Gibraltar Mine Water Management

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Group 9

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ABSTRACT

The purpose of this report is to evaluate the water management at the Gibraltar Mine, owned by Taseko Mines Ltd, and the public's reception of the water discharge increase to the Fraser River. The primary sources of information are the National Instrument 43-101 document and the Annual Environmental & Reclamation Report by Gibraltar Mine Ltd. Gibraltar Mine is the second largest copper mine in Canada; in its 22 years of operation, it has mined 140 million pounds of copper and 2.5 million pounds of molybdenum. The open pit copper-molybdenum mine was reopened in 2004 and has been undergoing a three-stage expansion since then, which is a 700-million-dollar investment.

The Gibraltar Mine has been operating with a positive water balance and as a result, was required to increase their water discharge to the Fraser River temporarily. The water discharge permit was increased from 3.04 million cubic metres in 2015 to 5.27 million cubic metres in 2016 and has gone back to standard discharge rates since. Gibraltar Mine has been making efforts to reduce water usage through their updated molybdenum circuit that recycles water and their clean water diversion.

The Gibraltar Mine is on the traditional and unceded territory of the Tsilhqot'in Nation. The Tsilhqot'in Nation has urged Taseko Mine Ltd (TML) to enter an Impact Benefit Agreement to share the benefits of the mining operation. At this point, TML has offered short-term agreements that have been deemed unacceptable. As a result, TML does not have Tsilhqot'in consent for the Gibraltar Mine.

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GLOSSARY

Comminution - reduction of solid materials from one average particle size to a smaller average particle size

Flotation – Process of separating minerals based on their affiliations with water

Meteoric Waters - Water whose source is precipitation

Reserves – minerals of value that are legally, economically, and technically feasible to extract

Resources – minerals that are potentially valuable, and for which reasonable prospects exist for eventual economic extraction

SAG Mill - semi-autogenous grinding mill

Supernatant - Denoting the liquid lying above a solid residue after crystallization, precipitation, or centrifugation

Surficial - Relating something to the earth's surface

LIST OF ABBREVIATIONS

COI – Committee of Interest

GML – Gibraltar Mine Limited

MAC – Mining Association of Canada

MLARD – Metal Leaching/Acid Rock Drainage

PAG – Potentially Acid-Generating

SAG – Semi-autogenous Grinding

TAC – Technical Advisory Committee

TML – Taseko Mines Limited

TSF – Tailings Storage Facility

TSM – Towards Sustainable Mining

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1.0 INTRODUCTION

The purpose of this report is to evaluate the mine water management at the Gibraltar Mine, owned by Taseko Mines Ltd, and the public's reception of the water discharge increase to the Fraser River. The report uses the National Instrument 43-101 document and the Annual Environmental & Reclamation Report by Gibraltar Mine Ltd. as its primary sources of information.

Gibraltar Mine is the second largest copper mine in Canada; in its 22 years of operation, it has mined 140 million pounds of copper and 2.5 million pounds of molybdenum. Since 2004, the open pit copper-molybdenum mine has been undergoing a three-stage expansion worth 700 million dollars.

The Gibraltar Mine has been granted a temporarily increased discharge permit. The water discharge permit was increased from 3.04 million cubic metres in 2015 to 5.27 million cubic metres in 2016 and has gone back to standard discharge rates since. Gibraltar Mine has been making efforts to reduce water usage through their updated molybdenum circuit that recycles water and their clean water diversion.

The Gibraltar Mine is on the traditional and unceded territory of the Tsilhqot'in Nation. The Tsilhqot'in Nation has urged Taseko Mine Ltd (TML) to enter an Impact Benefit Agreement to share the benefits of the mining operation. At this point, TML has offered short-term agreements that have been deemed unacceptable. As a result, TML does not have Tsilhqot'in consent for the Gibraltar Mine. The mine ownership history, the mine operations and mining methods, the water management, and the public relations are discussed in this report.

2.O GIBRALTAR MINE OWNERSHIP HISTORY

The copper deposit at the Gibraltar mine site was discovered in 1910. Focused exploration of the site and surrounding areas began in the 1960s. Development began in 1972 by Placer Development.

The operation of Gibraltar mine is closely tied to copper prices, as it has been shut down in response to falling copper prices twice in its operating life. Gibraltar operated under Placer Development from 1972 until 1993. In 1993 the price of copper dropped below 0.80$/lb, so operations were temporarily ceased causing a decrease in revenue for the mine. In 1994, as copper prices increased past $1.20 USD/lb Placer Development resumed operations at Gibraltar.

Mining operations were continued under Placer Development until 1996 when Placer sold Gibraltar to Westmin Resources. Westmin Resources, like Placer, had previously shut down mining operations in 1998 when copper prices dropped again below $0.80 USD/lb. Taseko Mines Ltd. subsequently bought Gibraltar Mine in 1999.

