Vegetation Establishment in Rock-soil Mixtures for Evapotranspirative Covers

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Tailings and Mine Waste 2017
Banff, Alberta, Canada
1 Project Background

Western New Mexico
Background

**Impetus for the paper**
- Regulatory and financial

- Ability to successfully establish vegetation in this climate in a rock-soil mixture?

- Economic benefits to the use of ET covers in this setting.
Mine material…prior to construction
Background

Design criteria

• Minimum design life: 200 years
• Infiltration less than 3 mm per year; for wettest year on record
• Erosion of cover surface limited to 445 mton/km²/year (2 tons/acre/year)
• Revegetation with minimum ground cover to 80 percent of reference area within 5 years
• Erosion protection designed for 100-year, 24-hour storm event
2 Cover Design

GRAVEL ADMIXTURE
$D_{50}=51\text{mm}$ GRAVEL, 33% BY VOLUME

GRAVEL ADMIXTURE
$D_{50}=76\text{mm}$ GRAVEL, 50% BY VOLUME

457mm

305mm

SANDY SOIL COVER

CLAY SOIL COVER

DISPOSED MINE WASTE MATERIAL

COMPACTED SURFACE

topslope

sideslopes
Mix gradations
3 Construction
4 Revegetation
Revegetation Procedures

Surface Preparation
• Surface was graded and compacted to final configuration
• Upper 3-6 inches was fragmented into unconsolidated material for seeding.

Amendments
• ET cover received 16 cubic yards per acre of sterile organic mulch (compost) on the top slope and 12 cubic yards per acre on the side slopes.

Seeding
• Seeding on the ET cover consisted of native species, which were adapted to local climatic and edaphic conditions.
• The seed mix for the ET cover consisted of only grasses and forbs.
5 Monitoring Results
Vegetation Results 2013-2017

The diagram shows the percent perennial ground cover for ET Cover Top and ET Cover Slopes from 2014 to 2017. The bars indicate the following:

- **ET Cover Top**
  - 2014: 7.2%
  - 2015: 20.9%
  - 2016: 29.6%
  - 2017: 34.4%

- **ET Cover Slopes**
  - 2014: 3.0%
  - 2015: 12.3%
  - 2016: 15.0%
  - 2017: 33.6%

A dashed line represents the 2017 Success Criteria, indicating the threshold for success.
<table>
<thead>
<tr>
<th></th>
<th>Unit ———&gt;</th>
<th>ET Cover</th>
<th>Reference Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Top</td>
<td>Slope</td>
</tr>
<tr>
<td>Summary by Lifeform:</td>
<td>Perennial Grasses</td>
<td>23.90</td>
<td>29.43</td>
</tr>
<tr>
<td></td>
<td>Annual Grasses</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Perennial Forbs</td>
<td>0.43</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>Annual &amp; Biennial Forbs</td>
<td>1.08</td>
<td>2.30</td>
</tr>
<tr>
<td></td>
<td>Noxious / Aggressive Weeds</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Shrubs, Sub-shrubs, Cacti &amp; Trees</td>
<td>10.10</td>
<td>3.50</td>
</tr>
<tr>
<td>Diversity (Number of Species with ≥1% Average Cover):</td>
<td>Number of Important Species =</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>
ET Cover Topslope 2013-2017
Rock Cover Results ET Cover Sideslope 2014-2016

The diagram shows the percent rock ground cover from 2014 to 2016:
- 2014: 8.5%
- 2015: 10.7%
- 2016: 14.5%
6 Conclusions
Conclusions

• ET covers are a sustainable solution to long-term stabilization of mine materials.
• Vegetation establishment is a necessary component of the design to limit infiltration.
• The case results show native vegetation can be established in mixtures up to 50% rock.
• Slopes are self armoring. As erosion occurs, more rock is exposed.
• Rock cover is important in arid climates with episodic precipitation regimes.
• Incorporation of rock in the rooting profile can influence depth of plant available water which can impact plant diversity.
Thank you!
Questions?

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