A Climate Adaptation Case Study
in Canada's Mining Sector

Enhancing Weather Resiliency at Nyrstar Myra Falls

Fraser Basin Council

mirarco
MINING INNOVATION

1 • Introduction

From long-range planning to day-to-day operations, mining companies manage many types of risk at all stages of the mining life cycle. The dynamics of global mineral markets, commodity price swings, skills shortages, regulatory considerations — as well as geotechnical environmental and social licence issues — represent sources of risk that companies must assess and address throughout the mining life cycle.

Severe weather events have been, and continue to be, important risk factors for mining companies. As demonstrated by recent flooding in Australia[1] such events can have significant impacts, including damage to key transportation assets critical to the flow of supplies, human resources and production outputs.

Although a subject of continued debate about causes, the International Council of Mining and Minerals, in a recent report,[2] along with evidence that weather-related catastrophic losses have been on the rise in recent years, suggests that the frequency and intensity of severe weather events may increase in the future.[3]

With this context in mind, this case study has been prepared to assist Canadian mining companies in responding to risks associated with severe weather events – today and in the future. By describing the efforts of one company – Nyrstar – to deal with weather-related challenges at its Myra Falls operation on Vancouver Island in British Columbia, it is anticipated that the mining sector in Canada as a whole will benefit.

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, 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).

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2 • Nyrstar Overview

Nyrstar is a multinational mining and metals corporation that specializes in zinc and lead extraction. Created in 2007 with the merger of Zinifex (an Australian mining company) and Umicore (a Belgian materials technology company), Nyrstar's operations now stretch across the globe with sites in the Americas, Australia, Europe and Asia. There are two mining operations in Canada: The Langlois mine in Northwestern Quebec and the Myra Falls mine in British Columbia.

Figure 1 | Nyrstar Myra Falls Mine

The Nyrstar Myra Falls mine (Figure 1) is located in a valley within Strathcona Provincial Park on Vancouver Island and has been in operation since 1966. In 2011 Nyrstar acquired the mine site through its purchase of Breakwater Resources. The underground mine currently produces zinc, copper and lead, as well as gold and silver as by-products. In 2012, production by metal type (in tonnes) included zinc (32,000 in concentrates), lead (1,100 in concentrates) and copper (3,800 in concentrates) as well as silver (580,000 troy ounces) and gold (13,600 troy ounces). The mine currently employs approximately 315 people and is linked to Campbell River port facilities by a 90 km asphalt road.

The location of the Nyrstar Myra Falls mine within a provincial park is a unique feature that has certain implications in comparison to mines elsewhere in BC. For example, mine activities and the eventual rehabilitation of the mine site fall under a park-use permit and are subject to particularly stringent permitting, monitoring and reporting requirements.

Interest in the mine on the part of local community stakeholders is very high as access to a public trailhead is via a road that goes through the site, and the mine is located in the Campbell River watershed which supplies drinking water to the town of Campbell River.

Although the mine, in contrast to other remote mines in BC, is reasonably close to a populated area, when it comes to emergency response planning, it is effectively an isolated site that requires operational personnel to have a distinct set of leadership skills in dealing with emergencies.