Taseko reopened the Gibraltar Mine site in 2004 when copper prices were at an all-time high of the decade at $1.30 USD/lb and operations at the mine have been ongoing since then, with a three-stage plan in place for expansion detailed in section 3.4. As seen in figure 1, at the lowest copper prices in 1994, 1998, the mine shut down and it wasn't until the copper prices were showing a general positive trend in 2003 that it was economically viable to reopen the mine.

Fig. 1. Copper prices over time.

3.0 GIBRALTAR MINE OVERVIEW

The Gibraltar mine is an open pit copper-molybdenum mine located approximately 60 km north of Williams Lake, in British Columbia, Canada. It has an area of 109 square kilometers, making it the second largest copper mine in Canada. Gibraltar first opened in 1972 under Placer Development but closed in 1998 due to low copper prices. In 2004, the mine reopened under Taseko. From 2006 to 2012, Taseko invested 700 million dollars in a three-stage expansion project to modernize operations and turn more of the resources into reserves. The first copper concentrate from this expansion was produced in March 2013.

3.1 GIBRALTAR MINE RESERVES AND RESOURCES

The Gibraltar copper-molybdenum mine is the second largest open pit copper mine in Canada and fourth largest in North America. With a workforce of 650 employees, Gibraltar has a high average annual copper production of 140 million pounds and 2.5 million pounds of molybdenum in its 22 years of operation (Life of Mine). Taseko's estimates on the reserves were completed by Scott Jones, PEng, Vice President, Engineering of Taseko. The estimates were done using the long-term metal prices of US$2.75/lb for copper and US$11.00/lb for molybdenum, and a foreign exchange rate of 0.85 C$/US$. The total proven and probable reserves and total measured and indicated resources are depicted in Table 1. Taseko plans on turning more of the resources into reserves.

Category	Size (Mtons)	Cu Grade (%)	Mo Grade (%)	Recoverable Metal Cu (B lbs)	Contained Metal Cu (B lbs)
Proven & Probable Reserves	688	0.26	0.008	3.1	3.6
Measured & Indicated Resources	1031	0.25	0.008	-	5.2

Table 1. Gibraltar Reserves and Resources as of December 31, 2016.

3.2 MINING METHODS AND MINERAL PROCESSING

Since the start of mining on site in 1973, the deposits have been developed using open pit mining methods. The pits at Gibraltar are mined in a phased manner that will allow support for mining until 2037. The current and future mining operations will continue to use open pit mining methods and equipment. The ore is mined using five electric blast hole drills, five electric rope shovels, one large front-end loader and twenty-six haul trucks of which four are 320 tons, thirteen are 240 tons, and five are 205 tons. The main mining fleet consists of track and rubber-tired dozers, motor graders as well as sand and water trucks.

The process diagram is shown below. The first stage of comminution is done through primary crushers where the ore is sized to 6 inches and then fed to the SAG mill. The final product from the SAG mill is less than 0.5 inches in diameter and fed to the ball mill. The product from the ball mill is smaller than 350 microns and is then fed to a rougher flotation that is processed and upgraded by a cleaner flotation. The copper and molybdenum are separated using differential flotation and then made into concentrates.

