The challenges of re-opening historical Canadian mine sites with respect to water quality

Tania Perzoff[1], Jessica Banning[2], Scott Kingston[3], Rick Hoos[4]

EBA, A Tetra Tech Company, 9th Floor – 1066 West Hastings Street, Vancouver, British Columbia,
[1]tperzoff@eba.ca, [2]jbanning@eba.ca, [3]skingston@eba.ca, [4]rhoos@eba.ca

Abstract Bringing historical Canadian mines back into production following a period of closure is discussed in the context of mine site water quality management and evaluation. Navigating the regulatory process for such projects can be challenging, particularly given stricter environmental expectations, guidelines and requirements for site water quality management and evaluation. Incorporating historical data into modernized water quality programs is sometimes difficult and often poses additional challenges. Examples are drawn from the experiences of the Cantung Mine, currently in operation in the Northwest Territories, Canada. Re-opening a historic mine can be challenging but can also provide numerous economic and environmental benefits.

Keywords water quality, historic operations, water licence requirements and expectations

Introduction

Increasingly rigorous environmental regulations and expectations pose a challenge to developers looking to permit mines, including those that are inactive or abandoned. Historical mines are often attractive targets as they once hosted, and still potentially host, economically viable mineral resources. Advances in mining technologies, higher resource prices, and changing demand for raw materials can all work to shift prospects that were previously considered un-economic back into an economically viable project. Historic mine sites with economically viable mineral resources can provide effective use of a previously disturbed area that often reduces the overall environmental impact of past and proposed projects. In many cases, when historic mines were abandoned or closed they were left in conditions that do not meet present day standards for reclamation. By reopening historic mines under the current regulatory and permitting processes in Canada, there is some assurance that the mine site will be left in better condition than when it was first abandoned or closed.

Regulations at both the Federal and Provincial/Territorial level push mines to operate at globally recognized standards. Although important in the context of protecting the natural environment, satisfying certain environmental regulatory and permitting requirements can pose a challenge for companies attempting to bring a historic mine back into production. Some of these challenges will be illustrated using extensive experience at the Cantung Mine, located in the Northwest Territories.

Challenges

Many of the challenges associated with re-opening historic mines result from legacy issues that remain from past operations. When re-opening a historic mine there will almost always be a requirement to improve site conditions to fit updated and more rigorous regulatory, permitting, and environmental management expectations. Additionally, more comprehensive data sets, particularly those characterizing site water quality, are often required as part of the regulatory and permitting process. Data that were collected and managed inconsistently during previous operations are typically more difficult to incorporate into modernized water quality programs than designing and implementing a program from scratch.

New mines are also being designed more consistently with closure in mind; however, historic mines often contain infrastructure components that were never intended to be remediated to the extent that reclamation activities are carried out today.

Water Quality Guidelines

Legislation regulating the quality of mine effluent in Canada has evolved over the years to become some of the most rigorous in the world. The primary Federal legislation governing mine effluent was enacted in 1977 as the Metal Mining Liquid Effluent Regulations (MMLER) under the Fisheries Act. These regulations have been amended over the years and are now known as the Metal Mining Effluent Regulations (MMER; Department of Fisheries and Oceans Canada 2013; Environment Canada 2012).

National Water Quality Guidelines (WQG) were also developed by the Canadian Council of Ministers of the Environment (CCME) in 1987 and serve as the benchmark for the protection of water quality and aquatic life in Canada.

In addition to conforming with established national water quality standards and guidelines, many Canadian provincial and territorial regulatory agencies are moving towards the establishment of site specific water quality objectives (SSWQOs) for contaminants of potential concern (COPCs). These objectives are being relied upon more and more to maintain site-specific conditions as a means of supporting and protecting the most sensitive identified use of water.

Defining Background Concentrations

The establishment of SSWQOs and identification of COPCs often relies on background or pre-mining water quality conditions which are commonly derived from data collected during baseline studies, as well as from established water quality guidelines such as CCME (CCME 2003). Baseline data collection is often implemented early in the regulatory process, and for many historical mines these data may not exist or be suitable for use.

