



A Climate Adaptation Case Study  
in Canada's Mining Sector

## Climate Change Planning at Glencore in Sudbury, Ontario

# 1 • Introduction

As part of their operational and strategic planning, mining companies manage various forms of risk. The dynamic nature of global mineral markets, commodity prices and labour availability or unrest, as well as geotechnical or environmental stresses, all contribute to future uncertainty for the mining sector. These risks challenge a mining company's ability to maintain stable operations, generate revenue and extend profit for its shareholders. Increasingly, mining companies are recognizing and responding to risks associated with changing weather and climate, stemming both from direct impacts and from regulatory pressures. Companies also have to be concerned with how and when supply and value chains are affected by extreme weather and climate change.

Climate data shows that average global air temperatures are increasing, the average precipitation regime is changing and extreme weather events, such as rain, wind, ice and snowstorms, are increasing in intensity. Projections, both at global and regional scales, suggest that these trends will continue, possibly to a larger extent.<sup>1</sup> Impacts stemming from these weather and climate changes are significant and warrant attention during the course of proper planning and operation.

Considering the extensive reach of climate change, long-term changes to temperature and precipitation, as well as near-term weather variability and extreme weather events, pose a range of challenges to the mining sector. Tailings impoundment design can be affected by long-term changes to temperature; transportation routes can be affected by freeze-thaw cycling or permafrost degradation; tailings management can be affected by extreme rainfall events; and mine site water balance can be affected by both short- and long-term changes in hydrology. Mine infrastructure, including buildings, bridges, culverts and communications towers, is also susceptible to extreme weather, while aspects of closure planning and perpetual care and maintenance likely will be affected by changing weather conditions. In addition to these operational challenges, there are other business risks, including supply chain disruptions, increasing insured losses, threats to health and safety, heightened legal liability, and project financing uncertainty. All warrant attention within the context of a changing weather

regime through design and implementation of appropriate adaptation measures.

This case study outlines planning and action underway to deal with the current and future threats stemming from the impacts of climate change at Glencore's mining operations in Sudbury. The case study yields an example of one mining company's efforts to take stock of climate risks in various facets of its business and the process underway to manage those risks. It is designed to provide an example of climate risk management in order for other mining companies in Canada to consider the changing nature of weather and climate, how it will affect their business, and ways to adapt.

This case study is made possible through funding from Natural Resources Canada's Enhancing Competitiveness in a Changing Climate Program. The Program facilitates the sharing and development of knowledge, tools and practices to assist decision-makers in the analysis and implementation of measures to deal with current and future climate- and weather-related challenges. This case study has been prepared by the Fraser Basin Council (FBC), a not-for-profit organization that facilitates collaborative efforts to advance sustainability throughout British Columbia and beyond. It was developed in partnership with the Mining Innovation, Rehabilitation and Applied Research Corporation (MIRARCO) of Sudbury and its parent organization, the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR).

This case study would not have been possible without generous contributions of time and knowledge by Marc Butler of Glencore and Sean Capstick of Golder Associates. FBC and MIRARCO are most grateful for their interest in sharing their stories with others and their support for this project.





Figure 1 | Glencore Sudbury Smelter

## 2 • Context

Glencore, a multinational mining corporation headquartered in Switzerland, has created Sudbury Integrated Nickel Operations (SINO) (formerly known as Xstrata Nickel). SINO operates two underground mines: Nickel Rim South and Fraser Morgan mine, as well as the Strathcona mill and Sudbury smelter (Figure 1) in the Sudbury basin of Ontario (Figure 2). Although the sites primarily produce nickel and copper, other metals such as cobalt, gold, silver and platinum are also produced. The Nickel Rim South mine is one of the largest nickel mining operations in Sudbury and has been in operation since 2009. Expansion of the existing Fraser Morgan mine has extended the mine's lifetime to 2025.<sup>2</sup>