3 • Weather-Related Impacts at Myra Falls Mine

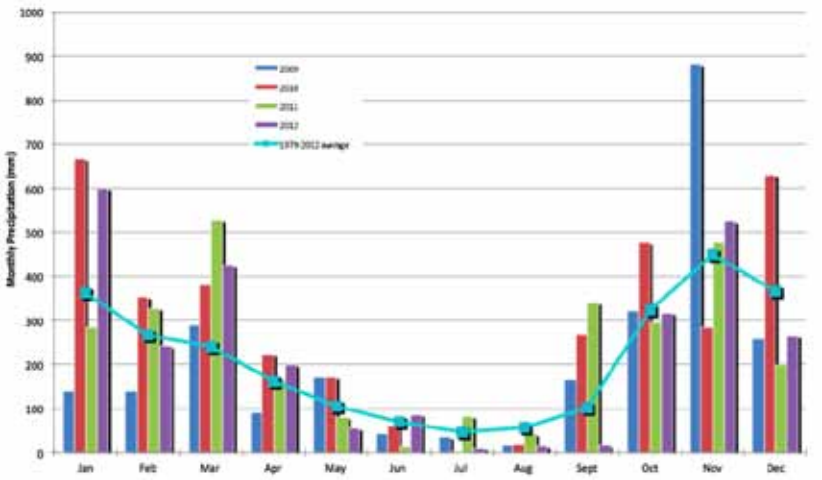

Figure 2 | Nyrstar Myra Falls Precipitation by Month 1979-2012

The Myra Falls mine is affected by a variety of weather-related risks. The mine site is located in a rugged mountainous region that is highly susceptible to weather patterns moving eastward from the Pacific Ocean. Such patterns can bring heavy precipitation,[4] particularly during the winter months (Figure 2). Dry conditions can also be experienced during the summer and at other times as well, such as the months of October and November 2013 when there was exceptionally low rainfall.

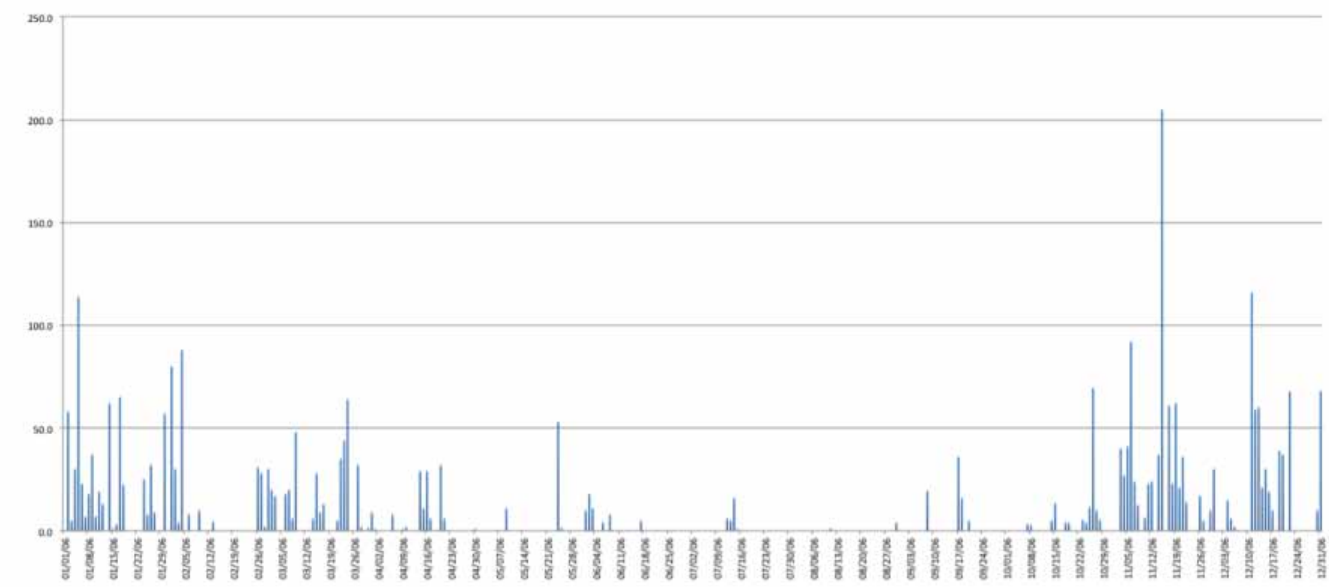

Figure 3 | Total Daily Precipitation – 2006

With respect to temperature extremes, occasionally in winter, air temperatures may drop to around -15°C and during the summer, air temperatures may approach 40°C. However, the Pacific Ocean tends to have a moderating effect on temperatures.

The most significant weather-related challenges at the Myra Falls mine typically involve heavy rainfall. Intense rain events occurring on snowpack can result in particularly high surface water runoff episodes.

On November 15, 2006, the Myra Falls mine experienced particularly intense rainfall, characterized as a 1 in 200 year flood event, when approximately 205 mm of rain fell over a 24-hour period (Figure 3).

Figure 4 | Top: Normal rain event surface flows (August 2013) Bottom: November 2006 flows

The event caused extensive flooding (Figure 4) and debris flows (Figure 5), resulting in suspension of operations for five days and damage to key infrastructure including:

- Partial breach of the diversion channel at the top of the mine tailings pond, resulting in large quantities of clean water flowing into the tailings pond and creating a risk of overtopping
- Undermining of hydropower penstock footings
- Damage to footings of a key bridge on the public road through the mine site (Figure 6)
- Washout of the main access road in two locations, completely suspending road access/egress to and from the mine for two days and restricting road traffic for five days
- The mine effluent treatment system being overwhelmed with inflows, causing effluent to back up.

