ABSTRACT

It is over 100 years since the Britannia Mine, located 50 km north of Vancouver, B.C., commenced production of copper ore. Some 33 years after the mine closed it continues to generate an average of around 300 kg/day each of copper and zinc, together with relatively minor amounts of other metals, dissolved in some 5 million cubic metres of acid rock drainage (ARD) each year. Environmental remediation work by the Province of British Columbia was kickstarted in 2001 by the injection of $30 million by the former mine owners. Implementation of the environmental remediation work at the mine stimulated interest in development of the mine property by a B.C.-based developer and, through a well planned and considered approach, resulted in a ‘win-win’ for the both developer and the Province. This has led to an almost completely new infrastructure being developed in the Britannia Beach community, private home ownership, new development lots and the rejuvenation of the town. In addition, this renewed interest in the mine and associated community has contributed to the injection of Federal, Provincial and private funds into restoration of the iconic Mill at the BC Museum of Mining and for the future development of a mining industry interpretive centre.

SITE BACKGROUND

The Britannia Mine is located at Britannia Beach on the east shore of Howe Sound, approximately 45 km north of Vancouver. The main mining activity was some 5 to 7 km inland from Britannia Beach, with mineral processing activities taking place at Mount Sheer, around 5 km inland, and the Britannia Beach
town area on the coast, to the south of Britannia Creek. The mine site covers an extensive area, with mineral tenure associated with the mine extending over some 36.5 km² (approximately 9,000 acres). The mining took place underground and in open pits and glory holes (the ‘Jane Basin’ area).

The mine was operated from 1905 to 1963 by the Britannia Mining and Smelting Company Ltd. and from 1963 to 1974 by the Anaconda Mining Company. At its pre-World War II peak, the mine was the largest producer of copper in the British Empire.

Seven ore bodies were mined through a combination of open pit, glory hole and underground developments. Approximately 80 km of underground workings, numerous stopes and four open pits were developed to extract the ore. Since the mine ceased operations in 1974, surface water and groundwater continue to enter the mine workings. Drainage is routed through the underground workings, eventually discharging via a portal at the 4100 Level of the mine, some 60 m above sea level. Until the completion of the WTP and new outfall at the mine in 2005 as part of a program of environmental remediation works being implemented by the B.C. Ministry of Agriculture and Lands (MAL), the untreated acid rock drainage (ARD) was directed to a discharge pipe into Howe Sound at a depth of approximately 26 m below sea level.

ENVIRONMENTAL ISSUES AT THE MINE

The mine water discharge typically has a pH of around 3.5 to 4.5, with elevated concentrations of dissolved metals, in particular copper, zinc and cadmium. It is the adverse impact of these metals in the aquatic environment that is the primary environmental concern at the mine (Figure 2), around 5 million cubic metres of ARD draining through the mine annually. Prior to treating, an average of almost 300 kg/day each of copper and zinc discharged to Howe Sound. The second environmental issue at the mine is the presence of large quantities of mineralized rock (ore), waste rock, tailings, remnant concentrate and other process wastes found
at various locations around the mine property. The largest accumulation of these materials (with the exception of outcrops of ore and mine waste in the Jane Basin area) is in the southern portion of the alluvial fan of Britannia Creek, referred to as the ‘Fan Area’ (Figure 1). Other areas of note in this regard are the 2200 Level, 2700 Level and Victoria Camp areas, the latter located in the Furry Creek watershed. The primary transport pathways for contaminants found in soils is leaching, followed by surface water and groundwater flow. Prior to remediation, groundwater movement resulted in an average of 10kg/day of copper and 16 kg/day of zinc discharged daily from the site. Offshore of the mine in the deeper waters of Howe Sound, some 40 million tonnes of mine process waste (‘tailings’) were deposited during the operational life of the mine. The offshore sediments do not form part the Britannia Mine remediation Project being undertaken by MAL, however, Environment Canada (EC) has undertaken a program of investigation and evaluation of the nature and distribution of the nearshore sediments (Hagen et al., 2004) that indicated that the metal content of the tailings is relatively inert and is tightly bound by sulphides.