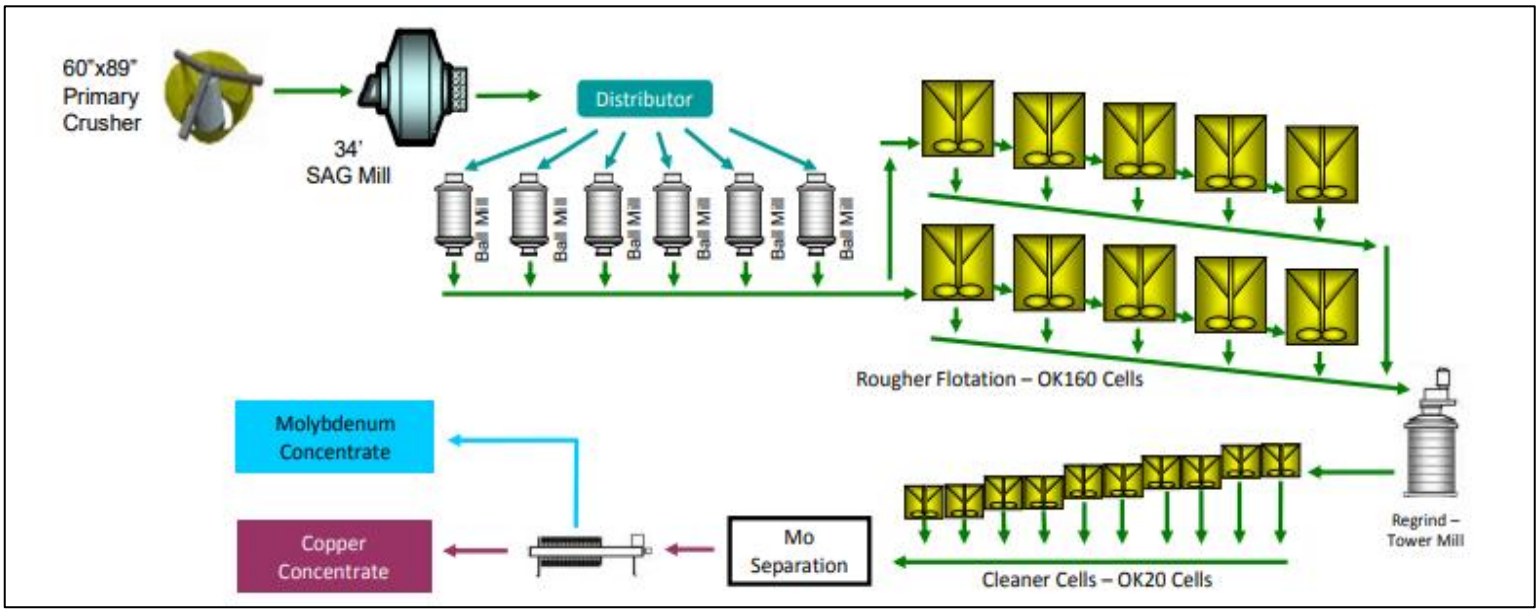

Figure 2. Flotation flow chart

3.4 CHANGES AFTER TASEKO

The operations were initially designed to process 36,000 tons of ore per day, producing approximately 60 million pounds of copper annually. After restarting operation in 2004, Taseko developed plans to increase the reserves and expand mining and processing. After approval from the Board of Directors, the first phase commenced in 2007 and the total capital investment was C$76 million and included the construction of a 34-foot semi-autogenous grinding mill (SAG mill). Taseko also converted the rod mills to ball mills for more efficient comminution and wholly replaced the flotation recovery system with 160 cubic meters of float cells. Once the first stage was completed in 2008, with the new equipment, the processing rate increased from 36,000 tons per day to 46,000 tons per day.

The SAG mill, from stage one of the expansion, has a maximum processing capacity of 55,000 tons per day. For the second stage of expansion, Taseko planned to increase the daily processing rate to this amount by increasing the maximum capacity in other circuits of the processing plant. The company commenced stage two in 2009 and invested in an in-pit crusher and a new conveyor system. There was also an upgraded tailings pumping system as well as a new coarse ore stockpile and SAG direct feed system. The upgrade to the fleet brought a sizeable 60-yard shovel and four new 320-ton haul trucks. The second stage was completed in 2011 and cost Taseko C$224 million.

The latest expansion was named the GDP3, and the project costs totaled at C$325 million. It involved the construction of another concentrator plant that increased the total daily processing rate by 30,000 tons per day. The expansion also brought a new molybdenum recovery facility which increased production of molybdenum by more than one million pounds per year. The expansion was completed in mid-2013 and increased the daily processing rate to 85,000 tons per day.

After the expansion stages were completed, the new total daily processing rate is 101,000 tonnes per day. Figure 2 summarizes the increase in regular processing after each stage.

