Mine Water Treatment Strategies at Resolution Copper Mining and the Eagle Project

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OVERVIEW

- Project Introductions
- Regulations that govern project design
- Water Treatment Design
- Water Management
Resolution Copper Project Overview

- Near Superior, Arizona
- Adjacent to the Magma Mine (1911-1996)
- Rio Tinto and BHP partnership
- 3rd largest undeveloped Cu resource in world
- 1.62 billion tonnes @ 1.47% Cu
- >$5 billion investment
- 40-year mine life
- Located in the Historic Pioneer Mining District
Resolution Copper Water Treatment

• Required for dewatering old Magma Mine workings adjacent to new work areas
  – Safety of shaft sinking-exploration activities

• Historic Treatment (pre -1996)
  – Onsite ponds
  – AZPDES requirement only

• Present Day
  – Over 2.5 billion gallons to dewater (2008)
  – New HDS treatment process: Lime (pH) and Soda Ash (prevent scaling)
  – AZPDES and Aquifer Protection Permits (APP) for discharges and solids storage ponds
  – Treats to Aquifer Quality Limits and surface water standards

  – Reverse Osmosis required for gypsum removal if discharging to nearby creek
  – Looked for alternative, beneficial use of water
Water Treatment Objectives

- Dewater existing underground copper mine
- Beneficially use the treated water in a cooperative effort
• **Goal**: remove water from existing copper mine (2009)
Project Cooperators

- **Resolution Copper Mining, LLC (RCM)**
  - Supply water and support sampling efforts

- **New Magma Irrigation and Drainage District (NMID)**
  - Facilitate land access and communicate with RCM
  - 6 cooperating growers

- **University of Arizona (UA)**
  - Provide laboratory services and quality control of data

- **NewFields Agricultural & Environmental Resources**
  - Coordinate and conduct sampling and reporting efforts and facilitate grower communication
5,200 acres; 68+ fields
## Monitoring Approach

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Sampling Frequency</th>
<th>Continuous</th>
<th>Monthly</th>
<th>Quarterly</th>
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</thead>
<tbody>
<tr>
<td>Water</td>
<td>Grab</td>
<td>X</td>
<td></td>
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<tr>
<td></td>
<td>In Situ Probe</td>
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<tr>
<td>Soil</td>
<td>0-12” &amp; 12-24” sample depths</td>
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<td></td>
<td>X*</td>
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<tr>
<td>Plant</td>
<td>Tissue</td>
<td></td>
<td></td>
<td>X*</td>
</tr>
</tbody>
</table>

- Water probes measure pH, specific conductance and temperature.
- Water grab samples measure salinity and nutrient related constituents monthly.
- Soil samples measure salinity and nutrient levels quarterly and metals annually.
- Plant tissue samples measure salinity and nutrient levels quarterly, depending on crop growth cycles, and metals annually.
Web Mapping Application

- Allows stakeholders to view Project data related to soil salinity
  - View Project infrastructure
  - View field information
  - Access Project documents
  - Chart trends for soil constituent
- Facilitates rapid, visual representation of key constituents to ensure project goals concerning agricultural production are being met
- Used frequently during grower meetings to spatially and temporally compare each grower’s data
  - Intended to be made available to each grower once login information is established
Web Mapping Application
Results: Soil Salinity 0-12”

- Crop productivity has not been impacted
Results: Dewatering, over 2B gallons to date

Shaft Water Depth as Influenced by Water Order

- Shaft depth below surface (ft)
- Dewatering trendline
- NMID Water Order (cfs)
Communication with Growers

• Semi-Annual meetings with growers prior to each sampling event
  – Discuss field conditions and recent field operations
  – Ensure all farm staff are aware of our activities
  – Share data
Results

- Nutrient and metal levels for the water, soil and plant tissue samples have all fallen within acceptable, expected ranges.
- Environmental health and agricultural productivity have remained unaffected.
- Soil salinities (gypsum) have increased slightly, as expected, but have not affected crop yield.
Lessons Learned

• Daily communication is critical among all project stakeholders
• Conservative sampling and irrigation efforts throughout the project have been helpful for tracking salinity trends
• Consistency in the water treatment and regular communications have led to continued project success.
Located in the Upper Peninsula of Michigan
Marquette County
Mine Site Layout

- Underground ore body (6 acres)
- Underground decline to ore body
- Surface road from portal to storage pad
- Site access road
- Surface facilities
- Salmon-Trout River
- Ventilation raise and aggregate backfill site
- Mine portal

Source: Kennecott Eagle
Michigan’s Environmental Regulations

- Part 632, Nonferrous Metallic Mining Regulations, of PA 451, Natural Resources and Environmental Protection Act, of 1994.
  - Covers all aspects of mining and includes EIA

  - Part 22 Rules, Groundwater Quality
  - Part 4 Rules, Water Quality Standards
  - Part 8 Rules, Water Quality Based Effluent Limit Development
Michigan’s Environmental Regulations

- Part 632, Nonferrous Metallic Mining Regulations, of PA 451, Natural Resources and Environmental Protection Act, of 1994.

Managing Water On Site

- Waters that Receive Treatment at WTF
  - Underground Dewatering
  - Storm Water Runoff from Operations Area
  - Temporary Development Rock Storage Area
    - Industrial Landfill Equivalency
    - Leachate Collection
    - Geomembrane Cover

- Not Treated at WTF
  - Sanitary Wastewater
  - Non-Contact Storm Water
Michigan’s Environmental Regulations


Water On Site Governed by:

- Part 22 Rules - Groundwater Quality
  - Contact Water Basin Liner Design
  - Basis of Design for Facility and Infiltration Gallery
  - Water Discharge Application Requirements

- Part 4 Rules - Water Quality Standards
  - Antidegradation - Best Technology in Process in Treatment for BCC Mercury

- Part 8 Rules - Water Quality Based Effluent Limits
  - Low Level Metals – Designated Use Protection

*Due to groundwater venting, the state agency applied surface water discharge requirements to the venting location (groundwater seeps).*
Final Agency Decisions

Ultimately, the State of Michigan issued a water discharge permit that included limits protective of both surface and ground water.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Eagle Permit Limit Monthly Average (ug/l)</th>
<th>Michigan Drinking Water Standard (ug/l)</th>
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<tr>
<td>Selenium</td>
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<tr>
<td>Copper</td>
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Compliance points are both groundwater and WTF effluent.
Water Treatment Facility Schematic

Facility rain/snow

Mine Inflow

Metals Precipitation Process

Filtration

Double Pass Reverse Osmosis

Recycle for Mine

Groundwater Infiltration System

350 gpm permitted

permitted
Questions are Welcome.
Thank You.