The discharge from the WTP is currently authorized under a permit issued by the B.C. Ministry of Environment (BCMoE) pursuant to the B.C. Environmental Management Act (EMA). The permit requires the discharge to meet specified concentration limits and to be non-acute toxic. The mine is also required to comply with the Provincial Contaminated Sites Regulation (CSR) under the EMA. BCMoE has responsibility to ensure that the remediation activities bring the mine into compliance with the requirements of the CSR. EC and the Department of Fisheries and Oceans (DFO) have responsibility to ensure that Federal requirements are met. The remediation work at the mine is also subject to the B.C. Mines Act, administered by the B.C. Ministry of Energy, Mines, and Petroleum Resources (BCMEMPR), which regulates mine reclamation effort, particularly regarding health and safety issues.

**FIRST, LET’S GO BACK...**

An excellent account of the context of the mine’s discovery, development, operation and life through to 1967 is provided in a book by Bruce Ramsey, *Britannia: The Story of a Mine*, and anyone wanting to scratch below the surface of the mine history will find the 2004 reprint at the BC Museum of Mining shop. Bruce Ramsey’s account, to 1967, is expanded on by long time resident Betty Shore’s epilogue, which touches on the years following the 1974 closure of the mine. As well as providing details of the mine operations through the years, it also contains many anecdotes, historic photographs and personal insights into the lives of those working at the mine and the conditions they experienced (Figure 3), including the great sense of community spirit and pride.
During the operational years of the mine, environmental issues were either not considered—as was contemporary industry practice and society’s expectations—or were only given cursory attention, usually only for acute human health reasons. By the 1950s, attitudes were changing, and by 1970, effluent pollution control laws were introduced in B.C. that were applicable to the situation at Britannia Mine. However, only minimal works were undertaken at the mine immediately post-closure, mainly comprising the construction of a deep water outfall for the untreated ARD discharge. In 1979, the mine property was sold to a real estate developer, Copper Beach Estates Ltd. (CBEL) and over time, it was recognized that the pollution control works were not being maintained and that there were substantial environmental issues attributable to the mine. Legal action against the property owner was considered by the Province, but due to a lack of definitive data showing environmental impact, the uncertainty of the necessary solution and associated costs, as well as concerns whether CBEL were able to fund remediation activities, Provincial and Federal government agencies focused on technical studies to better scope the environmental issues.

In the early 1990s, a Technical Advisory Committee (TAC) was formed to help coordinate Federal and Provincial efforts to remediate the mine, and the Province worked towards developing a full understanding of the mine ownership history (Azevedo and O’Hara, 2007). Following new B.C. environmental legislation introduced in the mid-1990s (the then B.C. Waste Management Act and the CSR) and with full knowledge of historical ownership, the Province pursued the former owners for funds to remediate the mine. This culminated in 2001 with the Province receiving a $30 million settlement from the former owners in exchange for environmental indemnification. In 2003, Macdonald Development Corporation (MDC) acquired and foreclosed on the mortgage on this land and an agreement between the Province and MDC was implemented that included clear ownership of the mine lands by the Province, additional funding towards the environmental remediation work from development activities and removal of the residential lands from the mine lands (and MEM jurisdiction) which enabled unfettered rejuvenation of the community and promoted its long-term sustainability.
THEN TO THE PRESENT

Province’s Remedial Concept

Figure 4 illustrates the remedial concept developed by the TAC, essentially comprising the reduction of influent water, use of the mine as a storage reservoir to regulate seasonal flows, direction of the mine water to a single discharge point to facilitate feeding this to a water treatment plant (WTP), before discharging to a new deep-water outfall. Also in this concept, contaminated soil “hot-spots” would be managed on-site, and contaminated groundwater and surface water would be intercepted and treated and/or discharged to the deep outfall in a controlled manner.