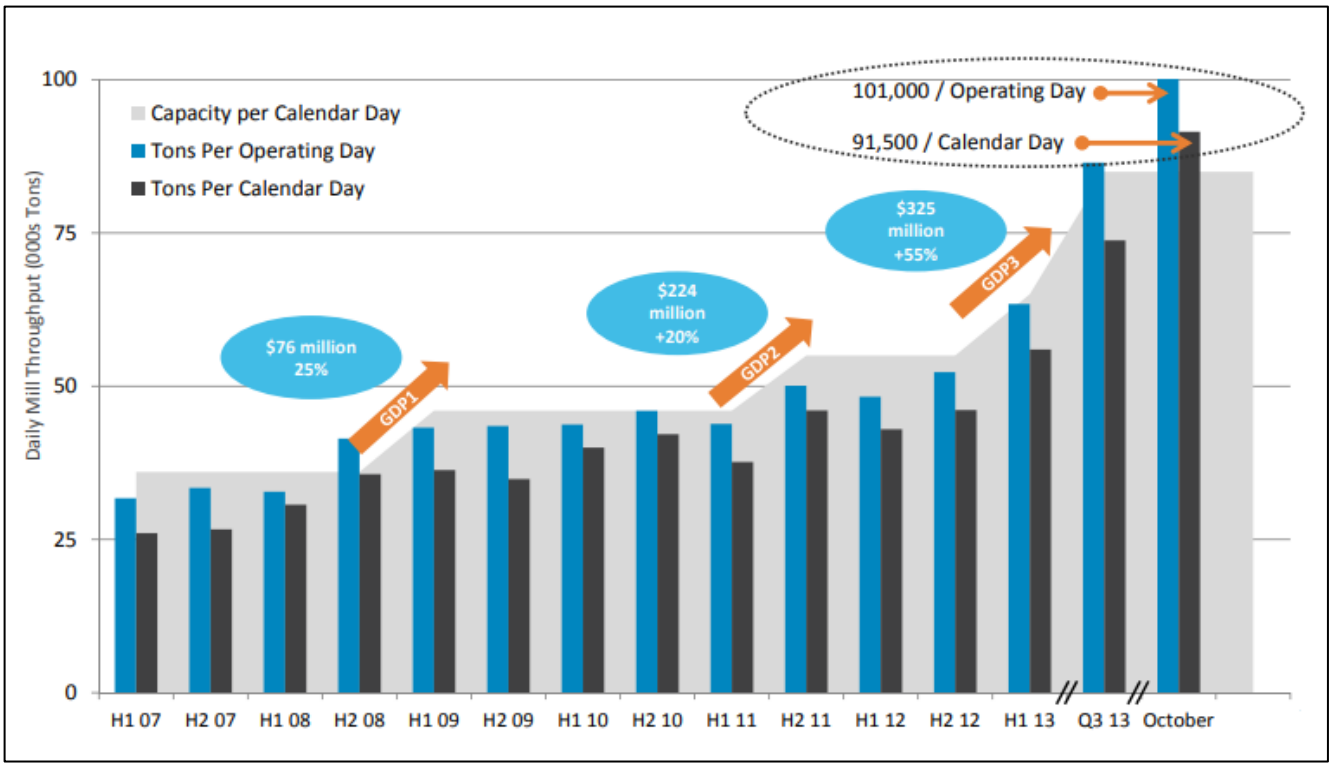

Figure 3. Daily processing rate after each expansion stage.

4.0 WATER MANAGEMENT

Gibraltar Mine has a surficial water management system. A surficial water management system is a system that routes, filters, and discharges water that is at the ground surface. The source of the water in this system is spring melt and precipitation. The main components of the surface collection system are surface drainage collection systems, clean water diversions, solvent extraction and electrowinning systems; tailings surface water and seepage drainage water collection ditches and ponds, Fraser River Discharge and Mill supply lines.

When precipitation falls onto the clean ground around the mine, it goes straight through the clean water diversion to the Fraser River. Water that has come into contact with ore, stock or waste piles goes to collection ponds, where solids settle. The bulk of the waste rock goes to the solvent extraction and electrowinning system which is composed of heap leach pads and process leach solution (PLS) ponds. Most of the stored water is from spring melt or precipitation and stored in the Tailings Storage Facility (TSF). There are two authorized discharge points from the TSF: the Fraser River (active) and the Arbuthnot Creek Wetland (inactive).

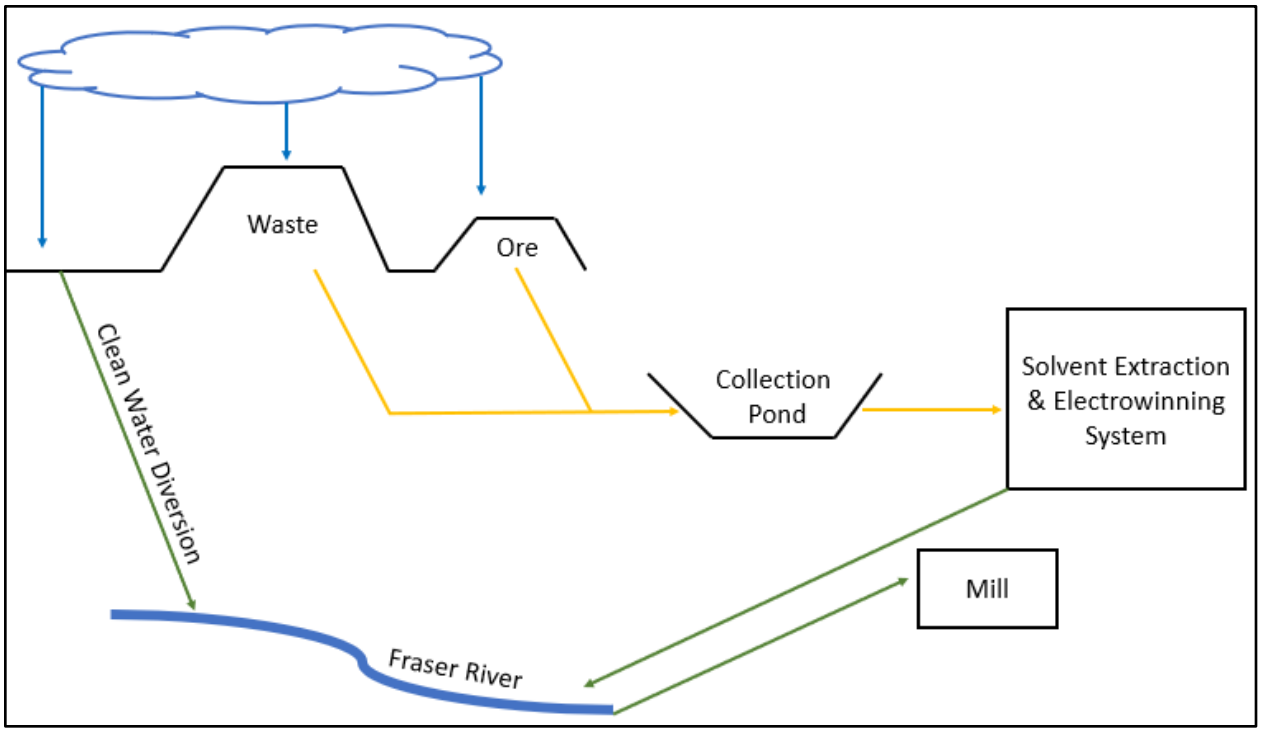

Fig 4. Diagram of water flow at Gibraltar Mine.