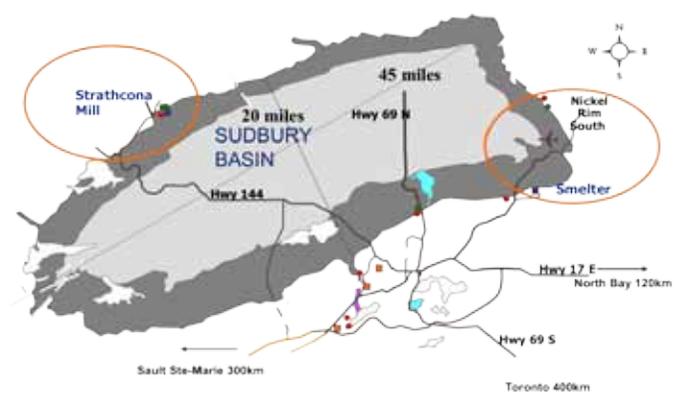


Figure 2 | Glencore Sudbury Basin Operations

### 3 • Climate Risk Assessment at Glencore

Driven by the strong desire to better understand local climate risks, Glencore has considered climate change impacts and adaptation alongside energy and greenhouse gas emissions. A risk-based approach to climate change impacts comprises one of three areas of focus to address energy/climate change issues. As noted in Figure 3, responses in each of the three categories were envisioned as “buckets of work” that would be undertaken to optimize energy efficiency, reduce emissions of greenhouse gases and adapt to current and future climate change impacts.



Figure 3 | Climate Change “Buckets of Work”

### 4 • Climate and/or Weather-Related Implications

Glencore has identified several climate- and weather-related risks that have already affected their operations, or could affect their operations in the future. The changing nature of extreme weather (including precipitation, temperature and wind) has the potential to change the current risk to critical infrastructure and safety of mine personnel.

The most common climate- and weather-related impact for Glencore’s Sudbury operations is the risk of flooding. Although flooding is most commonly associated with extreme precipitation events, it can also stem from normal levels of precipitation combined with other weather influences. Early spring warm periods, rain-on-snow events, rainfall on frozen ground and heavy rain on saturated soils can all lead to serious flood conditions.

During a rain event in 2012, heavy rain falling on frozen ground led to localized flooding. Excess water entered the converter aisle in the smelter, necessitating pumping efforts to remove the water. Other aspects of critical mine infrastructure can also be affected by flooding, including tailings and process water impoundments, transportation routes and energy transmission and distribution lines (Figure 4).

In addition to being a contributing factor to more frequent flooding events, seasonal variability presents other challenges for the mines. In recent years, weather in all seasons has been less predictable. Spring thaws occurring in January, warm summer-like weather occurring as early as May, and rain and thunderstorms in the winter all challenge the standard ways of dealing with weather and climate and make it difficult for the mines to plan and/or operate in the context of what was previously considered “normal” weather.

Sudbury operations have adjusted standard operating procedures to accommodate what appears to be a new weather regime. Rule curves that govern water levels for tailings areas and water balance equations for mine sites have been shifted earlier by 30-60 days, depending on the conditions. Warm spells in early spring and resulting rapid spring snow melts in recent years have created the need for significant pumping to prevent overtopping of impoundments and washouts. Rapid snow melt as a result of very warm temperatures in the spring have also overwhelmed streams and rivers, impacting drainage infrastructure and threatening local drinking water quality.

Additionally, an increase in the number of freeze-thaw cycles in January and February has affected operations at both the Nickel Rim South and Fraser Morgan mines of Glencore. These events have led to unsafe conditions on access roads and for brief periods have prevented transportation to and from the mines. This impact interferes with Glencore's ability to transport supplies and equipment to the mine and limits the mine's ability to move ore and concentrates.

Over the last three to five years, the company has experienced changes in the timing and extent of "curtailment hours" at the smelter (i.e., the amount of time that weather conditions require the smelter to stop normal production in response to elevated concentrations of sulphur dioxide in the local airshed.) Curtailment includes cessation of activity in the converter aisle, and may extend to decreasing production or shutting down roasters. In the past, production curtailments were most likely to occur in April or May. In recent years however, unfavourable weather conditions have begun as early as January. Along with occurring earlier in the year, the number of curtailment hours have been increasing. Despite this change, Glencore has been able to increase production levels through improved operational practices.