Since 2001, the Province has progressively implemented this remedial concept with the following major annual milestones:

- **2001**: 2200 Level Plug (installed by UBC-CERM3/CBEL), ensuring almost all ARD reported to the 4100 Level, and major technical study contracts awarded (mine geology/hydrology/hydrogeology, contaminated sites, water treatment feasibility and flood risk assessments).

- **2002**: Full-scale mine reservoir studies undertaken, proving the TAC’s concept of using the mine as a storage reservoir, with some 430,000m³ of dynamic storage identified.

- **2003**: Completion of major technical studies and the submission of the Mine Reclamation and Closure Plan to BCMoE, together with completing negotiations with a land developer, (MDC) to secure long-term site access for the Province and additional remediation funding.

- **2004**: Completion of preliminary surface water drainage works, long-term groundwater pumping tests and ‘hot-spot’ management, including permitting the Jane Basin open pit complex of the mine as a disposal site for contaminated soils and WTP waste products, together with procurement of the WTP design-build-finance-operate (DBFO) contractor and the construction of the WTP access road. In addition, an environmental effects baseline study was undertaken.

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**Figure 4: Province’s Remedial Concept (courtesy of MAL)**

- **(1)** Collecting all ARD
- **(2)** Treating the ARD
- **(3)** Controlling the discharge of contaminated groundwater
- **(4)** Reducing or preventing the formation of ARD by covering sulphide mineralization with soils and/or re-routing uncontaminated surface waters away from underground mine workings, and
- **(5)** Risk assessment/in-situ management is anticipated for contaminated sediments and soils at certain locations.
• **2005:** Construction of the Fan Area groundwater management system (GMS), the WTP (Figure 5), related infrastructure (including underground mine rehabilitation, deep-water outfall and micro-hydro system) and three surface water diversions (SWD’s) to reduce mine inflows. A long-term program of environmental effects monitoring (EEM) was implemented to assess the efficacy of the environmental improvements, this leading eventually to a Tier II risk assessment.

• **2006:** Improvements to the SWD’s, supplementary technical studies aimed at improving surface water drainages, together with several safety improvements, including capping two shafts in the Furry Creek watershed. Ongoing EEM.

• **2007:** Additional safety improvements completed, upgrades to the GMS and SWD’s underway, hot-spot removal from the 2200 Level waste dump and a Fan Area surface water drainage engineering feasibility study. Ongoing EEM.

...AND TO THE FUTURE

Much of the above, in particular details of the technical progress and environmental benefits of the remediation project, is described in various papers and presentations made at conferences and symposiums over the years (a few are noted in the References section) and in technical reports available for download at [www.britanniamine.ca](http://www.britanniamine.ca), but perhaps what has not been recounted is the effect that this work has had on the other ‘environment’, i.e., the social implications and spin-off benefits that were perhaps inconceivable when the remediation project commenced in 2001. At that time, CBEL owned the mine site as well as the Britannia Beach community lands, and with little funds for maintenance, the infrastructure – roads, bridges, power supply, water and sewage services - were all dilapidated and in need of significant investment. Over a hundred families occupying the community were on a month-by-month tenure and there was uncertainty over the...
future of the community and the intentions of CBEL. Further uncertainty resulted from conflicting claims on the private ownership of the mine in 2001/2002.

Changes to the Community

The agreement between the Province and MDC in 2003 enabled the immediate commencement of development in uncontaminated lands in and around Britannia Beach. MDC formed Britannia Bay Properties Ltd. (BBPL), dedicated to redevelopment of the existing and expanded residential areas of the Britannia Beach community. Components of the BBPL development plan, implemented and/or ongoing, include:

