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The role and contribution of Natural Resources Canada

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Minerals and Metals

Water Issues and Minerals and Metals

Mining in Canada has a rich history going back almost 9000 years—that is the estimated age of evidence of mining discovered by archeologists in a quartzite quarry near Manitoulin Island, Ontario. During the 1600s, mining became a substantial economic driver for some communities in the Maritimes. Over the years, the number and size of mines have increased substantially, especially since the 1940s.[53]

The growth in mining activity has increased the volume of water required for mine site management and increased the total volume of mine wastes, resulting in the potential contamination of our environment and water resources.[54]

Peak concentrations of contaminants discharged from mine sites may occur many years after the peak of mining activity, and even after a mine closure. This delay of contaminant release can occur because of natural mine flooding, temporary acid neutralization and contaminant attenuation, and long groundwater transport times.[55]

Today, Canada is one of the world's largest exporters of minerals and mineral products.

In 2003, minerals and mineral products provided 13.3 percent of Canada's total exports and contributed to the Canadian trade surplus. Some 80 percent of Canada's mineral and metal production is exported.

Water use in mining

Through land use associated with mining, impacts on water can arise from a multitude of sources.

To gain access to minerals, metal and non-metal mines are dewatered using pumping wells, diversion techniques and near-horizontal drainage passages. In mining operations water is mainly used to extract and process ore at the mine site.[56] This water is often recirculated, and as a result many mines are able to minimize water discharge during operation; however the concentration of contaminants increases. Waters are then primarily (78 percent) discharged to freshwater bodies and undergo little beyond primary treatment.[57] After ore recovery is complete, previously drained underground mines and open pits refill with water, further diverting ground and surface water flows. Precise estimates of water intake and discharge associated with mining activities are difficult to obtain due to uncertainties associated with evaporative losses, and gains and losses through subsurface flow during both the active and inactive stages of mining.[58]

Water quality

Very large volumes of waste are produced by the mineral extraction industry. Water used in the mining process and the precipitation infiltrating mine tailings can become highly contaminated with metals, process reagents and other undesirable constituents that result in concerns about discharge waters and require the implementation of treatment technologies.

There are numerous examples throughout the world where elevated concentrations of metals in mine drainage have had adverse effects on aquatic resources and created severe impediments to the reclamation of mined land. Metal leaching (ML) problems can occur over the entire range of pH conditions, but are most commonly associated with acid rock drainage (ARD). Once initiated, metal leaching may persist for hundreds of years. In North America, metal leaching and ARD (ML/ARD) have led to significant ecological damage, contaminated rivers, loss of aquatic life and multi-million dollar clean-up costs for industry and government.[59]

Degradation of water quality continues for decades or centuries after resource recovery is complete. At this time, there is no accepted methodology for estimating the value of the lost use of water due to these long-term adverse changes in water quality.[60]

Preventing future degradation of water quality often requires mitigation facilities capable of functioning across both normal climatic ranges, but also after extreme climatic events. Assignment of design flood magnitudes is hampered in most mining districts due to a lack of long-term temperature, snow course, precipitation and hydrological data from which predictive calculations can be made.[61]

The development of treatment technologies for the mining sector presents special challenges. Removing toxic substances in effluents can be difficult and the regulatory framework is shifting the focus from concentration-based criteria, to acute toxicity and, increasingly, to the potential for long-term chronic impacts on ecosystems. Given that many mines are located in remote regions, including ones that may be sensitive to disturbances, it is critically important to understand the potential for impacts and develop the treatment and mitigation systems to ensure environmental protection.[62]

MMS played a central role in the revision of the Metal Mining Effluent Regulations (MMERs), which directly regulate the quality of water and waste water emitted from mining operations." Since the announcement of the revised MMER scientists have continued to play a vital role, developing data and approaches towards applying and interpreting the regulatory context, assisting industry in working out solutions to problem discharges and continuing to build the understanding on the potential impact of mine effluents and how this should be assessed.

Through innovative research, development and technology transfer, the Mine Environment Neutral Drainage (MEND) Program has reduced the risk and liability associated with acid mine drainage by nearly half a billion dollars since its inception. This, in turn, has had positive implications for mineral investment, employment, regional development, human health and environmental quality throughout Canada and in other countries.

Water use in aggregate operations

The volume of aggregate removed from pits and quarries is large. At any given time, there are many thousands of aggregate operations in Canada. Small aggregate operations are numerous and often follow construction activities. Near urban centres, aggregate operations are usually larger and can last for several decades or longer. Where water tables are high, extensive dewatering is required to gain access to rock and gravel. This dewatering can affect local water supplies and water levels of adjoining surface water bodies. Washing activities can result in increased suspended solids. Impacts do not usually persist long after aggregate removal is complete. In urban areas, as shallow aggregate sources diminish, deeper operations become viable, and dewatering activities intensify.

