Objective 2 Ecological Impacts

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Objective Statement

to characterise the impacts on aquatic ecosystems based on potential risks to water quality identified in obj 1, and to determine the sequence of events by which streams recover

Specifically;

a) Identify threshold ranges of water quality which should support functioning stream communities
b) Characterise stream communities in mined streams
c) Test the recovery of streams post-remediation (obj 3)
Healthy stream ecosystems

- Algae (periphyton)
- Dissolved organic matter (DOM)
- Bacteria & fungi
- Bryophytes & Macrophytes
- Stream invertebrates
- Fish & crayfish
Mine impacted stream ecosystems

- Algae (periphyton)
- Dissolved organic matter (DOM)
- Bacteria & fungi

Stream invertebrates

- Stream invertebrates
- Fish & crayfish

Bryophytes & Macrophytes

- No presence of bryophytes & macrophytes

Red arrows indicating impact on ecosystems.
Stream invertebrate community

Mayflies

Stoneflies

Snails

Caddisflies

True flies
Approach

- Ecological field studies
  - Algae
  - Benthic invertebrates
  - Fish

- Ecotoxicological tests
  - Benthic invertebrates
Summary of West Coast work

Ecological field studies

✓ 54 field sites surveyed, ranging from highly AMD impacted to “natural” reference condition

✓ Water chemistry (pH, conductivity, Fe, Al, Ni, As), physical habitat and benthic invertebrates

✓ Additional MSc student working on algae

✓ Additional fish survey

✓ Data added to obj 1 geological database
Benthic invertebrates v water chemistry

- **pH**
  - Total taxa
    - 0, 5, 10, 15, 20, 25, 30, 35
  - Dissolved Fe (mg/l)
    - 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

- **Dissolved Al (mg/l)**
  - Total taxa
    - 0, 5, 10, 15, 20, 25, 30, 35
  - Dissolved Al (mg/l)
    - 0, 20, 40, 60, 80, 100, 120, 140, 160, 180

The graphs illustrate the relationship between benthic invertebrate species richness and water chemistry variables, specifically pH and dissolved iron and aluminum concentrations.
Other biotic indices

Stream condition

% EPT

Severe Moderate Impacted Reference

MCI

Severe Moderate Impacted Reference
Field studies summary

- Even the most highly degraded may have invertebrates
- Taxonomic richness depleted <4 pH, dissolved Al >1mg/l, dissolved Fe >1 mg/l
- Some taxa e.g. chironomids, stoneflies and beetles can survive in poor water chemistry contrary to accepted indices
Ecotoxicology test

- Aquatic invertebrates
- Standardised temp, day/night
- Treatments replicated
- 5 organisms/replicate
- Short-term test (96 hr)
- 24 hr survival checks
In uncontaminated water, West Coast mayflies survived in pH ≥ 3.5.

What happens in Acid Mine Drainage (AMD) water?
Mayflies survive in AMD when pH ≥ 3.8

Toxicity of AMD is ameliorated when pH is modified up to the natural pH of the stream.
Mayflies sourced from different streams

Mayfly tolerance to AMD depends on the pH of their home stream.

- pH = 7.4
- pH = 7.0
- pH = 7.0
- pH = 6.5
- pH = 5.9
- pH = 5.7

▲ = 4.0
■ = 3.5
♦ = 3.3

- Time (hr)
- Survival (%)

- Time (hrs)
- Survival (%)
Indicative pH thresholds of mayfly tolerance to AMD

<table>
<thead>
<tr>
<th>Level of impact</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&gt; 4.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>3.5 – 4.0</td>
</tr>
<tr>
<td>High</td>
<td>≤ 3.5</td>
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</tbody>
</table>
Preliminary Southland work

- Small scale benthic invertebrate survey of current mining operations;
  - Some localised AMD e.g. Belle-Brook alluvial gold
  - Possibility turbidity issue
  - Confounding issue agricultural landscape

- Numerous pit lakes (various ages)
A look forward

- Collation of existing benthic invertebrate
  - Environment Southland (SOE, Consent)
  - Theses, Academic publications
  - National databases; NIWA, Canterbury Museum (caddisfly & mayflies)
  - Others; DoC, F&G, Liquid Fuels Trust Board data

  Little focus site specific data on mining sites?

- Extensive benthic survey focused on potential & current mining sites

- Ecotoxicological tests on Southland species for tolerances to AMD and turbidity (?)

- Ecology of pit lakes

- Assess validity of West Coast water quality thresholds