Finally, extreme heat days contribute to increased temperatures underground and threaten worker safety. As surface temperatures rise, underground temperatures also rise because of incoming ventilation air. Provisions under the *Occupational Health and Safety Act* in Ontario require production be halted when temperatures exceed 31 degrees Celsius. In recent years, the Glencore mines in Sudbury have experienced an increase in the number of days when production has been halted due to high temperatures underground.



Figure 4 | Water Management Area

## 5 • Climate Risk Assessment Workshop

With help from Golder Associates, Glencore organized an internal risk assessment working session with key members of operations, engineering, capital and other departments. The session raised awareness of the impacts of extreme weather and climate change on operations, specifically infrastructure, and solicited measures to cope with the impacts. The risk assessment revealed several areas that are affected by extreme weather and climate change for Glencore's Sudbury operations, including:

- Water management issues, including flooding
- Employee safety (especially during extreme events)
- Transportation of product during variable weather
- Curtailment of production due to weather factors
- Energy security
- Infrastructure safety and operation; and
- Non-compliance with regulations due to changing climate trends (for example: higher levels of wastewater discharge due to climate change can put companies at risk of not meeting their discharge targets under provincial or federal regulations).



The climate change risk assessment working session also allowed Glencore to identify and prioritize site-specific challenges, leading to adaptation measures that are targeted, efficient and cost-effective. Risk results were also easily incorporated into the company's existing risk registry. Driven by internal champions, the risk assessment process also helped to engage management teams and technical experts in the process of identifying climate risks and proposing adaptive measures.

## 6 • Adaptation Planning

To help manage current and future weather- and climate-related challenges, Glencore is developing a two-tiered adaptation strategy composed of long-term and short-term adaptation measures. Long-term measures will include the development of a climate change adaptation plan within the context of a company-wide sustainable development plan. The plan is expected to be in place in 2014. The long-term aspects of the adaptation plan will see weather and climate resilience needs mainstreamed into management decisions pertaining to infrastructure planning and design. The plan will make use of both historical climate trends and future climate projections that, in turn, are used to model potential future climate scenarios.

In the shorter term, many actions are underway or are being planned to respond to climate change impacts. Measures to cope with changing weather patterns, often spawned by significant impacts to local operations, are becoming part of standard operating procedures at Glencore. For example, operators have noticed a significant change in the timing and volume of the spring freshet. Traditionally, Glencore operations have released water from its retention ponds on a certain date each year, regardless of cumulative water levels or precipitation. As weather has become more variable, and melts occur earlier in the spring, the company has begun to shift the release dates, and are ensuring that the timing of such action is more flexible to match the corresponding conditions.

One tool to optimize the existing water management practices is Golder's GoldSim model, which was used to develop a Water Management System Hydrological Model. Within the GoldSim environment, Golder developed the GoldSim Climate Generator, a stochastic model that generates daily, monthly and annual records based on existing historical climate statistics. Based on current climate and future trends identified from Global Climate Change Model output, the Climate Generator provides a range of potential future climate data.

The Climate Generator generates a large number of realizations for climate inputs to the site in order to identify potential extreme wet and dry events that, while possible, were not recorded in the historical climate data. These projections, in turn, can also be used to evaluate the effects of extreme events on the water system.



The Climate Generator first randomly samples an annual value (annual precipitation and mean annual temperature) from a distribution based on the distribution of historical annual values. The program then randomly samples 12 simulated monthly values (monthly precipitation and mean monthly temperature) until the 12 values sum and average, respectively, to the observed annual values for both parameters. This process is then repeated at the daily level for both precipitation (using a daily precipitation amount and a daily chance of rain) and temperature (using the previous day's temperature and a distribution of day-to-day temperature changes) until the daily values, in turn, sum/average to the monthly values. The program then goes back to the initial step and generates new annual values for a second year, and loops through the various steps until the required record length is reached.

The synthetic climate data sets are used in a calibrated hydrologic model in order to evaluate project design and operation based on potential risks. By adjusting its operational strategy to better accommodate a variable climate, Glencore is reducing flood risks that stem from over-topping or treatment bypasses during a precipitation event.