There are numerous examples in urban areas of Canada, such as Calgary and Toronto, where water intake for aggregate production conflicts with other demands such as municipal, industrial and recreational uses. With increased urbanization, these conflicts are expected to increase in frequency.[63]

Water use in diamond mines

The initiation of diamond mining in Canada has introduced some new issues regarding water use. Despite the presence of apparently extensive surface water in the North, much of the terrain is actually semi-arid by most climatic classifications. As a result, there may be limited water available for dilution of mine effluent. These new mines have also resulted in increased interest in the use of permafrost both for dams and as a means of limiting sulphide oxidation. Greater information is needed on the long-term impacts of permafrost development on water consumption and water-quality management.[64]

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Water-Related Minerals and Metals Sector Activities

The water issues addressed by NRCan's Minerals and Metals Sector (MMS) arise from use and disposal of metals and metal substances, as well as orphaned or abandoned sites that are contaminated. Understanding and mitigating the impacts on water resources are key factors for ensuring water quality, for maintaining markets for Canadian metal products, and for sustaining communities in Canada.

Assessment tools

Assessment tools are required to understand the potential for aquatic impacts on both a site-specific and an aquatic ecosystem basis. NRCan is actively engaged in developing the scientific and technological methodologies that improve the understanding of how to assess and mitigate against impacts in aquatic systems. For example, MMS is working on the development of physiologically based, bio-geo-chemical modelling approaches that can be used to predict the impacts of metals in aquatic systems on a site-specific basis. These developments have application in understanding the potential for impacts, setting effluent discharge objectives, identifying sources of toxicity and setting water quality guidelines and criteria. The development and application of these approaches is focussed on reducing regulatory uncertainty.

Treatment technologies

Affiliated with improved assessment tools and regulatory approaches is the need for innovative solutions with respect to the water-treatment technologies and water-use strategies within the mining and metals industry. These technologies will be essential to meet discharge targets and to maintain Canadian industry at the forefront of productivity, efficiency and environmental protection. These S&T activities help to ensure that Canadians are likewise able to benefit from the most innovative approaches in these areas.

Stewardship and safe use

MMS leads Canadian involvement with a Life Cycle Initiative sponsored by the United Nations Environment Program and the Society for Environmental Toxicology and Chemistry. MMS also works through the Organization for Economic Cooperation and Development to ensure that the potential environmental hazards and risks of metals products are assessed in the appropriate and correct manner.

Development of safe use and good stewardship principles to ensure minimal negative impacts on aquatic resources over the full life cycle of a metal substance is also a key issue for MMS. While the previous two activity areas deal primarily with the potential for aquatic impacts during the production process, this deals with the metal product itself. Ensuring the proper tools are in place to correctly and efficiently assess and manage metal products over the course of their life cycle (including recycling and/or final disposal) is an integral part of maintaining and sustaining aquatic resources. This issue is also a key factor in maintaining markets for Canadian products, for example with respect to non-tariff trade barriers. NRCan's activities include the life-cycle considerations of substances currently in use, as well as the development of innovative manufacturing and design processes directed a minimizing potentially toxic releases.

MMS is also involved in the design of novel metal alloys and other materials for plumbing fixtures, pipes and other water delivery infrastructure which are safer and better performing; and the development of protocols for determining the hazards and bioavailability of metals, metal compounds, alloys and other inorganic substances in the aquatic environment.

Suppression of acid mine drainage and toxic releases

An example of an MMS program activity that incorporates the above is the suppression of acid mine drainage and toxic releases. The progress achieved in this area has been made through the following activities:

- Development and application of novel tools and predictive models for assessing the long-term risks of mine and smelter emissions in aquatic ecosystems.
- Design and long-term stability of mine waste sludges directed at minimizing release of metals into the aquatic receiving environment.
- Development of novel and improved treatment technologies and water recycling methods to reduce the impact of mine and smelter waste discharges.
- International programs to enhance water management in the mining industry through
- capacity building, training and mine-rehabilitation projects directed at water management.
- Increased understanding of processes, fate, and chronic toxicity of mine and smelter emissions in relation to long-term impacts and sustainable ecosystems.

Participation in multi-stakeholder consortia such as the Mine Environment Neutral Drainage (MEND), Toxicological Investigations of Mine Effluents (TIME) and the Thiosalts Consortium.

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Notes:

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Last Updated: 2005-08-152005-08-15 **Important Notices**