REVEGETATION AND HABITAT REHABILITATION PLAN

De Aar 2 South Wind Energy Facility near De Aar in Northern Cape Province

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Location:

Emthanjeni Local Municipality and Renosterberg Local Municipality, within the Pixley Ka Seme District Municipality

Prepared for

Mulilo De Aar 2 South (Pty) Ltd

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Contents

Introduction

This document presents the Revegetation and Habitat Rehabilitation Plan for the proposed construction and operation of the De Aar 2 South Wind Energy Facility Project in De Aar in the Northern Cape Province, the general locality of which is shown in Figure 1.

In terms of Condition 16.4 of the Environmental Authorisation, a Revegetation and Habitat Rehabilitation Plan is required to be formulated and submitted to the Department of Forestry, Fisheries and the updated Environmental Management Programme (EMPr). This is to ensure that an acceptable plan is in place before construction activities take place on site, and to ensure that affected areas are adequately rehabilitated in accordance with the sustainability principles of Integrated Environmental Management, promoted by the National Environmental Management Act (Act No.107 of 1998) (NEMA).

An infrastructure footprint was provided for the purposes of compiling the Revegetation and Habitat Rehabilitation Plan and is provided in Figure 2 below. Recommendations relating to rehabilitation have been provided on the basis of the plans provided. It is expected that this Plan could potentially be reviewed and updated when Project designs are finalised, should the final design deviate significantly from that shown in Figure 2.

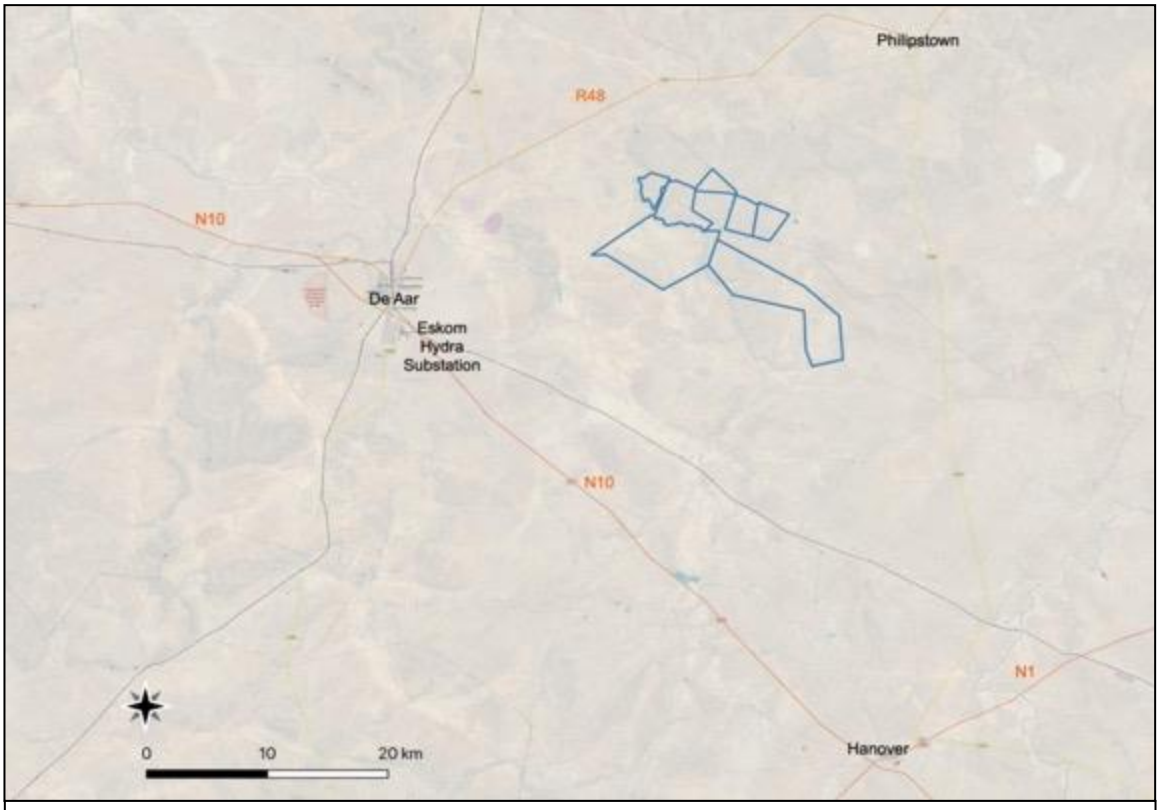

Figure 1: Location and extent of the study area.

Figure 2: Proposed project final layout.

