Closure Activities – Progress over the last 10 years, Britannia Mine

BC MEND ML/ARD Workshop
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Golder was contracted by the Crown Contaminated Sites Program of the Government of British Columbia, Ministry of Forests, Lands, Natural Resource Operations and Rural Development, for this work.
Presentation Overview

Mine history 01

Remediation/Risk Assessment 02

Operation & Maintenance Challenges 03
Britannia Mine - History

- Mine operated from 1904 to 1974
- Largest producing copper mine in Canada in the 1920s
- Closed in 1974 after owners ordered to collect/treat ARD discharge
  - Mining methods: open pit, gloryhole, open stoping
  - Length of underground workings: >80km
Britannia Mine

REMEDIATION APPROACH

• Phase 1 (2001 to 2009)
  • Identify and address high priority issues
  • Reduce loadings to Howe Sound
  • Investigate/monitor lower priority issues

• Phase 2 (2010 to current)
  -addressed the lower priority issues from original phase
  -used a risk based approach to achieve closure
  -includes site safety and operation & maintenance
Britannia Mine Study Areas

Britannia Creek Watershed

Furry Creek Watershed

Britannia Fan Area
Furry Creek

SITE LOCATION
Furry Creek

**BETA PORTAL REMEDIATION**

Prior to 2005

Beta Portal

Beta Portal

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**Graph:**

- **Title:** Total copper (ug/L)
- **X-axis:** Reference Points
- **Y-axis:** Copper Concentration (ug/L)
- **Data Points:**
  - **Current (2011)**
  - **Historic (2001-2006)**
- **Legend:**
  - **Bar:** Grey
  - **Circle:** Black

**Locations:**

- **Cvigna Creek**
- **Fairview**
- **Empress Creek**
- **Portal Creek**
- **Hydro Station**
- **Mouth of Creek**
Furry Creek

BETA PORTAL REMEDIATION REMEDIATION OPTIONS ANALYSIS

• Evaluated several options involving = Re-injection into the mine and treatment at the water treatment plant
Furry Creek

BETA PORTAL REMEDIATION REMEDIAL OPTIONS ANALYSIS

- Preferred Option - Re-injection into the Glory Holes (GH)
- Construction completed in 2016
Furry Creek

BETA PORTAL POST-REMEDIGATION MONITORING

Total Copper Concentration (µg/L)

- 2015 (dry season)
- 2017 (dry season)
- Jun-2018 (wet season)
- Sept-2018 (dry season)

Portal Creek

Graph showing monitoring data for Furry Creek.
Britannia Creek

INVESTIGATION AND RISK ASSESSMENT

- Initiated similar approach at Britannia Creek as Furry Creek
- Investigation complete
- Detailed risk assessment underway
1) 2200 L Portal
2) Jane Creek
3) 2200 L Waste Rock Pile
4) Copper Plant Residue Area

Main sources of copper loadings from 2200 Level

Britannia Creek
Britannia Creek
2200 LEVEL PORTAL

• Identified as a primary source of loading of Cu loading to Howe Sound during earlier remedial phase
• Plug installed in 2001
Britannia Creek

POST 2200 LEVEL PLUG

Britannia Creek d/s Jane Creek

Copper Concentration (ug/L)

Dissolved Copper in Groundwater (mg/L)

T Cu
D Cu

2002 2006 2016
Britannia Creek

Britannia Creek Loadings Assessment

• 2200 L is still primary source of copper loading to Britannia Creek
1) 2200 L Portal
2) Jane Creek
3) 2200 L Waste Rock Pile
4) Copper Plant Residue Area

Main sources of copper loadings from 2200 Level

Britannia Creek
**Britannia Creek**

**DETAILED RISK ASSESSMENT**

- Surface water and sediment chemistry
- Periphyton
- Benthic invertebrates
- Fish presence
- Tissue chemistry

**Copper in Britannia Creek**

![Copper in Britannia Creek graph]

- Ref Sites
- Britannia Creek (up to down stream)

**Benthic Community Abundance**

![Benthic Community Abundance graph]
Fan Area

STORMWATER MANAGEMENT

• Stormwater monitoring completed
• Loadings understood
• Copper launders removed
• Engineering underway
Operation and Maintenance Challenges

Scaling of the Groundwater Management System (GMS) Forcemain

On-site sludge disposal
Scaling of the GMS Forcemain

**GROUNDWATER MANAGEMENT SYSTEM (GMS)**

- Objective: Capture most highly contaminated groundwater in Fan Area
- Pumped up to treatment plant
- Operational since 2005
Scaling of the GMS Forcemain

THE PROBLEM

Iron scale formation restricting flow of groundwater to treatment plant
Scaling of the GMS Forcemain

THE APPROACH

• Options analysis
• Bench scale testing
• Preferred option selected: Injection of 37% HCl
• Through ITT process, work awarded to Quantum Murray
Scaling of the GMS Forcemain

CLEANING PROCESS

- Total process took 8 months
- Cleaning stage took 5 weeks

Results of daily assays for iron during cleaning stage
Scaling of the GMS Forcemain

CAMERA INSPECTIONS AND FLUSHING – POST CLEANING

Charge flushing

Residual Scale Concretions
Scaling of the GMS Forcemain

POST CLEANING

Initial condition

Final condition
Jane Basin Disposal Facility

EVALUATION OF OPTIONS FOR FUTURE SLUDGE DISPOSAL

• Province holds permit to dispose of sludge from WTP on-site in Jane Basin

• Needed to revise permit to add a few other waste streams from other remedial activity at the Site

• As part of this looked at:
  • Remaining capacity
  • Future options
Jane Basin Disposal Facility

CURRENT DISPOSAL FACILITY
Jane Basin Disposal Facility

**CAPACITY**

![Graph showing remaining volume in East Bluff GH (m$^3$) from 2015 to 2050]
Jane Basin Disposal Facility

EVALUATION OF ALTERNATIVE OPTIONS
Jane Basin Disposal Facility

**NEXT STEPS**

- Short term and long term recommendations identified
- Work will be on-going

Fairview Area – Looking Southeast
Questions?