Sullivan Mine: Water Collection Closure Plan vs. 10 yrs Post-Closure experience
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Description of Site Reclamation and Seepage Collection Systems

Post Closure Projections and Current Experience:
- Underground Mine filling, dewatering flows, water quality and metal loading
- Mine Area Seepage flows, water quality and metal loading
- Tailings Area Seepage flows, water quality and metal loading

Summary of Results
Sullivan Mine Location
Mine and Mill areas

Lead, Zinc and Silver

Operated 1909 – 2001
Primarily underground, some open pit
150 million tonnes ore

Production (tonnes):
Concentrate: 25.8 million
Waste rock: 9.8 million
Tailings: 122 million

Total area of disturbance:
1100 ha
Environmental Concerns: Acid Rock Drainage (ARD)

Sulphide oxidation:
   Pyrrhotite and pyrite
Principal Ore:
   • Galena and sphalerite

ARD impacts to surface water and groundwater:
   • mine workings;
   • waste dumps;

Historic Photo of North and South Waste Dumps adjacent to Mark Creek

Historic Photo of No. 1 Shaft Waste Dump
Environmental Concerns: Acid Rock Drainage (ARD)

Sulphide oxidation:
- Pyrrhotite and pyrite

Principal Ore:
- Galena and sphalerite

ARD impacts to surface water and groundwater:
- mine workings;
- waste dumps; and
- tailings impoundments

Historic Photo of Tailings produced by Concentrator
Revised Decommissioning and Closure Plan 2000

Main Objectives:

- Wildlife habitat
- ARD collection and treatment for *perpetuity*

Reclamation progressive from 1990 to 2010
Review Reclamation Plan: Mine Site

- **Source Control:**
  - Rock from the Open Pit Waste Dump was placed in the Open Pit.
  - Waste dumps were capped with till and re-vegetated with grasses and legumes.

- **Seepage collection:**
  - Underground Mine reservoir
  - No.1 Shaft Waste Dump groundwater collection
  - Sullivan Creek surface and groundwater collection
  - Lower Mine Yard groundwater interception wells
Mark Creek: Before and After

North and South Waste dumps adjacent to Mark Creek Valley

Reclaimed Mark Creek Valley
Source Control – Mill Area
- Engineered cover systems placed on waste impoundments
- Re-vegetated with grasses and legumes.

Seepage Collection
- Groundwater interception ditches keyed into bedrock/till surface
- Shallow seeps and runoff collected in ditches
- Water collected from all collection systems is stored in the ARD Pond, and treated in Teck’s Drainage Water Treatment Plant (DWTP)
Tailings Reclamation – Before and After
DWTP built in 1979

- high density sludge process
- operates in the spring (~ 12 weeks) and fall (2 ½ weeks)
- Dewater the u/g mine reservoir and ARD Pond in the spring
- Completely empty the ARD Pond in the fall
Post Closure Projections

U/G Mine filling projections

- Estimated void space between mine elevations from bottom of mine 2450 ft and max. operating elevation 3650 ft (initial filling)
- Operating range of reservoir is from 3550 ft and 3650 ft with a capacity of 625,000 m³
- Allowance of a 50 ft contingency freeboard
U/G Mine filling projections

Water introduced into the mine 2 ways:
1. Surface infiltration from subsidence area
2. Groundwater inflow

Infiltration rate 1.4M m³/yr assuming average precipitation

Subsidence area
Mine Filling Graph

Sullivan Mine Water Level

- Predicated
- Actual

Elevation (feet)

Jun-02 to Dec-08
### U/G Mine Dewatering in subsequent years

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume m³/yr</th>
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<tbody>
<tr>
<td>2011</td>
<td>667,377</td>
</tr>
<tr>
<td>2010</td>
<td>382,312</td>
</tr>
<tr>
<td>2009</td>
<td>588,713</td>
</tr>
<tr>
<td>2008</td>
<td>627,926</td>
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<tr>
<td>Projected</td>
<td>1,400,000</td>
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</tbody>
</table>

Original prediction – dewater spring and fall  
Actual volume – dewater spring only
Underground Mine Water Quality

<table>
<thead>
<tr>
<th>Compound</th>
<th>Predicted</th>
<th>Initial</th>
<th>2011 end</th>
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</thead>
<tbody>
<tr>
<td>Zn mg/l</td>
<td>130</td>
<td>138</td>
<td>24</td>
</tr>
<tr>
<td>Fe mg/l</td>
<td>629</td>
<td>1,150</td>
<td>366</td>
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<tr>
<td>SO4 mg/l</td>
<td>11,115</td>
<td>9,030</td>
<td>5,730</td>
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</tbody>
</table>

Initial water worse than predicted except for SO4
With pumping water quality is better than predicted
Mine Area seepage collection –
- No. 1 Shaft waste dump
- Sullivan Creek
- Aquifer pumps in Lower Mine Yard

Predicted volume 940,000 m$^3$/yr
Mine Area seepage collection –
- No. 1 Waste Dump
- Sullivan Creek
- Aquifer pumps in LMY

Predicted volume 940,000 m³/yr

Actual volume currently
~600,000 m³/yr

Volume: down immediately upon closure and decreased as reclamation progressed
Mine Area Seepage Collection

No. 1 Shaft Waste Dump

- Metal concentrations: increasing especially Zn with decreasing volume
- Metal Loading: generally decreasing except when there is a flushing event
Lower Mine Yard

- Volume increased with additional aquifer pumps which has reduced impacts on Mark Cr. by 100 times since 1992
- Groundwater metal concentrations: increasing Fe and decreasing Zn from South Dump.
Tailings Area Seepage Collection

Predicted volume 340,000 m³/yr avg. precipitation
Actual volume average 500,000 m³/yr last 4 years
Tailings Area Water Quality

Tailings Seepage Water

Dissolved Metals mg/L

Fe
Zn
S

31/12/2001 31/12/2002 31/12/2003 31/12/2004 31/12/2005 31/12/2006 31/12/2007 31/12/2008 31/12/2009 31/12/2010

Teck
Summary

Predictions and Actuals

- Closure 2001
- Post reclamation conditions since 2007 (3 years of vegetation growth)
- Volumes are approx. 60% less than predicted (primarily u/g)
- Water quality better than predicted, the lime consumption is much lower than predicted

<table>
<thead>
<tr>
<th>Projected Flow (m³/yr)</th>
<th>Actual (m³/yr)</th>
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</thead>
<tbody>
<tr>
<td>U/G</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Mine</td>
<td>940,000</td>
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<tr>
<td>Tailings</td>
<td>360,000</td>
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<tr>
<td>Total</td>
<td>2,700,000</td>
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<table>
<thead>
<tr>
<th>Lime consumption</th>
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</thead>
<tbody>
<tr>
<td>Projected</td>
</tr>
<tr>
<td>Average (2008 – 2011)</td>
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</table>
Summary

Volume trends

- Mine area seepage decrease since reclamation of No. 1 Waste Dump

- Tailings area seepage slightly lower than pre reclamation, too early to see a significant difference

- Total seepage volume no significant trend
Summary

Metal loading

• U/G - Significant decreasing trend, expect to level off

• Mine area seepage – decreasing trend primarily due to reclamation of No. 1 Waste Dump

• Tailings area seepage – no significant trend

• Total loading – no trend at this point
Elk on Reclaimed Pond