Purpose of the Revegetation and Habitat Rehabilitation Plan

The site contains natural vegetation with moderate biodiversity value and is currently used for live-stock grazing purposes. The purpose of the Plan is to ensure that any areas that will be cleared of vegetation or that will be impacted in some way by construction activities on site are rehabilitated in such a way as to achieve the following:

- Return disturbed areas to an acceptable state.
- Re-establish vegetation cover with suitable plant species so that remaining biodiversity features and prior land-use options are not compromised.
- Reduce the risk of soil erosion to achieve long-term stability of the landscape.
- Prevent alien plant invasion on site.
- Restore ecosystem function to areas that are to be revegetated.
- Ensure that all areas are free-draining and non-polluting.

Responsible persons

Effective rehabilitation during the construction and operational phases of the project will be dependent on several project personnel. These are listed below:

- **The Developer**

This refers to the project proponent/owner, Mulilo De Aar 2 South (Pty) Ltd. They will be responsible for the following:

1. Overall accountability for rehabilitation and setting and reviewing related targets related to this Plan.
2. Ensure that the requirements set out in this rehabilitation plan are adhered to and implemented.
3. Allocate the responsibilities of the Environmental Control Officer (ECO) to an independent suitably qualified individual appointed prior to the start of construction activities on site.
4. Provide all principal contractors working on the project with a copy of this management plan as part of tender contract documentation to allow the contractors to cost for its requirements within their respective construction contracts.

- **The Project Manager**

The project manager of the proposed development will be responsible for the overall implementation of the Revegetation and Habitat Rehabilitation Plan during the construction phase of the project. To effectively implement the Plan, the project manager must have a

thorough understanding of the Environmental Management Programme (EMPr), the requirements of the EA, and this Revegetation and Rehabilitation Plan.

- **The Environmental Control Officer (ECO)**

An ECO will be appointed to provide inputs during the construction phase of the project. These functions will be taken over by the holder during the operational phase. The ECO is responsible for monitoring and verifying the implementation of the management plan during the construction phase of the project.

- **Rehabilitation specialist**

The rehabilitation specialist will provide guidance on the rehabilitation process, including soil management, landscaping, vegetation establishment, seed selection and collection, biodiversity enhancement and management, and provide guidance on any specific issues during the rehabilitation process.

- **The Contractor**

The contractor, being any directly appointed company or individual undertaking the implementation of works, will be responsible for always complying with the rehabilitation plan during the construction phase.

Proposed activities on site

This section provides an outline of the proposed activities on site in terms of the likely impacts expected from different project components. The purpose is to provide an indication of the type of rehabilitation activities that will be required.

Project components

The main infrastructure components to be constructed are as follows:

The infrastructure assessed here includes the following (shown in Figure 2):

1. WTGs X 26, each with 180 m hardstand buffer zone (Note: The proposed Final Layout comprises 28 possible WTG positions, however only up to 26 WTGs positions would be developed).
2. Internal roads: 6 m wide = 39.66kms
3. Substation and Building Complex
4. 33kV OHL internal reticulation lines

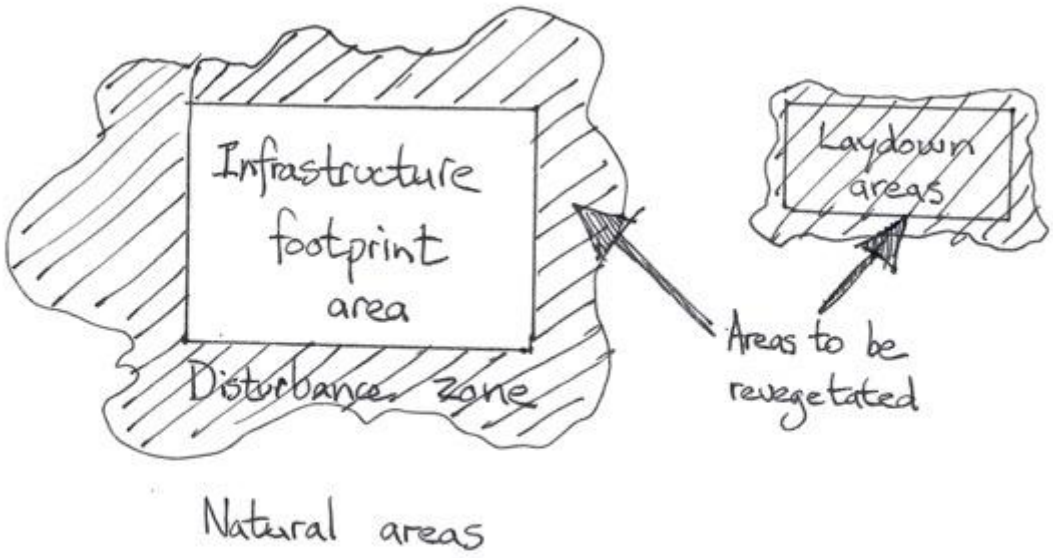

Figure 3: Conceptual diagram of revegetation requirements.

