Strip mine rehabilitation (South Africa)

**DESCRIPTION**

Rehabilitation of areas degraded by strip mining, through returning stockpiled topsoil and transplanting of indigenous species, to promote revegetation.

In contrast to the land degradation commonly caused when 'strip mining' is carried out, a land rehabilitation technology, which was first developed experimentally, is now routinely applied by mining companies on the west coast of South Africa. Indeed it is now a legal requirement in South Africa for mining companies to rehabilitate mined areas to a condition and productivity equivalent to the pre-mining situation.

The primary purpose of the technology described here is to achieve this result – thus allowing the site to be used again for extensive grazing by sheep and wild animals. Revegetation also reduces wind erosion. The technology further contributes to increasing biodiversity, as particular attention is given to planting a range of locally endemic and other indigenous species.

The sequence of operations is as follows: during strip mining operations the topsoil is pushed to one side by bulldozer, and stockpiled. The substrata is then excavated mechanically, removed by tipper truck, and processed to extract the heavy metals. The tailings (waste materials) are returned by tipper truck to the area from which they were mined, and then levelled by bulldozer. The stockpiled topsoil is returned and spread by bulldozer over the levelled tailings. Indigenous succulents and other plant species are dug out by hand, with a spade, from either the surrounding areas of natural vegetation, or from the piles of topsoil (where plants may have naturally established) and transplanted manually into the newly spread topsoil. The planted areas are protected from wind erosion by erecting fine mesh nylon netting as windbreaks. These are 0.8 metre high and 5 metres apart. The nets are usually installed for a period of up to 2-3 years. Subsequently they are removed, once the vegetation has successfully become re-established, and they may be re-used at the next rehabilitation site. Maintenance activities continue for a few years – until the site is rehabilitated. An individual mine strip is usually about 1 km long and some 100 m wide.

This form of strip mine rehabilitation has been in operation since 1990, and costs on average just over US$ 200 per hectare, with all expenses met by the mining company. This particular approach was developed for the Anglo-American subsidiary – ‘Namaqua Sands’. A similar approach was adopted by ‘PBGypsum Mines’ located further inland, where rehabilitation is also conducted on several hundreds hectares of mined land. Not all mining companies use the same technology, however.

Purpose of the Technology: Establishment activities:

Mining activities (not part of technology)
1. Removal and stock piling of topsoil
2. Excavation, removal and processing of substrata to extract heavy minerals
3. Return and levelling of the mine tailings
4. Return and spreading of topsoil Technology activities
5. Collection/digging up of indigenous plants
6. Transplanting into returned topsoil
7. Erection of fine mesh nylon net windbreaks Activities 1-4 are a continuous process associated with the speed of mining activities and involve the use of heavy earth moving machinery (bulldozers, front end loaders, tipper trucks). Activities 5&6 take place immediately prior to the onset of the rainy season and involve hand labour for collection.

**LOCATION**

Location: Brand-se-Baai, Western Cape, Western Cape, South Africa

No. of Technology sites analysed:
- 17.9128, -31.2736

Spread of the Technology: evenly spread over an area (approx. 1-10 km²)

In a permanently protected area?:

Date of implementation: less than 10 years ago (recently)

Type of introduction:
- ✓ during experiments/ research
- through land users’ innovation
- through projects/ external interventions
- as part of a traditional system (> 50 years)
and transplanting and tractor and trailer for transporting collected plants. Activity 7 can take place at any time of the year involving hand labour for erection of the nets and tractor and trailer for transport.

Maintenance / recurrent activities per year:
Maintenance activities restricted to:
1. Ensuring the nylon nets remain upright
2. Supplementary watering during the winter months, when rainfall inadequate, to support plant growth

