Regional Environmental Impacts of Mining the Duluth Complex and the Tamarack Intrusive Complex

Bruce Johnson December 2023
Geology & Mining Plans
THE MIDCONTINENT RIFT

An attempt at continental separation 1.1 billion years ago
Rift contains *disseminated* mineralization = metal minerals scattered as specks and veinlets throughout the rock

- Low grade
- Inconsistent higher grade areas
- Very large waste volumes 95 -99%
- Overall large total volume of metals
- Waste also can contain environmentally problematic minerals *e.g.* arsenic, mercury, manganese, chromium, chlorides, asbestiform particles.
Mining Plans
* Totally dependent on Known mineral locations

* Mining is incremental not static

* Shallow minerals economics require open pits
Graphic 1: Co-located Surface Facilities and Underground Facilities
Duluth Complex Vs Tamarack Intrusion Ecology and Chemistry
Ecoregions are areas where an ecosystems type, quality, and quantity of environmental resources are generally similar. Ecoregion 50.
Duluth Complex/Tamarack Intrusion Chemical Comparison
(Tamarack Mineralogy Non-Public)

• Tamarack higher Nickel than Copper (averaging 4%)
• Tamarack higher Cobalt -
• Lead - Likely present
• Mercury - Likely present & added sulfate and dewatering will increase wetland release
• Zinc - Present
• Sulfates will be similar if not higher
• Chloride
• Sodium
• Nitrogen from underground blast likely higher than open pit
• Asbestos-like particles from dust from mine ventilation likely will be released
• Beneficiation Chemicals & Degradates - currently will be in North Dakota ??
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Waste rock **</th>
<th>Tailings ***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leachate</td>
<td>Leachate</td>
</tr>
<tr>
<td>Cobalt</td>
<td>7.4x</td>
<td>7x</td>
</tr>
<tr>
<td>Copper</td>
<td>2.9x</td>
<td>9x</td>
</tr>
<tr>
<td>Nickel</td>
<td>4.8x</td>
<td>2x</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.7x</td>
<td>9x</td>
</tr>
<tr>
<td>Chloride</td>
<td>NR</td>
<td>1.8x</td>
</tr>
<tr>
<td>Sulfate</td>
<td>73 x or 3.2 x</td>
<td>175x or 7.5x</td>
</tr>
<tr>
<td>Specific Conductivity *</td>
<td>9.7x</td>
<td>14x</td>
</tr>
</tbody>
</table>

* Specific Conductance standard eliminated by MPCA recently.

Used Fond du Lac standard 300, and Copper Nickel data

** Data from MPCA 2009

*** Data from MNDNR 2004
Total Impaired waters listing MPCA 2024 draft: 6,345 impairments of lakes and stream segments for various pollutants.

Sensitive Ecology – this is just a few of the local impairments

- Big Sandy Lake (nutrients, Mercury (fish))
- Sandy River (aquatic life, aquatic insects)
- Kettle River (numerous runs for mercury) (upper Kettle, fish)

DNR Biodiversity significant

Named Wetland Complexes

native plant communities
Technical Issues
Backfilling with Crushed Waste Rock & Cement

- Underwater (low oxygen)
- Cement (lime) gets coated (deactivates buffering)
- Ineffective with chlorides & sulfates
- Subsidence?
Water Quality Treatment - Reverse Osmosis?

- Talon has not described treatment of mine contact water before discharge. Reverse osmosis described below.

- Fine filter, high pressure/high energy requirement

- Before RO pretreatment is necessary

- Back flush water is a disposal problem
  - Up to 50% concentrated brines (metals, salts)
EQB determined that conventional site-specific environmental impact statements and the corresponding regulatory process are inadequate to deal with the broader issues involving large areas of unexploited resources in mining districts.

Developed baseline conditions area that included:

- Surface water chemistry, ground water conditions
- Air quality
- Noise
- Ecology
Tamarack Intrusive Complex

Again, today conventional site-specific environmental impact statements and the corresponding regulatory process remain inadequate to deal with the broader issues involving the Tamarack Intrusive Complex unexploited resource.
“...Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web he does to himself...”

Chief Seathl, 1857, Suquamish and Duwamish Tribes