REVEGETATION FOR SLOPE STABILIZATION AND EROSION CONTROL IN CALIFORNIA MINE RECLAMATION

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Many treatments are used to control surface erosion in reclamation. These include limiting the surface area being disturbed, operating outside of the rainy season, reducing slope length and steepness, and applying erosion control BMPs.
Fig. 9.10 -- Treatment of cuts and fills. Slope gradient is an important factor in determining appropriate restoration measures.


By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the U.S.)
Why is revegetation the best long-term solution?
WHAT IS REVEGETATION?

- Provide long-term erosion control
- Establish self-sustaining vegetation where plants have been removed or disturbed
- Blend a site with the surrounding landscape
- Replace the naturally occurring plant communities using local native plants
- Restore wildlife habitat, ecosystem functions, and chemical/biological interactions
- Speed up succession; “jump-start” the system
Establish self-sustaining vegetation where plants have been removed or disturbed.
Blend a disturbed site with the surrounding landscape
Replace the naturally occurring plant communities using local native plants
Restore wildlife habitat, ecosystem functions, and chemical/biological interactions
Speed up succession and “jump-start” the system
WHY NOT RELY ON “NATURAL REVEGETATION”? 

* Won’t provide sufficient cover fast enough to stabilize slopes and prevent erosion 
* May not have sufficient input of seed from full suite of species 
* Difficult to meet any targets or performance criteria 
* Won’t provide aesthetically pleasing site for a long time 
* Disturbed sites favor invasive, weedy species
PLANT SELECTION

Determining the Plant Palette

- Dominant or representative local native species of each plant community present from baseline data
- A large number of species; minimum of 30% of species present should be reintroduced
- A variety of plant types:
  - Annual & perennial
  - Grasses, herbs, shrubs, trees
  - Early and late successional species

“By diversifying species selection, the chances of success are greater, the diversity of the resulting site is greater, & the root systems of selected species are less likely to compete.”
WHY USE NATIVES?

- Adapted to local climate, soils, pathogens
- Co-evolved with other native plants & animals
- Blend with surrounding natural environment
WHY USE A SITE-SPECIFIC MIX?
- Use a site-specific set, not a generic mix
- Use local ecotypes
PLANT SELECTION:

WHY USE PERENNIALS?
PLANT SELECTION:
Different Rooting Strategies
Roots increase soil shear strength
Provide long-term erosion control
Vegetation reduces raindrop impact damage & slows runoff velocity

**raindrop impact damage**

- **energy** = \( m \times v \times v \)
- 1mm = 15 km/h
- 5mm = 32 km/h
- = 500 times worse

- dense crops
- soil cover
- fertilise
- sheet wash

water is 800 times heavier than air!
Plant litter, low-growing plants, and humus layer act like a sponge.
Factors Affecting Slope Stability

**Driving Forces**
- Gravity tangential to failure surface
- Water, Water, Water
- External Loading/Accelerations

**Resisting Forces**
- Gravity normal to failure surface
- Material/Discontinuity strengths
- Reinforcement
Transpiration: Plants draw up water, removing it from the soil.
Illustration 4: Effects of Vegetation in Minimizing Erosion

- **Evirotanspiration**
  - From Foliage: Removes water from soil

- **Vegetation**
  - Absorbs the energy of falling rain

- **Shrub Roots**
  - Hold surface soil

- **Ground Covers**
  - Protect soil

- **Deep Roots**
  - Help hold and stabilize bank materials, ties layers together

- **Grasses**
  - Trap soil particles and intercept rain drops

- **Grass Roots**
  - Protect surface soil

- **Vegetation**
  - Helps to maintain absorptive capability

  - Slows the velocity of runoff and acts as a filter to catch sediment
## Table 18-1 Approaches to upland slope protection and erosion control

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
<th>Appropriate uses</th>
<th>Role of vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vegetative plantings</strong></td>
<td>Conventional plantings</td>
<td></td>
<td>Control weeds. Bind &amp; restrain soil. Filter soil from runoff.</td>
</tr>
<tr>
<td></td>
<td>Grass seedlings</td>
<td>Control water and wind erosion.</td>
<td>Maintain infiltration. Moderate ground temperature.</td>
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<td></td>
<td>Transplants</td>
<td>Minimize frost effects.</td>
<td></td>
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<td></td>
<td>Forbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Soil bioengineering</strong></td>
<td>Woody plants used as reinforcement,</td>
<td>Control of rills &amp; gullies.</td>
<td>Same as above, but also reinforce soil, transpire excess water, &amp; minimize</td>
</tr>
<tr>
<td></td>
<td>as barriers to soil movements, &amp; in</td>
<td>Control of shallow (translational) mass movement.</td>
<td>downslope movement of earth masses.</td>
</tr>
<tr>
<td></td>
<td>the frontal openings or interstices</td>
<td>Filter sediment.</td>
<td>Reinforce fill into monolithic mass.</td>
</tr>
<tr>
<td></td>
<td>of retaining structures.</td>
<td>Improved resistance to low to moderate earth forces.</td>
<td>Improve appearance and performance of structure.</td>
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</tr>
<tr>
<td><strong>Vegetated structures</strong></td>
<td>Wall or revetment with slope face</td>
<td>Control erosion on cut &amp; fill slopes subject to</td>
<td>Stop or prevent erosion &amp; shallow sloughing on or at the slope face above the toe.</td>
</tr>
<tr>
<td></td>
<td>treatments</td>
<td>scour &amp; undermining.</td>
<td></td>
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<tr>
<td></td>
<td>Tiered structures with bench</td>
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<td></td>
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<tr>
<td></td>
<td>planting</td>
<td></td>
<td></td>
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<tr>
<td><strong>Nonliving structures</strong></td>
<td>Rigid construction</td>
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<td></td>
</tr>
</tbody>
</table>
Chapter 18

Soil Bioengineering for Upland Slope Protection and Erosion Reduction

http://www.fs.fed.us/publications/soil-bio-guide/
Revegetation Requirements under SMARA (section 3705)

- Revegetation plan specific to the site, including a monitoring plan
- Test plots
- Use native species
- Plant during correct season
- If irrigated, self-sustaining for 2 years
- Weeds managed
- Plant protection where needed
- Success standards for cover, density, and species-richness
Successful revegetation takes time, but the results are tangible. The reclaimed site blends with the surrounding landscape. Revegetated areas resist erosion and invasive species and provide aesthetic values, wildlife habitat, and ecosystem services.