Determining appropriate SSWQOs can be a challenge for many prospective mine sites, particularly those with a previous development history. Sites that are being evaluated for their mining potential often exhibit water quality conditions that do not conform to established guidelines, largely because of naturally occurring mineralization (Nordstrom 2008). Historical sites displaying water quality concentrations above established guidelines have the added challenge of determining whether these conditions are the result of naturally occurring mineralization or past operations and site disturbance (or both).

Meeting Data Expectations

Historical data, where they exist, may contribute to the process of determining background concentrations of COPCs for a particular site as they may provide an indication of water quality conditions prior to any disturbance. Alternatively, they may simply highlight water quality trends over the years.

However, prior to the incorporation of historic data into more contemporary water quality programs, consideration must be given to the quality of the data collected. Over time, improvements to sampling equipment, collection methodologies, and QA/QC procedures have generally resulted in the generation of higher quality data.

Additionally, changes to sampling requirements such as an increase in the sampling frequency, the number of sampling locations, or the number of parameters analyzed can result in datasets that contain gaps or that are unbalanced. Such datasets may limit the ease of which direct comparisons can be made, particularly during statistical analyses.

Changes in project ownership and prolonged periods of mine closure can also result in data gaps.

Improvements in laboratory techniques and equipment have contributed to higher quality data over time. Standardized analysis techniques and lower detection limits allow water quality samples to be analyzed more accurately than was once historically possible.

The drawback to these advances, both in terms of data requirements and more sensitive analysis techniques, is that it can invalidate or make more challenging the comparison of data collected under these differing conditions. For mines that have maintained a long-term water quality program, these changes can unintentionally obscure data trends and interpretation.

Case Study

Some of the challenges described above are being experienced at the Cantung Mine, located at Tungsten in the Northwest Territories (NWT), just east of the Yukon border. The mine has operated on and off since 1962, for a total of 33 of the past 51 years, and has held a valid water licence since 1975. The water licence has been renewed a total of nine times to date, and is up for renewal in 2016.

Canada Tungsten Mining Corporation Ltd. owned and operated the mine from 1962 to 1997, and following a long period of closure from 1986–2001, sold it to North American Tungsten Corporation (NATC). Since being purchased by NATC, the Mine has operated more or less consistently since December 2001, with short term closures from 2003–2005 and 2009–2010. A relatively recent photo of the Cantung Mine site is presented in Fig. 1.

The Cantung Mine is not without its legacy issues. During the initial years of operations in the early 1960s, approximately 172,000 t of tailings were deposited directly into the Flat River floodplain behind a causeway (which has since been removed) designed to partially contain the tailings. Additional tailings were likely introduced to the Flat River from accidental spills from the tailings ponds and untreated sewage was also historically discharged directly into the Flat River just upstream of the causeway.

The first Conditional Water Licence was issued to the Cantung Mine by the Northwest Territories Water Board (NWTWB) in 1975. Since this time, the mine has been responsible for the execution of monitoring programs, particularly those that focus on the aquatic environment. Initial monitoring in 1975 was in