Glencore has also enhanced its capacity to respond to intense events using improved short-term weather forecasts. Traditionally, weather data was based on historical norms, and year-long forecasts were consulted for planning purposes. Updated short-term forecasts (including five-day forecasts) give better lead time to prepare for, and respond to, changing weather and potential hazards.

## 7 • Overcoming Adaptation Challenges

Efforts to assess and manage weather- and climate-related risks at Glencore have revealed nominal technical, operational and management challenges. Risk assessment participants questioned the accuracy of global-scale projections of climate change and the nature and timing of future weather extremes. To deal with this, consultants used best practices in downscaling weather and climate hazards that would lead to damage situations. Scenarios stemming from models helped operators envision future changes to the weather regime and recognize increasing risk to people and property. Although the modelling work provided a clearer picture of expected future challenges, areas requiring further clarity and support were noted. For example, a clearer regulatory framework within which to address climate risks and further guidance through enhanced engineering codes and standards were identified as means to further enhance adaptation action, both at Glencore and in the mining industry as a whole. A stronger adaptation cost-benefit analysis for capital-related infrastructure spending was also deemed important.

Workshop attendees were at first uncertain of how climate change would affect their operations. The workshop was useful in overcoming this uncertainty by addressing the questions in the context of “how does weather affect your work?” and talking about “weather variability.” Climate change was often viewed as an event/occurrence that would occur in the distant future, well beyond the end of the mine life in Sudbury. However, evaluation of data on historical trends and recent changes in weather patterns support the notion that climate change is already occurring at the

Sudbury operations. Including climate change in the existing “risk vocabulary” encouraged buy-in from project team members and advanced the discussion.

The impetus for consideration of climate change impacts and adaptation was driven in large part by select internal staff. A core group of employees, including one senior manager, led the development of information workshops, training sessions for employees, and climate change risk assessments. Such efforts were supported by the existence of an organizational mandate to consider weather and climate risks under the company's sustainable development program.





## 8 • Advancing Adaptation

Results from the risk assessment will be used by Glencore to better prepare the Sudbury operations for the impacts of changing weather and climate. More specifically, the following actions have been initiated by the company:

- Equip the individual sites with temperature, precipitation and wind gauges to provide real-time weather data to establish local climate trends and put operating procedures in place to identify pending extreme weather
- Develop a model to more accurately project short-term atmospheric conditions that would lead to curtailment conditions for the mine
- Continue organization and community engagement efforts on climate change adaptation, which will be used to assist Glencore in implementing new adaptation measures
- Update the GoldSim water balance to process a range of future climate data to replace the observed data and update the results of the current water balance
- Complete the Climate Change Adaptation Strategy.

## 9 • Conclusions & Lessons Learned

Adaptation planning at Glencore's Sudbury operations has yielded many lessons to date. For example:

- Management and staff engagement on the topic of climate change requires clear examples of context-specific information on climate trends, projections and impacts. Language that explains climate threats in business terms—such as costs stemming from extreme weather or loss of productivity, potential liabilities or threats to supply chains/value chains—can often be more engaging than more theoretical discussions about long-term climate change impacts.
- Assessing and managing risks is often a well-understood and easily recognizable process within mining companies, thus providing a suitable context for climate adaptation planning and decision-making. Risk assessment also allows the company to prioritize actions needed to build resilience against current and future climate change threats and provides for emerging threats being easily integrated into existing company-wide risk registries.
- Methods from other environmental threat action planning (e.g., SO<sub>2</sub> abatement) may be easily transferrable to the context of climate change adaptation planning. Stakeholder communications, threat assessments, data collection and analysis and response prioritization all constitute components of standard environmental risk management.
- It is beneficial to incorporate climate change into existing organization mandates, procedures and policies. Mainstreaming adaptation removes the perception that planning for climate change will require a unique and significant effort or substantial additional capacity.
- Using available resources and expertise will help contextualize climate change impacts for different aspects of mining operations (such as energy, transportation, water usage, tailings management and closure planning) and convey the importance of integrated climate-sensitive planning.

### References

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