4.1 FRASER RIVER DISCHARGE

Tailings supernatant is approved for discharge to the Fraser River. The supernatant portion of the tailings storage facility is the upper layer that does not contain suspended solids (see figure 5). The main quality parameters that are tracked include dissolved sulphate, copper, and molybdenum. Copper and Molybdenum are toxic to the environment, and sulphate is monitored to indicate if there is any mine drainage or seepage waters. The discharge permit allows for a maximum limit of 0.03 mg/L of copper. Testing has shown that the median value for copper concentration in discharge was 0.002 mg/L in 2015.

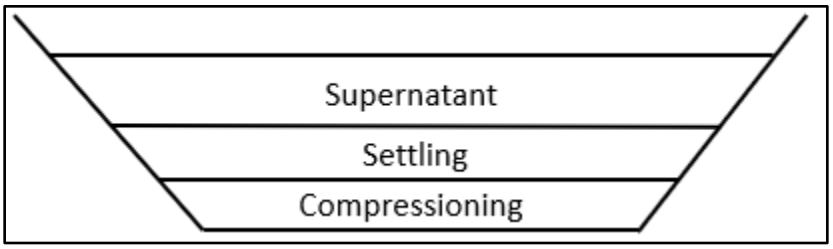

Figure 5. Diagram of settling layers in the TSF.

4.2 DISCHARGE RATES AND PIT WATER ELEVATION

In 2015, the mine received temporary authorization to increase the discharge rates to the Fraser River. The reasoning behind the increase in discharge was that there was excess water from when the mine operation was in care and maintenance and that, for there to be a safe amount of water stored, discharge needed to increase temporarily. The discharge to the Fraser River was 3.04 million cubic metres for 2015; the temporary increase in discharge allowed for 5.27 million cubic metres in 2016. In 2015, the Gibraltar East pit authorized storage limit was increased to 3200 ft from 3190 ft.

4.3 WATER TREATMENT

The permit TML has indicates that the open pit and rock dump drainage that is discharged to the TSF must have a pH higher than 6.5 pH units, which is significant as approximately 50% of ore and waste rock is considered potentially acid generating rock according to the 2016 MLARD report. The pH levels of the discharge to the TSF is measured six times per day. There is significantly less dissolved copper in the TSF now compared to pre-1990 levels, as seen in the graph below. The majority of the pit water will be stored in the Granite Pit once mining is completed in 2018.

