaptation Pathways.

This stage involves:

- defining objectives
- identifying possible adaptation measures
- evaluating options through pre-screening and decision analysis
- developing flexible “adaptation pathways” that outline when and how to implement measures, whether immediately, in response to specific climate thresholds, or not at all

Stage 3. Implement Adaptation Pathways.

This stage involves:

- designing the pathways
- implementing the selected pathways and their corresponding adaptation measures
- regularly revisiting the pathways to reassess risks and adjust plans as needed

The adaptation guide includes practical advice and tools to help mining companies complete the three-stage process and integrate climate change considerations into their decision-making. This support includes:

- **checklists** for each of the three stages in the process
- a **detailed methodology** for developing baseline and projected climate datasets
- a **series of case studies** to showcase adaptation happening across the sector
- structured **templates and frameworks** for identifying vulnerabilities, assessing risks, and recognizing opportunities
- **guidance** on how to develop and evaluate flexible adaptation pathways by using decision-support tools such as **cost-benefit** and **multi-criteria analysis**
- **protocols** for ongoing monitoring, identifying climate thresholds, and applying adaptive management approaches

Another protocol of the TSM program is the [Indigenous and Community Relationships Protocol](#), which supports mining companies in fostering respectful and productive Indigenous and community relationships. Climate change is a common area of interest for communities, and the TSM program's Climate Change Protocol encourages this dialogue to support sustainability outcomes. Similarly, the adaptation guide recognizes the importance of engaging with Indigenous communities and incorporating Indigenous knowledge and perspectives into adaptation planning.

» Project results and impact

Widespread Uptake

The publication of the MAC adaptation guide in 2021 was an important step toward resilience for Canada's mining sector. It helped mining companies adapt to the landscape changes and extreme events caused by a changing climate. Public performance reporting against the TSM program's Climate Change Protocol started in 2023, replacing the previous Energy and GHG Management Protocol that had been in place since the launch of the TSM program in 2004 ⁴.

Although TSM is a voluntary program, **participation is mandatory for MAC members in their Canadian operations.**

Consequently, the Climate Change Protocol is being implemented at more than 60 facilities across Canada. It has also had international uptake, with national associations from 13 countries adopting the TSM program's Climate Change Protocol and along with it, the adaptation guide.

Improved Climate Resilience

In the first year of public reporting for the TSM program's Climate Change Protocol, MAC members reported excellent performance for the Corporate Climate Change Management indicator. Nearly **90% of facilities reported a Level A or higher**. Of those facilities, 70% achieved the highest standard of Level AAA, and this number rose in 2024⁵. The adaptation guide played an important part in helping companies to achieve this high level of climate change preparedness.

⁴ TSM program results are verified externally and are publicly available: [Performance Reports & Awards](#).

⁵ [Annual Report 2023, 2024 Annual Report](#), The Mining Association of Canada

>> Lessons learned

Several lessons were learned by reflecting on the project, the adaptation guide, and its impact since publication.

- **Collaboration.** Engage early and often with key stakeholders such as governments, research institutions, mining companies, and Indigenous rights holders to ensure the final product has real-world applicability. MAC held two workshops with its members to gather contributions and feedback which proved invaluable to the development of the adaptation guide.
- **Training.** Offer training to encourage use of the adaptation guide. MAC provided training to its members and associate members to support the use of the TSM Climate Change Protocol and adaptation guide
- **Data.** Projections of future climate conditions are dependent on good meteorological data to understand historical and current climate conditions. In remote areas or in areas with microclimates (e.g., mountainous areas), collection of meteorological data on site should start as soon as possible to collect representative data.
- **Uncertainty.** Uncertainty is inherent in projecting future climate conditions and planning adaptation measures. It is important to recognize this, but lack of certainty should not be a reason to defer or disregard the need to adapt to changing climate conditions. The adaptation pathways approach described in the MAC adaptation guide is specifically intended to help plan when there is uncertainty.

Adaptation actions

The MAC adaption guide includes examples of adaptation actions implemented by mining companies across Canada, including:

- **Glencore's Sudbury, Ontario, nickel operations** used climate risk assessments and cost-benefit analysis to better prepare infrastructure for heavy rains and flooding.
 - **Agnico Eagle Mines in Nunavut** used detailed climate data and modelling to design waste rock covers that keep permafrost frozen and prevent acid drainage as temperatures rise.
 - **Suncor's Millennium oil sands mine in Alberta** tested a new tailings management system and built flexibility into closure plans so they can adapt to future climate conditions.
-
- **Applicability.** One of the characteristics of the MAC adaptation guide is that the process described is applicable regardless of the local climate. Companies applying the process will need to use appropriate data sets and models to project future climate conditions. However, the process itself is applicable to all climates in Canada and can also be applied internationally.

>> Ongoing and future work

Building Capacity

The MAC adaptation guide provides a framework for addressing climate risks. Creating the guide has been an important step for the sector in developing capacity and expertise in resilience. MAC members will continue to implement the protocol, including requirements related to climate change adaptation, as part of their member commitments.

Linking Protocols

MAC is also working to strengthen links between climate change adaptation and topics covered by other protocols under the TSM program. Notably, the TSM requirements and guidance for tailings management were updated in 2021 and 2022. They incorporated stronger references to climate change as part of risk assessment and management. More updates to the TSM requirements and guidance for tailings management are expected to be completed in late 2026.

Establishing Partnerships

In addition to managing the ongoing implementation of the TSM program, MAC is partnering with the International Council on Mining and Metals, the World Gold Council and the Copper Mark to develop the Consolidated Mining Standard Initiative. Much of the architecture of this new standard is based on the TSM program, including multiple levels of performance and a similar level of detail in the standard. The Climate Change component of the standard is also strongly aligned with the TSM program's Climate Change Protocol and includes a similar focus on climate adaptation, which will bring awareness of the adaptation guide to a larger audience globally.

>> Conclusion

Thanks to MAC, NRCan, and project partners, the mining sector is building resilience to the impacts of climate change. By using the structured approach in the MAC adaptation guide, mining companies are undertaking climate risk assessments and incorporating adaptation strategies into their planning and day-to-day operations.

This proactive approach reduces long-term risks, avoids costly disruptions, and builds resilience across the sector – which benefits both businesses and communities. In doing so, this initiative both strengthens the mining sector and supports Canada's wider national efforts to prepare for a changing climate and build a more resilient, climate-ready economy.

For information on the Adaptation Guide,
contact communications@mining.ca.

**For information on NRCan's Climate
Change Adaptation Program,**
contact ccap-pacc@nrcan-rncan.gc.ca.

Aussi disponible en français sous le titre :
*Étude de cas : Renforcer la résilience climatique
du secteur minier au Canada*

Commercial reproduction and distribution are prohibited
except with written permission from NRCan.
For more information, contact NRCan at
copyright-droitdauteur@nrcan-rncan.gc.ca.

Photos: © Natural Resources Canada

Cat. No. M4-293/2-2026E-PDF (Online)
ISBN 978-0-660-99701-8

© His Majesty the King in Right of Canada, represented by
the Minister of Energy and Natural Resources of Canada,
2026

