Hydraulic Adit Plug Closure
World’s Fair Mine, Patagonia, Arizona

Region 3
Coronado NF

Mine Design, Operations & Closure Conference

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Allan Kirk
Matt Wetter
Nathan Stormzand
Eli Curiel, USFS
General Location Map

[Map showing Patagonia and World’s Fair Mine in Arizona]
A. WORLD'S FAIR MINE.
Mill at lower right. Looking S. 70° W.
World’s Fair Mine

- Harshaw Mining District in the Patagonia Mountains
- Mined from 1879 – 1957
- Ag - Pb - Cu - mine
- Produced 30,000 tons of 58 opt Ag, 6.6 % Pb, 0.7% Cu, minor gold /zinc.
- North-south trending vein system dips at about 80° to SW.
- Occurs at contact of quartz diorite intrusive and rhyolitic volcanic flows
Mine Workings – Plan Map

- Mined along strike for about 600 feet
- Over a dip-slope distance of about 1,000 feet
- 15,000 ft of drifts, tunnels, stopes, shafts, and winzes
Developed to a depth of 450 feet below the main haulage level adit.
Site Visit to Adit Portal – All you could see in 2009

30-feet to drop-out and thigh deep water

pH = 3.0
Elevated metals
The (1.8) Million Dollar Question

Given what you see - can you provide us with a firm fixed price for the cost to reopen this mine, set two hydraulic plugs, and reclaim the site?

Simple answer: No
Consultant’s answer: ….well Sure!
Table 1.
Dissolved metal concentrations (mg/L) from monitoring locations\(^1\).

*World's Fair Mine*

<table>
<thead>
<tr>
<th>Metal</th>
<th>Alum Gulch Upstream</th>
<th>Adit Discharge</th>
<th>Alum Gulch Downstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>N/R</td>
<td>N/R</td>
<td>0.0005</td>
</tr>
<tr>
<td>Barium</td>
<td>0.0089</td>
<td>0.0062</td>
<td>0.0064</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.117</td>
<td>0.0543</td>
<td>0.1576</td>
</tr>
<tr>
<td>Chromium (III)</td>
<td>0.007</td>
<td>0.008</td>
<td>0.002</td>
</tr>
<tr>
<td>Copper</td>
<td>1.483</td>
<td>0.66</td>
<td>1.563</td>
</tr>
<tr>
<td>Iron</td>
<td>0.79</td>
<td>35.84</td>
<td>3.655</td>
</tr>
<tr>
<td>Lead</td>
<td>0.024</td>
<td>0.027</td>
<td>0.135</td>
</tr>
<tr>
<td>Manganese</td>
<td>56.392</td>
<td>91.94</td>
<td>102.25</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.0002</td>
<td>&lt;0.0002</td>
<td>&lt;0.0002</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.2</td>
<td>0.219</td>
<td>0.214</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.002</td>
<td>0.0032</td>
<td>0.0036</td>
</tr>
<tr>
<td>Silver</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Zinc</td>
<td>31.423</td>
<td>34.02</td>
<td>40.866</td>
</tr>
</tbody>
</table>

\(^1\) Adapted from USGS (2003). Data are believed to be means from 16 monitoring events. N/R = Not reported

Red font = exceeds human health standards
Metals Loading (2)

Concentration (mg/L)

- Alum Gulch Upstream
- Adit Discharge
- Alum Gulch Downstream

- Iron
- Manganese
- Zinc
World’s Fair Adit – Flow and Water Quality

- Flow typically 3-5 gpm, maximum 18 gpm
- pH 2.9 – 3.7
- Geochemically degraded waters with respect to Cd, Cu, Fe, Pb, Mn, Ni, and Zn
- Significant source of loading to Alum Gulch
- However, sources other than the World’s Fair Mine adit are responsible for the majority of metal loading to Alum Gulch
Water quality - Low pH and metals concentration and loading to Alum Gulch

Closure **principally** to eliminate a point source discharge from the adit portal.
RFP to stem the flow of water from the Adit

- Tetra Tech chose to evaluate the possibility of using two hydraulic, water-tight plugs to stem the flow.

- Objectives:
  - Eliminate or reduce the flow of contaminated water from the adit
  - Eliminate or reduce metals loading to Alum Gulch from the adit
  - Elimination of a point source discharge in exceedence of water quality standards and in violation of the Clean Water Act (for discharging without a permit)
Schematic Sketch of Two-Plug System

- Low Pressure Plug @ 250'
- Highly Fractured Rock Mass
- Competent Rock Mass
- High Pressure Plug Between 300' - 500'
- Rock or Mine Waste Fill
- Portal Closure Plug
- Adit Opening
Infrastructure to Support Project
Eli Curiel, USFS OSC and a TT Exploration (?) Geologist
Closure Plan
6-inch steel H-beams
Faced with 2 x 6” Nailing Strip
Nailer faced with 3” lagging on inside of Bulkhead
“Jimmy Hoffa” Window
Cement pumping lines and grout pumping lines
Perimeter of lagging packed with burlap and grouted
Pumper and Concrete Trucks
After the Concrete Pour ~ 30 cubic yards

Prior to grouting the interior plug station arch
Greatest Job Safety Risk

TRAVEL CAUTION
SMUGGLING AND ILLEGAL
IMMIGRATION MAY BE
ENCOUNTERED IN THIS AREA
Constructing Dam near Portal
Piping Through Dam
Mixing Cement for Dam - Atlas Fausett Mobile Mixer

(Just kidding)
Piping Behind Dam – Not Perforated yet
Beginning of Adit Surface - Closure Looking from Portal
Goin’ Back for More Rocks
Final Underground Portal Closure
Infiltration Basin
Reclaimed Waste Rock Dump
Closure Effectiveness and Cost

- Reduction in flow – 100%
- No metal loading from adit source
- Uses existing engineering technology
- Cost of:
  - Engineering design
  - Rehabilitating the adit –
  - Construction of plugs and closure of site -
  - Relatively high - but one time cost of $1,105,000
Comparison Glengarry Mine vs. World’s Fair Mine

World’s Fair Mine, AZ
- Mine rehab to 500’
- Two hydraulic plugs
- Limited plug backfill
- Portal closure
- Infiltration basin
- 100% flow reduction
- Cost = $1,105,000

Glengarry Mine, MT
- Mine Rehab to 1900’
- Shaft rehab to 290’
- Shaft collar grout curtain
- Shaft Plug and backfill
- Four hydraulic plugs
- Extensive plug backfill
- Underground fault grouting
- Portal Closure
- 98% flow reduction
- Cost = $2,900,000
Most Importantly
Hydraulic Plug Mine
Closures Can Provide

“A Walk-Away Solution”
Questions?