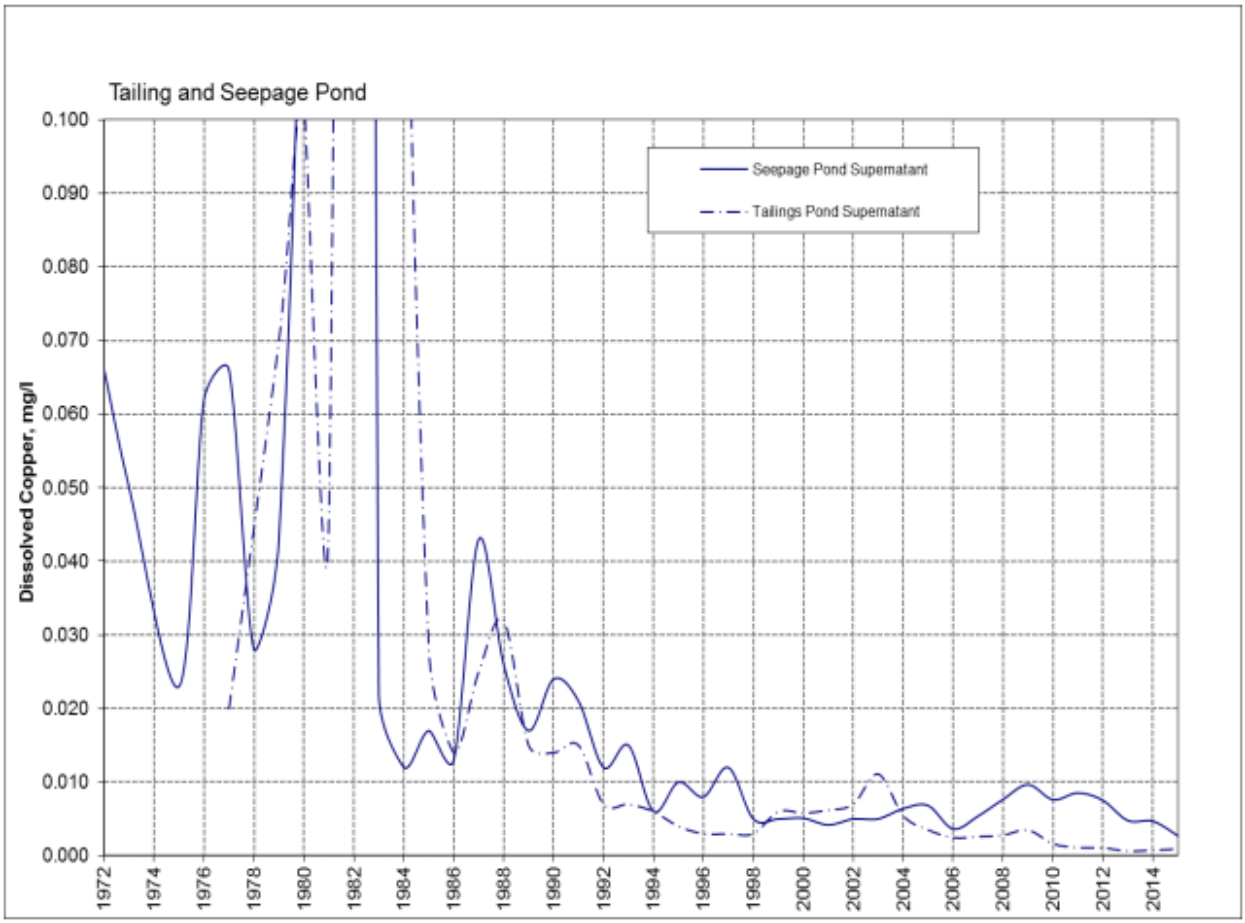

Fig 6. Dissolved Copper - TSF and Seepage Pond Supernatant.

4.4 WATER REDUCTION

Water usage at Gibraltar mine was reduced in three main ways: a modification to the molybdenum circuit, evaporators, and a clean water diversion. The modification to the molybdenum circuit was part of the newly expanded molybdenum recovery facility that opened in 2013. The new circuit recycles waste water back into the system, and some processes were modified to use less water. As a result, in 2008, Gibraltar stopped using water from the Fraser River for process water.

In 2011, two evaporators were purchased for the Gibraltar West pit to reduce water storage in the system; this meant that excess water would go into the atmosphere rather than being collected in the TSF. In 2015 a clean water diversion was installed to direct precipitation and spring melt through a series of settlement ponds directly to the forest floor, to percolate back into the watershed at a more natural rate.

4.5 RESEARCH INTO NEW PLANS AND WHY THAT'S NOT BEING PURSUED

Pilot Wetland Trial

In 2011, Gibraltar constructed a wetland to treat tailings and reclaim water passively. The wetland was composed of two parallel cells, designed for water depths of 20-60cm, and flow rates of 1-5L/min. The results of this trial found that the water was not meeting quality guidelines. More research is being done to change the parameters of the wetland to ensure that the water gets treated properly.

Conventional Lime Treatment

In 2013, Gibraltar assessed water treatment and discharge using traditional lime technology. This plan was ruled out as it posed challenges in getting government authorization and the high capital cost of the infrastructure. Lime (CaO) changes the pH of a solution and is frequently used in cylinder settling tests. Lime acts as a coagulant, as it neutralizes the particles, reducing the repelling forces, so the particles stick together and sink to the bottom of settlement ponds. A 2016 report by the Metal Leaching/Acid Rock Drainage Monitoring Program (MLARD) found that waste rock samples were 54% potentially acid-generating (PAG) and 46% non-PAG. Low grade ore samples were 46% PAG, 31% non-PAG and 23% was classified as uncertain.

4.6 MANAGEMENT COMMITTEE POLITICS

The Mining Association of Canada (MAC) has an initiative called "Towards Sustainable Mining" (TSM) that commits to responsible mining. Part of TSM is to engage with communities, drive world-leading environmental practices, and to be committed to the health and safety of employees and the surrounding communities. Gibraltar Mine Ltd is part of MAC and thus is required to be part of TSM.

The committee involved with creating requirements for the mine is the Technical Advisory Committee (TAC). This committee includes provincial and federal regulator representatives, First Nations bands, Community of Interest Advisory Panel (COI) and Gibraltar Mine Ltd (GML) staff. The COI is composed of 12-15 individuals from Aboriginal groups, the local community, environmental and social NGOs and labour and financial organizations.

5.0 FIRST NATIONS AND MINING AND GOVERNMENT

This section will aim to outline the relationship between TML and the local First Nation communities that are relevant to the Gibraltar mine. It will cover the history of the First Nations communities in the area focusing on the Tsilhqot'in wars, then the current First nation relations concerning the Gibraltar mine, and new developments that are occurring right now and where they might be heading towards in the future.