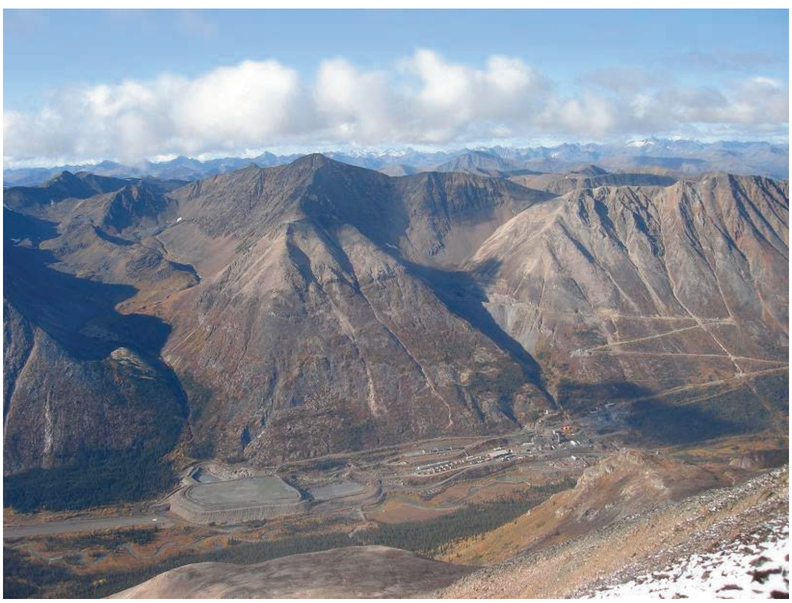

***Fig. 1** Cantung Mine Site*

the form of a Surveillance Program and involved the regular monitoring of several fixed stations and parameters (the exact number and parameters assessed by this program are unknown). With successive Water Licence renewals, this program has gradually evolved into a Surveillance Network Program (SNP), which is a program commonly implemented at mines throughout the NWT, and remains a key component of the Cantung Mine Water Licence to this day. Available records indicate that the number of stations comprising the SNP has varied since NATC’s involvement in mine operations, with stations being added and abandoned throughout the years.

The current SNP includes 19 surface water monitoring stations that are located upstream and downstream of the mine infrastructure as well as throughout the mine site area. There are six stations sampled monthly, and alternative sampling locations that can be sampled if the primary stations are inaccessible. Five stations are sampled when seepage is visible, one station is sampled bi-weekly, and another station is sampled weekly. All water quality samples are analyzed for a standard suite of parameters which includes ICP metal scan (total and dissolved), total suspended and dissolved solids, total ammonia, nitrite and nitrate nitrogen, chloride, fluoride, sulphate, alkalinity, hardness, and pH. Select stations, dependant on location, require additional analyses which may include total organic carbon, total Kjeldhal nitrogen, ortho-phosphorous, biochemical oxygen demand (BOD), extractable petroleum hydrocarbons (EPH)/benzene, toluene, ethylbenzene, and xylene (BTEX), and faecal coliforms.

In 2002, following the enactment of the MMER, effluent sampling and quarterly reporting were required of the mine, in addition to the established SNP. Furthermore, periodic Environment Effects Monitoring (EEM) biological studies were also required under the MMER to determine whether discharges from mine operations have resulted in downstream effects to aquatic biota. Three EEM studies have been conducted to date (in 2006, 2009, and 2012) which analyzed fish, benthic invertebrates, water quality, and sediment quality for potential contaminants of concern.

Other studies of the Flat River environment that have been commissioned by NATC include an aquatic study to characterize fish presence in the Flat River (EBA 2002); a Flat River Plume Study to delineate the exfiltration plume emanating from the tailings pond adjacent to the Flat River (NATC 2008); a Comparative Qualitative Ecological Risk Assessment (QERA) to evaluate two primary management options for the historic tailings located within the Flat River floodplain (EBA 2009); and a report that summarized available water quality data for the Cantung Mine (which spanned from the 1980s to present) and compared results to limits established in the current Water Licence and CCME guidelines (EBA 2013b).

Additionally, the University of Saskatchewan carried out a multi-trophic level effects monitoring program on two tributaries of the Nahanni River, which included the Flat River downstream of the Cantung Mine and the Prairie Creek Mine (Spencer *et al.* 2008).

Discussion – Ongoing Permitting Issues

Findings from the various environmental monitoring programs, studies, and reports carried out to date have concluded that there is no evidence of adverse effects to water quality, fish, or aquatic life in the Flat River downstream of the mine (EBA 2013a). Some measurable differences in the Flat River ecosystem downstream of the mine are present, and these differences, in terms of invertebrate community indices and sediment chemistry can be attributed in part to past, discontinued practices.

Despite the increasing rigour and breadth of the various monitoring programs that have been carried out at the Cantung Mine over the years, the overall conclusions have remained fairly consistent in that no significant adverse effects to the receiving aquatic environment have been identified. All water quality parameters currently regulated under the Water Licence, with a few limited exceptions, are at or below CCME guidelines, and the EEM program continues to show benign results where aquatic organisms are concerned.