Underground workings were susceptible to flooding during this emergency: protection infrastructure was very close to being breached by high water inflow rates of approximately 3000 gallons per minute. Had the underground flooded, the mine would have been put out of commission indefinitely.

The 2006 flood event had major financial consequences for Breakwater Resources, the owner of the mine at the time. In addition to the $4M in lost production over the downtime period of five days plus start-up and the construction of a Bailey Bridge to restore the main access road, the company incurred costs of $250K for emergency pumping equipment. Subsequently, it cost the company approximately $550K to implement a pumping system designed to handle future events of a similar magnitude and $100K for a second effluent drainage line.

Figure 5 | Example of debris flow in vicinity of Nyrstar Myra Falls mine

Figure 6 | Damage to main access road

4 • Company Responses

If it wasn't for the timely and coordinated actions of company personnel, the impacts of the 2006 severe rainfall and flooding event could have been far more serious. Heroic efforts were taken to minimize threats to people, the environment and infrastructure critical to the continued operation of the mine. Factors that contributed to the effectiveness of the response to this emergency included:

- The calm and decisive leadership of the on-site senior manager
- Adequate emergency response plans
- The creativity, skills and teamwork of personnel during the emergency
- Timely support from the company's suppliers and contractors; and
- The good fortune that the most severe rainfall occurred during the day shift when personnel were on site to take action.

As the main access road was out of commission, mine personnel had no option but to stay at the site under challenging living conditions for two days prior to the main access road being reopened.

The 2006 event highlights a number of challenges, including:

- Aspects of the mine water management infrastructure, although compliant with regulatory requirements, were insufficient to withstand a severe rainfall/flooding event of this magnitude
- Although the regional weather forecast indicated that a storm was approaching, local information about its intensity and duration was lacking; and
- The severe weather event quickly resulted in multiple compounding impacts, including debris flows and flooding; this was a challenging situation for personnel, who had to respond to multiple simultaneous emergencies.

Here are some of the specific actions taken during the flood emergency and in the days that followed:

- Suspension of operations and immediate evacuation of the underground
- Dispatch of an excavator to effect emergency repair of the diversion channel above the tailings pond
- Rapid sourcing and deployment of additional pumps
- Repair of penstock footings damaged by runoff and debris flows (Figure 7); and
- Construction of a pipeline routed from the 1500 level underground to surface (to control water flows).

Following the 2006 event, efforts were undertaken to identify ways to better protect the mine site from severe weather events in the context of the company's risk assessment process at the time. The risk assessment process was examined, emergency response plans were evaluated and refined, personnel education and skills training needs were addressed, and specific physical improvements were made.

Actions taken include the following under internal (human resources and planning) and external (physical and monitoring) categories.

Internal Planning and Capacity-Building

- Scenario analyses to look at potential future severe weather and other impacts and identify strategies to limit operational vulnerability
- Risk identification exercises to determine infrastructure resiliency needs and costs
- Use of dry runs, wet runs and tabletop exercises to hone emergency management response plans and identify feasible operational adjustments
- Following the acquisition of Breakwater Resources by Nyrstar in 2011, harnessing the Nyrstar risk assessment framework and related internal expertise
- Increasing focus on education and training for management and staff, particularly in relation to the roles they play in emergency situations
- Developing pre-warning programs to give staff more time to respond to emergencies; and
- Revising evacuation scenarios and protocols for use in emergency management.

Figure 7 | Repair of damaged hydropower penstock footings

Enhancing Physical Infrastructure and Monitoring

Key areas of focus for physical infrastructure improvements and monitoring included tailings management infrastructure, transportation assets and general site water management. The vast majority of effort and funding were dedicated to address vulnerabilities in these three areas. In determining what measures to take to adapt to future severe weather, the costs involved to obtain a given level of risk reduction was a key consideration.