5.1 HISTORY OF FIRST NATIONS RELATIONS

The First Nations of BC has had a storied past filled with conflict. This conflict peaked when political opportunist, Alfred Waddington rallied politicians and businesspeople to invest in building a toll road to the interior Quesnel gold fields in the mid-1850's. The proposed road would cut straight through land that was held by the Tsilhqot'in (People of the River), and this created a hostile tension between the two. The first nations believed they were at war with the British and one night attacked a sleeping road crew and killed twelve members of the crew. This attack led to days of armed standoffs until the six Tsilhqot'in chiefs were offered an opportunity to negotiate peace with the British. Upon appearing to the peace talks, the six chiefs were arrested. They were then tried and hanged in 1864 for the murders of the twelve British road crew and the lands owned by the Tsilhqot'in were then claimed by the British. The public hanging of the six Tsilhqot'in chiefs caused a tension over land ownership in British Columbia that continues today.

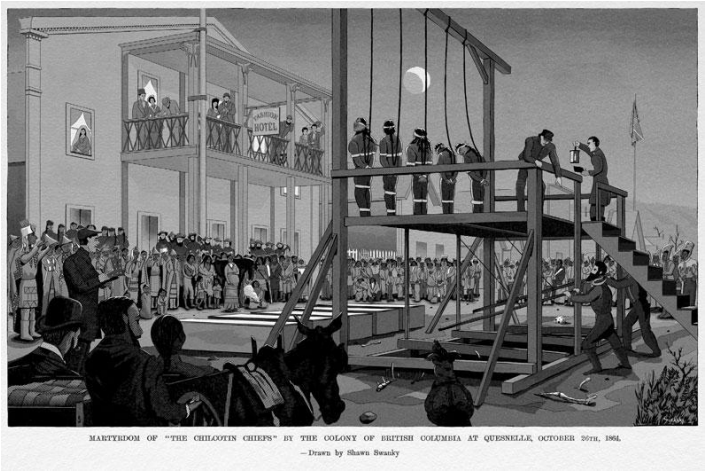

Figure 7. Depiction of public hanging (Chilcotin)

Recently, Prime minister Justin Trudeau offered an official exoneration for the six Tsilhqot'in chiefs hanged in 1864 on behalf of the Canadian government on March 27, 2018, easing the conflict that has existed between them for over a century.

5.2 CURRENT FIRST NATIONS RELATIONS WITH TASEKO

The conflict that started a century ago is still ever present in the new battle for mine development in this area. Taseko Mines Ltd. (TML) has owned the 44-year old Gibraltar since 1999. The Tsilhqot'in Nation, the closest Aboriginal community to Gibraltar Mine, has reserve lands almost directly adjoin the mine site.

For years, the Tsilhqot'in Nation has urged the management of TML to enter into a meaningful Impact Benefit Agreement, so there is a share in the benefits from the mining operation and not just the decades of negative impacts. To date, TML's management has offered only short-term agreements with terms that are seen as unacceptable by the Tsilhqot'in Nation. As a result, TML still does not have the consent of the Tsilhqot'in for the Gibraltar Mine or the other developing Taseko projects in the area; especially the Taseko New Prosperity Mine project.

The management of TML has been overall disrespectful and insensitive in matters involving the Tsilhqot'in Nation. Examples of this are seen through TML's attempts to get the Prosperity, and then New Prosperity projects permitted in the area, even after the project was denied by federal court twice. However, this area is of profound cultural and spiritual importance to the Tsilhqot'in Nation and are opposed to the further development of these projects without further negotiations. The Tsilhqot'in Nation has warned TML's management that the proposed area is too highly important to their people and the survival of their culture to allow Taseko's projects to proceed, yet this has in no way swayed the decision to try and get Gibraltar's expansion approved.

5.3 NEW DEVELOPMENTS REGARDING FIRST NATIONS AT GIBRALTAR MINE

Recently Taseko Mines application to increases discharge water into the Fraser River has caused the company to run into opposition from the Tsilhqot'in Nation, which has concerns the tailings increase will harm fish, including salmon and sturgeon. In response to this application, Tsilhqot'in Nation tribal chairman Joe Alphonse, the chief of the Tsilhqot'in said "We are not opposed to development, but it has to be responsible development," stating that Taseko's only interest it to make as much money in the cheapest possible way. Ultimately the battle for the land claim will continue to be fought between the developers and the First Nations of BC. Currently, Taseko is not doing anything to address these concerns brought forward and seems content with scraping by, regarding environmental regulations, to maximize profit.

6.0 CONCLUSION

Gibraltar Mine is the second largest copper mine in Canada; in its 22 years of operation, 140 million pounds of copper and 2.5 million pounds of molybdenum have been mined. The open pit copper-molybdenum mine was reopened in 2004 and has been undergoing a 700 million dollar three-stage expansion since.

In 2015 the Gibraltar Mine received a temporary increased discharge permit to account for their positive water balance and had gone back to normal discharge levels since 2016. The Tsilhqot'in Nation has urged Taseko Mine Ltd to enter an Impact Benefit Agreement to share the benefits of the mining operation, which has been denied by TML. As a result, TML does not have Tsilhqot'in consent for the Gibraltar Mine.