### CLASSIFICATION OF THE TECHNOLOGY

<table>
<thead>
<tr>
<th>Main purpose</th>
<th>Land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>improve production</td>
<td>Grazing land</td>
</tr>
<tr>
<td>reduce, prevent, restore land degradation</td>
<td>Ranching</td>
</tr>
<tr>
<td>conserve ecosystem</td>
<td></td>
</tr>
<tr>
<td>protect a watershed/ downstream areas – in combination with other Technologies</td>
<td>Mines, extractive industries</td>
</tr>
<tr>
<td>preserve/ improve biodiversity</td>
<td>- Specify: Stockpiling of topsoil, processing of subsoil</td>
</tr>
<tr>
<td>reduce risk of disasters</td>
<td></td>
</tr>
<tr>
<td>adapt to climate change/ extremes and its impacts</td>
<td></td>
</tr>
<tr>
<td>mitigate climate change and its impacts</td>
<td></td>
</tr>
<tr>
<td>create beneficial economic impact</td>
<td></td>
</tr>
<tr>
<td>create beneficial social impact</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose related to land degradation</th>
<th>Water supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>prevent land degradation</td>
<td>✓ rainfed</td>
</tr>
<tr>
<td>reduce land degradation</td>
<td></td>
</tr>
<tr>
<td>✓ restore/ rehabilitate severely degraded land</td>
<td></td>
</tr>
<tr>
<td>adapt to land degradation</td>
<td></td>
</tr>
<tr>
<td>not applicable</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degradation addressed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>soil erosion by water - Wt: loss of topsoil/ surface erosion</td>
<td></td>
</tr>
<tr>
<td>soil erosion by wind - Et: loss of topsoil</td>
<td></td>
</tr>
<tr>
<td>physical soil deterioration - Pu: loss of bio-productive function due to other activities</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SLM group</th>
<th>SLM measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>n.a.</td>
<td>agronomic measures</td>
</tr>
<tr>
<td></td>
<td>- A3: Soil surface treatment (A 3.1 No tillage)</td>
</tr>
<tr>
<td></td>
<td>vegetative measures</td>
</tr>
<tr>
<td></td>
<td>- V5: Others</td>
</tr>
<tr>
<td></td>
<td>structural measures</td>
</tr>
<tr>
<td></td>
<td>- S11: Others</td>
</tr>
</tbody>
</table>

### TECHNICAL DRAWING

Technical specifications
Technical knowledge required for field staff / advisors: moderate
Technical knowledge required for land users: moderate

Main technical functions: reduction in wind speed

Secondary technical functions: improvement of ground cover, increase in organic matter, increase of infiltration, increase in soil fertility

Scattered / dispersed

Vegetative material: O : other

Number of plants per (ha): 2000

Vertical interval within rows / strips / blocks (m): 5

Other species: Succulent plants

Slope (which determines the spacing indicated above): 4.00%

Structural measure: silt fence

Spacing between structures (m): 5

Height of bunds/banks/others (m): 0.8

Construction material (other): nylon net - small grid size

Silt fence: all 5m and height of 0.8m

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**ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS**

<table>
<thead>
<tr>
<th>Calculation of inputs and costs</th>
<th>Most important factors affecting the costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs are calculated:</td>
<td>Labour costs</td>
</tr>
<tr>
<td>Currency used for cost calculation: Rand</td>
<td></td>
</tr>
<tr>
<td>Exchange rate (to USD): 1 USD = 9.07 Rand</td>
<td></td>
</tr>
<tr>
<td>Average wage cost of hired labour per day: 12.00</td>
<td></td>
</tr>
</tbody>
</table>

**Establishment activities**

1. Collection of plants from natural vegetation (Timing/ frequency: Pre-rainy season)
2. Collection of plants from topsoil stockpiles (Timing/ frequency: Pre-rainy season)
3. Transport plants to rehabilitation area (Timing/ frequency: Pre-rainy season)
4. Plant all plants (Timing/ frequency: Pre-rainy season)
5. Insert droppers into net pockets (Timing/ frequency: all year)
6. Spread nets over topsoil areas (Timing/ frequency: all year)
7. Erect nets and hammer in droppers (Timing/ frequency: all year)

**Establishment inputs and costs**

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Unit</th>
<th>Quantity</th>
<th>Costs per Unit (Rand)</th>
<th>Total costs per input (Rand)</th>
<th>% of costs borne by land users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>hectare</td>
<td>1.0</td>
<td>75.0</td>
<td>75.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Equipment</td>
<td>machine hours</td>
<td>0.5</td>
<td>134.0</td>
<td>67.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Plant material</td>
<td>Seedlings</td>
<td>ha</td>
<td>1.0</td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td>Construction material</td>
<td>Nylon net</td>
<td>ha</td>
<td>1.0</td>
<td>70.0</td>
<td>70.0</td>
</tr>
</tbody>
</table>