Actions included:

- Effectively doubling the site's capacity to control surface water flows during peak events. Measures included installation of a second effluent discharge line to handle peak flows through the water treatment system, construction of additional ditches and doubling the underground pumping capacity, using both diesel and electric pumps (the former providing resiliency in the event of power outages)
- Constructing bulkheads in pit areas that are particularly vulnerable to flooding
- Planning to store key equipment in strategic locations when severe weather is forecast. This measure is to facilitate speedy repair of damaged transportation routes (e.g. position heavy equipment on both sides of bridges); and
- Enhancing monitoring tools and equipment (e.g., flow monitoring, weather stations, cameras and alarms) to alert personnel of emerging issues.

5 • Lessons Learned

In light of weather-related challenges at the Nyrstar Myra Falls mine – particularly the major rainfall and flooding event of 2006 – mine management underlines the importance of the following:

- Cultivating leadership and teamwork skills critical to effective emergency response
- Ensuring personnel are fully prepared, as is the case with isolated sites, to provide initial emergency response measures entirely on their own. This requires an appropriate mindset and distinct set of leadership skills to ensure that timely and well-coordinated actions are taken on multiple fronts, often involving both underground and on-surface issues occurring simultaneously
- Engagement of site personnel proactively in planning for and responding to severe weather through, for example, ensuring near-term weather forecasts are a regular agenda item in management meetings, and developing well thought-out internal communications/action plans in advance of an anticipated severe event
- Holding joint regulatory/industry consultation workshops to develop a mutual understanding of priorities and responses during extreme events (i.e., events that are not generally foreseen and/or are covered in permitting scenarios)
- Adopting a site-wide approach to risk management to help mine management identify and prioritize appropriate severe weather adaptation measures
- Seeking solutions that are "layered" (i.e., building in redundancies when undergoing infrastructure upgrades) rather than looking for the one "home run" solution
- Developing strong working relationships with external stakeholders and ensuring regular interaction and communication about weather resiliency / emergency management plans
- Strengthening the business case for weather/climate adaptation measures that link several considerations (see power generation on page 8) to help justify the investments needed to improve weather resiliency
- Ensuring availability of, and timely access to, locally relevant short- and long-term weather forecasts
- Respecting Mother Nature by showing humility in anticipating risks associated with 1:x year events, which may emerge in unexpected ways; and
- Recognizing the limitations of predictive tools to "know" exactly what will happen far into the future with respect to severe weather. The importance of ongoing vigilance and readiness to respond – versus assuming "we've got it covered" – cannot be overstated.

Power Generation

Responding to Weather-Related Impacts on Hydropower Generation

One compelling example of the importance of weather to the Myra Falls mine relates to energy supply. As the mine is not connected to the BC Hydro electricity grid, a combination of hydroelectricity and diesel-generated power is used to meet the energy needs of the mine. During dry periods, reservoir storage limitations and low surface water flows can result in the mine relying heavily on diesel-powered generators, with fuel costs approaching $500,000 per month.

Nyrstar has identified actions to reduce reliance on diesel generation during periods of dry weather, including:

- Applying for permits that would allow for the adaptation of the existing dam on the Jim Mitchell Lake reservoir. This approach involves inserting inflatable sleeves underneath the spill gate, allowing the dam freeboard to be raised 2-3 meters as required to improve water storage.
- Developing a power conservation strategy, designed by mill operators, to improve the monitoring and coordination of all power-consuming activities at the mine, adjusting timing of energy demands to avoid spikes in energy use, thus conserving diesel fuel and minimizing reservoir draw-down.

The business case for dam enhancement to improve water storage is strengthened by the ability of the sleeve to be deflated to spill water in response to severe precipitation events.

6 • Enhancing Preparedness for Severe Weather Events: Suggestions for Further Investment

Nyrstar Myra Falls mine management has noted the following needs that, if met, will improve their ability to respond to severe weather events in the future:

1. Local weather forecasting capability and timely notifications (e.g. heavy rainfall warnings) need to be improved. Improved long-range local forecasts would also be helpful for planning purposes,for example, with respect to predicting water availability for reservoir recharge and related hydroelectricity generation.
2. Regional weather variability often results in current weather stations (e.g. Campbell River and Zeballos) showing very different weather conditions. More and better weather stations are needed to capture sub-regional variability in current conditions and also help build a more robust set of historical data to inform decision-making.
3. Improved tools and services for the synthesis, analysis and reporting of local climate data (past and present) would be helpful, in particular, to help address knowledge gaps regarding the nature and extent of changes to weather patterns in the vicinity of the Myra Falls mine over different time scales.

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