- Legal surveys to define existing (tenanted) lots, valuations and offering these for purchase to tenants at discounted prices – this leading to property improvements and re-development (Figure 5);
- Complete replacement and upgrade of the existing dilapidated infrastructure, including:
  - a groundwater well public water supply;
  - state-of-the-art potable water purification plant;
  - potable water reservoirs and delivery system;
  - new sewage lines, state-of-the-art sewage treatment plant and dedicated new deep water sanitary outfall;
  - upgrades to the existing road infrastructure, construction of new roads and bridges;
  - upgrades to the electricity supply system, including underground cabling, new power transformers and street lighting;
  - environmental improvements, e.g., removal of old fuel oil tanks and local soil remediation;
  - telephone and other utility upgrades;
  - landscaping;
- Partnership with the Province to share the cost of the WTP access road that would become the main feeder route to the re-vitalized community and newly-developed lots;
- Created 96 fully-serviced development lots on the newly-acquired lands adjacent to and east of the existing community;
- Landscaping, sympathetic restoration of historic mine/community buildings on BBPL property together with other aesthetic improvements and investments in the community.

Altogether a rather impressive turnaround for the community, summed up by a quote from BBPL:

We worked together with the existing residents to keep this rare and unique community intact. We were delighted, along with the community and the B.C. government, to be a part of the solution of the remediation and rejuvenation of this important piece of B.C. history. The community has an active and energized sense of pride in ownership and Britannia Beach is a case study in renewable communities. We continue to work with the community to make Britannia Beach a truly sustainable healthy home. Who are the winners? Please ask the residents of Britannia Beach.

The agreement also provided significant benefits to the Province in the way of mine ownership, access and environmental levies on sale of the new lots: to date $500,000 has been raised towards the environmental remediation from this funding source.
The next phase of development being contemplated by BBPL is creating commercial and employment opportunities within the community. There are significant challenges to optimize these opportunities however, including overcoming flood protection issues in the flood plain of Britannia Creek. The shoreline area at Britannia Beach, one of the few publicly accessible stretches of shoreline along Howe Sound, has long been isolated from the main body of the Britannia Beach community by Highway 99 and the CN rail line. The utility of this area is also currently marred by the presence of a dilapidated wharf – another legacy from the mining days – together with an unattractive rip-rap and shingle shoreline. BBPL, along with the BC Museum of Mining’s ‘Britannia Project’ (described below) also have a vision for this area: to turn it to productive recreational use and link it back into the community. Ideas include ‘greening’ the ‘concentrate wharf’ (foreground in Figure 1), removal of the dilapidated timber wharf structure, a new marina, installation of a rail spur and artisan workshops/concessions. As per BBPL’s past and present projects in the community, all these would involve stakeholder consultation and implementation plans sympathetic to the proud heritage of Britannia Beach. Achieving this goal will require significant ingenuity and continued close working relationships between BBPL, the BC Museum of Mining, the Province, regulatory agencies and other stakeholders to overcome many technical, permitting and funding issues – however, the track record to date demonstrates a willingness and ability by all parties to do this and provide a win-win outcome.

Implications for the BC Museum of Mining

The BC Museum of Mining opened in 1974 and occupies lands once owned by the former mineral processing operations at the mine immediately to the south of the Britannia Beach community (Figure 1), including the striking and historic #3 Mill building, or ‘concentrator’, constructed in 1922 and which forms the dominant structure within the community (Figure 6). The Museum is primarily funded through earned revenues from entrance fees and self generated business opportunities with additional operating funds derived from government grants and industry donations. Business opportunities include letting the facilities out to the movie industry from time to time, e.g., the ‘X-Files’ and ‘Scooby Doo 2’. Prior to the renewed interest in Britannia Beach resulting from the community infrastructure upgrades and remediation works outlined above, the Museum was struggling to attract partners and funding sources to help achieve their vision for the future. This vision included refurbishment of the dilapidated and unsafe concentrator building, improvements and upgrades to Museum infrastructure and displays, and the provision of on-site conference and other facilities to realize long-held tourism potential. The efforts were crippled by the risk involved to potential partners who saw the environmental problems as too all-encompassing.

It was clear that the Museum’s long-term problems were only solvable once the environmental issues at the mine were addressed and the risks reduced to acceptable levels for partners to invest and contribute with confidence.