After analyzing the publicly available documents, and with the newest public reactions from Justin Trudeau's recent exoneration of the six Tsilhqot'in chiefs that were hanged, we deem that TML has not addressed the needs and concerns of the public. The mine water management plan has not changed, and no long-term solutions have been reached.

REFERENCES

By Teachers, For Teachers. (n.d.). Retrieved April 01, 2018, from https://www.mineralsed.ca/learning-resources/bc-mineral-resources-map/bc-operating-mine-profiles/gibraltar-mine/

Chart, H. (2018). *Historical Copper Prices and Price Chart. Infomine.* Retrieved March 25, 2018, from http://www.infomine.com/investment/metal-prices/copper/all/

Community of Interest Advisory Panel. (2015). Retrieved April 01, 2018, from http://mining.ca/towards-sustainable-mining/community-interest-advisory-panel

Fraser, J. (2015, May 05). Tuesday Morning news: Taseko, Roxgold, and Endeavour Mining. Retrieved April 01, 2018, from http://blog.ceo.ca/2015/05/05/tuesday-morning-news-taseko-roxgold-and-endeavour-mining/

Gibraltar Copper-Molybdenum Project. (2012). Retrieved April 01, 2018, from https://www.mining-technology.com/projects/gibraltar-copper/

Griffin, K. (2017, November 07). Environmental group resigns from advisory panel for Gibraltar Mine. Retrieved April 01, 2018, from http://vancouversun.com/news/local-news/environmental-group-resigns-from-advisory-group-for-gibraltar-mine

Jamasmie, C. (2016, August 10). Taseko may look into Gibraltar copper mine expansion after new claims acquisition. Retrieved April 01, 2018, from http://www.mining.com/taseko-may-look-into-gibraltar-copper-mine-expansion-after-new-claims-acquisition/

Kane, E. (2015, January 22). B.C. First Nation launches independent study of Gibraltar Mine expansion. Retrieved April 01, 2018, from http://www.timescolonist.com/b-c-first-nation-launches-independent-study-of-gibraltar-mine-expansion-1.1739529

Lamb-Yorski, M. (2017, November 15). Conservation society drops out of Gibraltar mine advisory committee. Retrieved April 01, 2018, from https://www.bclocalnews.com/news/conservation-society-drops-out-of-gibraltar-mine-advisory-committee/

Lavoie, J. (2017, November 20). Taseko's Contaminated Water Discharge into Fraser River Prompts Resignation of Community from Mine Group. Retrieved April 01, 2018, from https://www.desmog.ca/2017/11/20/taseko-s-contaminated-water-discharge-fraser-river-prompts-resignation-community-mine-group

Resource World. (2017, July 18). Wildfires suspend Gibraltar mining operations. Retrieved April 01, 2018, from http://resourceworld.com/index.php/wildfires-suspend-gibraltar-mining-operations/

Swanky, T. (2015, September 10). Exoneration of the Chilcotin Chiefs. Retrieved April 01, 2018, from http://www.shawnswanky.com/articles/canadas-war/exoneration-of-the-chilcotin-chiefs

Taseko Annual Report 2016 [PDF]. (2016). Vancouver, BC: Taseko Mines Ltd. Retrieved April 01, 2018, from, http://www.miningdataonline.com/reports/annual/TASEKO2016AR.pdf

Taseko Mines Ltd. (2013, December). *Taseko: Major Mining Projects Presentation* [PPT]. Vancouver: Taseko Mines Ltd. Retrieved 01 April, 2018, from https://www.tasekomines.com/assets/docs/presentations/TKO-Presentation-2013Dec.pdf

Taseko Mines Ltd. (2015, September). *Taseko: Major Mining Projects Presentation* [PPT]. Vancouver, BC: Taseko Mines Ltd. Retrieved April 01, 2018, from https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0ahUKEwjovard5qjaAhUCQKwKHfAABngQFghKMAQ&url=https%3A%2F%2Fwww.tasekomines.com%2Fassets%2Fdocs%2Fpresentations%2FTKO-Presentation-September_2015.pdf&usg=AOvVaw1_IYhZMi1oJbbv-Ht9y1P7

Tremblay, R., Pierce, B., & Jackson, J. (2016, March 31). *Gibraltar Mine Ltd.: Annual Environment and Reclamation Report for 2015* [PDF]. Vancouver, BC: Taseko Mines Ltd. Retrieve April 01, 2018, from https://mines.empr.gov.bc.ca/api/document/589aaa8e87567d001d187dd7/fetch

Tremblay, R., Pierce, B., & Jackson, J. (2017, March 31). *Taseko Gibraltar* [PDF]. Vancouver, BC: Taseko Mines Ltd. Retrieved April 01, 2018, from https://mines.empr.gov.bc.ca/api/document/5a454c7832e41c0019acadb1/fetch