Mine Tailings Water Treatment

September 11\textsuperscript{st}, 2018

Wayne Ingham, Ph.D.
BluMetric Environmental Inc.
Overview

TUNDRA MINE CHALLENGE
• Logistics and Schedule

DESIGN REQUIREMENTS
• Logistical Constraints
• Treatment Requirements
• Construction Requirements
• Analytical Requirements
Tundra Mine
Tailings Water Treatment
Tundra Mine
Tailings Water Treatment
Tundra Mine Challenge

- Very short timeframe
- Remote location
- No roads
- High quality of treatment required
- Large volume to be treated
- Need to train for staffing
- Must disassemble and remove
2009 Pilot - Timeframe

- Bid in mid-May
- Award on June 15th
- Equipment to Yellowknife on July 6th
- Onsite by July 12th
- Construction complete and ready to discharge July 19th
- First discharge on July 29th
- Reached design volume of 120,000 m³ Sept 7th
- Ceased treating Sept 24th at 180,000 m³
Traditional Set-up
Transport Constraints
The Design Needs

- Air access
- Small components
- Rapid delivery
- Ease of construction
- Building block design
- Treat 24/7
- Direct discharge
Variables

• Flow Volumes
• Concentrations
• New Contaminants of Concern
• Extremely High TSS
  – Low tailings pond
  – Weather
Configurable Treatment Trains

- Flexibility in treatment train configuration
- Series for double pass and pH manipulation
- Parallel when appropriate and able to achieve higher flows
Chemical Treatment Process

- Precipitating arsenic from solution
- Chemical reaction with ferric sulphate (ferric) and lime
- Minimum ratio of iron to arsenic (by weight) of 5:1
- Arsenic, zinc and other heavy metals are precipitated as metal hydroxide and adsorb to create flocs.
- Polishing treatment of zinc and lead
- Degraded influent quality
- Injection of a SMB to precipitate metal sulphides
- Solids separated by dewatering using Geotubes®
- Discharge to the environment
Plant Design and Layout
Treatment Quality

ARSENIC LEVELS

• Influent levels around 3 ppm
• Required a maximum of .5 ppm
• Finite chemicals on site
• Positive capture of the contaminant
• Require immediate and direct discharge
# Discharge & Contract Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Effluent Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contract Specifications: Maximum Daily Average Concentration</td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total arsenic</td>
<td>mg/L</td>
<td>0.20</td>
</tr>
<tr>
<td>Total copper</td>
<td>mg/L</td>
<td>0.01</td>
</tr>
<tr>
<td>Total lead</td>
<td>mg/L</td>
<td>0.01</td>
</tr>
<tr>
<td>Total nickel</td>
<td>mg/L</td>
<td>0.05</td>
</tr>
<tr>
<td>Total zinc</td>
<td>mg/L</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Anions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrate (as N)</td>
<td>mg/L</td>
<td>5.00</td>
</tr>
<tr>
<td>Nitrite (as N)</td>
<td>mg/L</td>
<td>0.40</td>
</tr>
<tr>
<td><strong>Conventional Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total ammonia nitrogen</td>
<td>mg/L</td>
<td>5.00</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>mg/L</td>
<td>15.0</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>6 - 9</td>
</tr>
</tbody>
</table>
Structural Components
Assembled Plant
Solids

• Hyroxide precipitation design to trap arsenic in a metal flock
• Must capture the flock for treatment to be effective
• Had to do that in positive and immediate way
• Must be able to handle new design flows of 150 m³/hr from 60 m³/hr
• Had to operate 24/7 with minimum attention
Onsite Laboratory

- AA – allowing for low level zinc and arsenic detection
- Allowed much greater control of the treatment process and real time adaptation to changes to influent chemistry
- Ensured plant maintained discharge compliance at all times
Onsite Laboratory
Results

Arsenic and TSS Field Sample Test Results

Arsenic Dissolved
- Orange squares: Total Suspended Solids

Date
- 16/07/2009 to 14/10/2009
Results

Daily Flow Rates

Flow Rate (m$^3$/hour)

Date

Train 1
Train 2
Results

pH Measurement During Water Treatment

Date

pH
7 7.5 8 8.5 9 9.5

Legend:
- **Feed**
- **End of Plant**
- **Discharge Tank**
Final Benefits

- 180,000 m$^3$ of tailings water treated to an average of 0.08 ppm arsenic
- Over 58 days w/ average operation time 23 hr/d
- Average solids in discharge of 5 ppm
- Water levels reduced by 0.4 meters below requirement
- Lower pond final level 7.65
- Local community members trained as operators
- Over 80% of project was aboriginal labour
- Completed on time spec and on budget
Treatment Progress

- 2009 Dual Train Pilot: 180,000m$^3$
- 2010 Dual Train: 250,000m$^3$
- 2011 Triple Train: 300,000m$^3$
- 2012 Dual Train (Not onsite): 350,000m$^3$
- 2013-2016 Dual Train: 100,000m$^3$–200,000m$^3$
- 2017 Dual Train (New): 60,000m$^3$
- 2018 (No Treatment Required)
- Total: ~1.8 million m$^3$
Overview
Operating Challenges
Long Term Monitoring
Remote Monitoring
Thank You
Thank You
Thank You
Thank You

QUESTIONS WELCOME