There are several positive outcomes from the successful environmental remediation for the BC Museum of Mining. The state of the environment (past and future) and the mining industry’s role and impact on the environment is an important message for the Museum to deliver as part of its mission as a communicator and educator for the general public. The public has an appetite for information and
engagement on the subject of mining and the environment, and the Museum is well positioned to be the primary service provider for this locally and regionally. The Museum is also able to lead involvement with other local initiatives such as Capilano College's intent to create an institute that will make Britannia Beach and Squamish a learning destination for tourists.

The story of Britannia Mine’s environmental clean-up is compelling, and likely even more so because of the rehabilitated Museum’s icon building, the once dilapidated Mill (Figure 7). For years the ‘environmental’ problem was perceived as the Mill building, not the invisible water pollution from the mine workings. The building’s past state, often called ‘an eyesore’ was the most often chosen symbol to illustrate the poor state of the environment and the unattractive legacy of the mining industry in general. Had the Museum been unable to secure the interest of government and industry to address the building’s physical needs concurrently with the environmental remediation work, the good news of the environmental remediation itself would certainly have been harder to communicate to the general public. The Museum is now able to use its most prominent artifact to communicate messages of both community transformation and response to environmental matters across time.

The BC Museum of Mining’s vision, referred to as The Britannia Project, is more than the preservation of historical buildings: the project is comprised of seven core visitor attractions that will over time be implemented. These include:

- **Visitors Centre at Copper Square** – *a welcoming place* – an exciting arrival point featuring gift shops, facilities, orientation maps and comfortable seating. The Visitors Centre will become the introduction to the Britannia Project, offering a taste of the exhilarating journey of discovery to come.
• **Enhanced Mill Building Experience**  
  *Innovation and sustainability* will be showcased as well as a brilliant multimedia presentation of Britannia’s rich history (Figure 8). Twenty stories up the Concentrator, accessed via an articulated rail system, dynamic historical exhibits will be displayed against the majestic backdrop of Howe Sound in an enhanced BC Museum of Mining and Discovery Centre and the departure point for an Underground Train Ride – an incredible journey through the historical sights, sounds and sensations of the earth underground.

• **Earth Garden** – *designing with nature*  
  a dramatic series of hillside earth gardens, waterfalls and waterways demonstrate the Earth’s power of regeneration.

• **Main Street** – *blending market-style commerce with old mining town flair* – featuring all the amenities and ambience of an authentic historical mining town combined with the attractions of a contemporary commercial district. It will appeal to all ages with exciting places to visit, shop, eat and be entertained.

• **Outdoor Adventures** – *exploring Britannia’s backcountry* – with a variety of outdoor experiences to offer, from nature hikes to rock climbing, Britannia will be a hub for a thriving eco-tourism industry.

• **Waterfront** – *revitalizing Britannia’s Waterfront* – the restored Waterfront and wharf will be the access point for boats, ferries and trains at the adjacent train station. Offering specialty shops, amenities and First Nations’ heritage tours, the Waterfront will become alive with activity.

*The Britannia Project* is a celebration of the importance of natural resources to Canada’s history and the future role minerals will play in meeting the demands of society whilst minimizing environmental impact.

**CLOSURE**

The successful implementation of the environmental remediation works at Britannia Mine have provided significant improvement to the environment and catalysed the rejuvenation of both the Britannia Beach community and the BC Museum of Mining. For the first time in many decades the future is very bright for Britannia: recent upgrades to Highway 99, funding from the Federal government towards *The Britannia Project*, further plans by BBPL for infrastructure, local employment and aesthetic improvements, the 2010 Olympics and rising property values in the Sea-to-Sky corridor, all bode well.
This is the real legacy of Britannia Mine—a success story going back to the past and using ingenuity and vision to leverage the future for the benefit of the environment, residents and visitors to Britannia Beach. A long journey—over 100 years—sometimes a struggle, sometimes seemingly hopeless, but now a heritage to be proud of and a positive story to tell the world for the future.

REFERENCES


Ministry of Agriculture and Lands Britannia Mine website: www.britanniamine.ca