Integrated hydrologic modeling to inform risk assessment for large-scale mining and salmon in Bristol Bay headwaters

David M. Albert,
Director of Conservation Science
The Nature Conservancy, Alaska Chapter

Alaska Board of Trustees
27 February, 2018
2010 TNC Alaska Resolution:

• Based on our assessment of the risks and state of current, proven mining technology, large scale mining in these critical watersheds at this time presents an inappropriate risk to the salmon systems of the region

• The Conservancy recommends that mining and other activities not be allowed that:
  – Destroy or impair habitat such that sustained abundance is placed at risk
  – Require water withdrawals that exceed ecological flow needs for fish
  – Require active management in perpetuity to avoid contamination
  – Result in acid mine drainage that cannot be eliminated by proven methods at comparable sites and scale
Presentation Outline:

• What is an integrated hydrologic model?

• How did this help us understand risks associated with a preliminary Pebble mine design in 2012?

• Review preliminary details from 2017 Pebble Mine application for Clean Water Act wetland permits
From work published in 2015

RESEARCH ARTICLE

Hydrologic Alterations from Climate Change Inform Assessment of Ecological Risk to Pacific Salmon in Bristol Bay, Alaska

Cameron Wobus¹ *, Robert Prucha², David Albert³, Christine Woll³, Maria Loinaz⁴, Russell Jones¹


* cwobus@stratusconsulting.com
What is an Integrated Hydrologic Model?

- Spatially explicit estimate of atmosphere-surface water-groundwater interactions
- Water moves among reservoirs according to local physics: water balance is internal
- Provides a physically based background for ecological risk assessment
Study Area

Location Map

Bristol Bay, Alaska

Lake Illiamna
**Model Input:**
- Precipitation
- Temperature

**Model Parameters:**
- Lakes and streams
- Vegetation
- Soils / wetlands
- Geology
- Aquifer geometry
- Hydraulic conductivity

**Calibration:**
- Stream flow gage stations
Streamflow Calibration: Upper South Fork Koktuli
Northern Dynasty Preliminary Mine Plan: 25-year Scenario

Mine Facilities:

- Open Pit
- Waste Rock
- Tailings Storage Facility

- ~5 billion tons of material

- **Water Management Systems:**
  - Open pit collection system
  - Tailings storage facility collection system
  - Waste rock leachate collection system
- **Transfer water for use, treatment, and release back into the environment**
Scenario 1: Short-term failure of leachate collection system

Results: Downstream Water Quality 1

<table>
<thead>
<tr>
<th>Copper Concentration (μg/L)</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT100D</td>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>UT100B</td>
<td>80</td>
<td>10</td>
</tr>
</tbody>
</table>

Acute Water Quality Criteria

Results: Downstream Water Quality 1
Water Quality Scenario 2: No Leachate Collection from Waste Rock (long-term failure)

**South Fork Koktuli**

**Upper Talarik**

**Results: Downstream Water Quality 2**

**Copper Concentration (μg/L)**

Acute Water Quality Criteria
Conclusions:

- Meeting water quality standards for this preliminary design was dependent upon continual functioning of active leachate collection and water treatment systems.

- Even 1-month failure of leachate collection resulted in exceedance of acute (i.e., lethal) water quality standards for copper throughout much of the model domain.

- The ability to design and test the effects of mining scenarios like this one requires access to advanced hydrologic modeling tools.

Next Steps: We are currently evaluating the feasibility and seeking funding to use this model to analyze the 2017 Pebble Mine permit application.
In December 2017, Pebble Partnership applied to the Army Corp of Engineers for wetland fill permits under the Sec. 404 of Clean Water Act

Design Summary:

• 20-year mine operating life
• 1.2 billion tons of material mined
  – 1.1 billion tons in Tailings Storage Facility
  – 330 million tons in low grade ore facility
• 83 mile transportation corridor
  – Includes 18 mile lake crossing
• 188 mile gas pipeline from Kenai Peninsula
Design Considerations

• Limited to mining the near-surface portion of the Pebble Deposit
  – This proposal only utilizes 1.2 billion of the estimated 12 billion tons in the Pebble Deposit.

• Layout consolidates most infrastructure in the North Fork Koktuli watershed, seeks to avoid Upper Talarik

• No secondary recovery of gold from pyritic tailings using cyanide leaching

• Segregation of bulk from pyritic (acid-generating) tailings to facilitate physical closure of bulk tailings

• Low-grade ore stockpile will be lined for storage of potentially acid generating (PAG) waste rock
Post-Closure Water Management

- Dewatering will stop and the open pit will begin to flood
- Pyritic tailings will remain sub-aqueous to prevent oxidation and acid generation
  - Seepage water from the embankment will be collected and either treated or directed into the pit
- Physical reclamation will contour to facilitate surface runoff to be collected for treatment or directed into the pit
- Surface water in the pit lake is expected to be acidic with high metal concentrations
  - Once the pit water level reaches a level ~50’ below groundwater, water will be pumped, treated and discharged into the environment
- Water treatment during this phase will use the existing Water Treatment Plants as necessary.
  - The reclamation and closure bond package will include provisions for periodic replacement of water treatment facilities and ongoing operation and monitoring costs over the long-term post-closure period.
Thanks!