**Total costs for establishment of the Technology**

212.0

**Total costs for establishment of the Technology in USD**

23.37

**Maintenance activities**

1. Topsoil pushed into stockpile (Timing/ frequency: all seasons / continuous)
2. Subsoil removed and processed (Timing/ frequency: all seasons / continuous)
3. Processed subsoil returned to mined area and levelled (Timing/ frequency: all seasons / continuous)
4. Stockpiled topsoil spread over processed subsoil (Timing/ frequency: all seasons / continuous)
5. Plants transplanted onto spread topsoil (Timing/ frequency: just before rainy season / late autumn/winter)
6. Ensure nets remain upright (Timing/ frequency: all year/continuous)

**Maintenance inputs and costs**

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Labour</td>
<td>ha</td>
<td>1.0</td>
<td>37.0</td>
<td>37.0</td>
<td></td>
</tr>
</tbody>
</table>

**Total costs for maintenance of the Technology**

37.0

**Total costs for maintenance of the Technology in USD**

4.08
### NATURAL ENVIRONMENT

#### Average annual rainfall
- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

#### Agro-climatic zone
- humid
- sub-humid
- semi-arid
- arid

#### Specifications on climate
- n.a.

#### Slope
- flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- steep (11-30%)
- very steep (>60%)

#### Landforms
- plateau/plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

#### Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

#### Technology is applied in
- convex situations
- concave situations
- not relevant

#### Soil depth
- very shallow (0-20 cm)
- shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

#### Soil texture (topsoil)
- coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

#### Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

#### Topsoil organic matter content
- high (>3%)
- medium (1-3%)
- low (<1%)

#### Groundwater table
- on surface
- < 5 m
- 5-50 m
- > 50 m

#### Availability of surface water
- excess
- good
- medium
- poor/ none

#### Water quality (untreated)
- good drinking water
- poor drinking water (treatment required)
- for agricultural use only (irrigation)
- unusable

#### Is salinity a problem?
- Ja
- Geen

#### Occurrence of flooding
- Ja
- Geen

### CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

#### Market orientation
- subsistence (self-supply)
- mixed (subsistence/commercial)
- commercial/market

#### Off-farm income
- less than 10% of all income
- 10-50% of all income
- > 50% of all income

#### Relative level of wealth
- very poor
- poor
- average
- rich
- very rich

#### Level of mechanization
- manual work
- animal traction
- mechanized/ motorized

#### Sedentary or nomadic
- Sedentary
- Semi-nomadic
- Nomadic

#### Individuals or groups
- individual/household
- groups/community
- cooperative
- employee (company, government)

#### Gender
- women
- men

#### Age
- children
- youth
- middle-aged
- elderly

#### Area used per household
- < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2.5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

#### Scale
- small-scale
- medium-scale
- large-scale

#### Land ownership
- state
- company
- communal/village
- group
- individual, not titled
- individual, titled

#### Land use rights
- open access (unorganized)
- communal (organized)
- leased
- individual

### IMPACTS

#### Socio-economic impacts
- fodder production
- fodder quality

### Wocat SLM Technologies

| Strip mine rehabilitation | 4/6 |
animal production

Socio-cultural impacts

Ecological impacts

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

CLIMATE CHANGE

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

Has the Technology been modified recently to adapt to changing conditions?

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler's or other key resource person's view

Weaknesses/ disadvantages/ risks: land user's view → how to overcome

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome

How can they be sustained / enhanced? Make use of whatever resources and potentials are naturally available (such as micro-catchments to trap rainwater and improve soil moisture conditions for plants) to lower establishment costs.

How can they be sustained / enhanced? Regular monitoring of soil and vegetation conditions.

How can they be sustained / enhanced? Seeding as well as transplanting.

How can they be sustained / enhanced? Rehabilitation is an extra cost for the mining company.

→ Ensure mining company meets the costs through enforcing legislation.

Land productivity is restored and biodiversity increased

How can they be sustained / enhanced? Wind erosion minimized.

Land can be used again for extensive grazing after mining

improved conservation / erosion knowledge

restoration of bio-productive function

biodiversity enhancement

reduced wind velocity

Wind velocity increased

reduced wind velocity

CLIMATE CHANGE

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

Has the Technology been modified recently to adapt to changing conditions?

To which changing conditions?

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler's or other key resource person's view

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Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_970/

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