These encouraging results aside, regulatory expectations continue to increase for the Cantung Mine. Discussions with various agencies allude to future commitments to SSWQOs as part of the upcoming Water Licence renewal process even though downstream water quality remains unaffected. SSWQOs established for several new mines have, in some instances, been set below accepted CCME values, making for even more stringent levels than the accepted national guidelines. Similarly, although the Cantung EEM program continues to show negligible results to aquatic organisms, further studies continue to be required under the MMER.

Conclusion

There are multiple challenges associated with re-opening and operating historic mines in Canada including meeting increasingly more stringent environmental regulations and expectations, establishing backgroundwater quality concentrations when pre-mine water quality data is either non-existent or not sufficient, and working with historic data, should they exist. Further to these challenges, re-opening historic mines often involves assuming responsibility for environmental issues caused during past ownerships.

Experience at the Cantung Mine has shown an increase in the number and extent of environmental studies geared towards the characterization of effects to the aquatic environment, all of which have demonstrated that adverse effects are minimal to negligible. Determining with certainty whether any differences detected in the downstream receiving environment are attributable to legacy issues or current operations remains a challenge. Even with these results, regulatory expectations continue to increase.

Despite these challenges there are many benefits to re-opening a historical mine site when economically viable. Historical mines coming back into operation will contribute to both local and provincial/territorial economies while maintaining a smaller environmental footprint than opening a new mine. During current operations, mines will comply with the current environmental standards and at closure the mine will be reclaimed to a higher standard than it had been historically.

Acknowledgments

The authors thank North American Tungsten Corporation Ltd. for allowing the use of the Cantung Mine as a case study for this paper. They also acknowledge the International Mine Water Association for providing an opportunity to present on this topic.

References

Canadian Council of Ministers of the Environment. 2003. Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numercial Water Quality Objectives.

EBA Engineering Consultants Limited. 2002. Fish and benthos inventory for the Flat River at Tungsten, NT-Fall 2002. EBA Engineering Consultants Ltd., prepared for the North American Tungsten Corporation Ltd.

EBA Engineering Consultants Limited. 2009. Comparative Qualitative Ecological Risk Assessment for the Cantung Mine Site, NWT. Report prepared for North American Tungsten Corporation Ltd., March 2009.

EBA Engineering Consultants Limited. 2013a. Cantung Mine Metal Mining Effluent Regulations Third Interpretive Report for Environmental Effects Monitoring Studies. Report prepared for North American Tungsten Corporation Ltd., March 2013.

EBA Engineering Consultants Limited. 2013b. Historical Data and Interpretation Report of Water Quality at the Cantung Mine, NWT. Report prepared for North American Tungsten Corporation Ltd., Revised January 2013.

Environment Canada. 2012. Assessment of the Aquatic Effects of Mining in Canada. Environment Canada. Retrieved March 16, 2013, from www.ec.gc.ca/eseeeem/default.asp?lang=En&n=8AF5467D-1&offset=1&toc=hide

Fisheries and Oceans Canada. 2013. Metal Mining Effluent Regulations. Fisheries and Oceans Canada. Retrieved March 16, 2013, from www.dfo-mpo.gc.ca/index-eng.htm

NATC. 2008. 2008 Flat River Plume Survey, Results Summary Report. North American Tungsten Corporation. Watson Lake, NT.

Nordstrom, D. K. 2008. Questa Baseline and Pre-mining Ground-water Quality Investigation 25. Summary of Results and Baseline and Pre-mining Ground-water Geochemistry, Red River Valley, Taos County, New Mexico 2001–2005. US Geological Survey.

Sigma Resources Consultants Ltd. and John A. Jemmett Associates Ltd. (Sigma and Jemmett). 1978. The Effects of Heavy Metals and Sewage on the Biota of the Flat River, NWT. Report prepared for Canada Tungsten Mining Corporation Ltd., January 1978.

Spencer P., Bowman, M.F., and M.G. Dubé. 2008. A multitrophic approach to monitoring the effects of metal mining in otherwise pristine and ecologically sensitive river in Northern Canada. Integr. Environ. Assess. Manag. 4(3): 327–343.