5. Laydown Area 1
6. Laydown Area 2
7. Laydown Area 3
8. Access road north (orange - existing road to be upgraded)
9. Access road south (pink – part of a separate BA process for the grid connection)

Rehabilitation will be required adjacent to all infrastructure (WTGs, roads, substations), as well as in the areas to be used as laydown areas. Typically, construction will affect a larger footprint area than that required for the infrastructure. Once construction is complete, the boundary and laydown areas (Figure 3) must be stabilized and revegetated.

Status of habitat on site

This section provides an outline of the existing status of the site with respect to natural vegetation. The purpose is to provide context for the Revegetation and Habitat Rehabilitation Plan.

Ecosystem context

The project is located within a low mountain range (Figure 4). There are two regional vegetation type occurring in the project area, namely Northern Upper Karoo and Besemkaree Koppies Shrubland.

Northern Upper Karoo occurs in the northern parts of the Upper Karoo Plateau, with its southern extent ending near De Aar. It is a shrubland dominated by dwarf karoo shrubs, grasses and some low trees (Mucina et al. 2006). Within the project area, it occurs in the lower-lying parts of the landscape.

Besemkaree Koppies Shrubland is found on the slopes of koppies, butts and tafelbergs within the plains of the Eastern Upper Karoo (Mucina et al. 2006a). It is a two-layered karroid shrubland. The lower (closed canopy) layer is dominated by dwarf small-leaved shrubs and, especially in

Figure 4: Landscape in the study area looking northwards from the proposed position of WTG28.

precipitation-rich years, also by abundant grasses. The upper (loose canopy) layer is dominated by tall shrubs, namely *Searsia erosa*, *Searsia burchellii*, *Searsia ciliata*, *Euclea crispa* subsp. *ovata*, *Diospyros austro-africanus* and *Olea europea* subsp. *cuspidata* (Mucina et al. 2006a). Within the project area, this is the main vegetation cover type, occurring in the upland parts of the site.

The vegetation on site is typical of this vegetation type. Local species richness is moderate and there is moderate species turnover from one part of the site to another due to topographic and surface rockiness variation. Typical surface terrain is shown in Figure 5.

Ecosystem dynamics in this area are driven by aridity, topographic variation, and substrate conditions. Rehabilitation methods that rely on agricultural techniques such as the application of fertilizer and the planting of cover crops are not necessarily appropriate without additional management, such as irrigation. Seasonal rainfall characteristics can be a limiting factor (in the dry season) and can also affect the risk of soil erosion (during the wet season). The major implication is that active revegetation needs to consider sparse, shallow soils and limited moisture availability.

Figure 5: Typical surface terrain and vegetation on site.

Possible problem areas

Some components of the landscape are more vulnerable to disturbance than others and are therefore more likely to become problematic areas with respect to revegetation. These areas have mostly been avoided in the design of the project but there are areas where they coincide with proposed infrastructure. The most sensitive conditions are as follows:

- Drainage areas. These areas are vulnerable to erosion from water-flow during storm events which could pose a risk to infrastructure and/or rehabilitation efforts. Active flow and erosion activity is perpendicular to infrastructure, such as roads. Post construction rectification is possible to achieve by implementing additional control measures, although downstream damage is possible. Most drainage areas have been avoided in the design of the layout but there are places where linear infrastructure will cross minor drainage lines.
- Steep slopes: Roads that traverse steep slopes are vulnerable to continuous erosion because of water-flow during storm events. An example of a continuously eroding gravel road at a nearby location is shown in Figure 6. Active flow and erosion are parallel to infrastructure. Post construction rectification is difficult to achieve without major intervention. Sensitive design is therefore crucial, primarily by avoiding construction of roads with steep gradients.

Figure 6: Example of perpetual erosion on steeply sloping gravel road.

Potential constraints to successful rehabilitation

This section provides an outline of key risks and constraints to successful rehabilitation. These include the following:

- Scale of clearing.
- Climate seasonality.
- Weeds.
- Seed availability.
- Soil management.
- Landform stability.
- Ecosystem connectivity; and
- Ecosystem resilience.

Scale of clearing

Clearing for construction will be over a wide area but with a relatively small overall amount of the landscape affected. Most of this clearing will be within the proposed footprint areas, i.e., it will remain permanently cleared and will not require revegetation prior to operation. The amount of revegetation that is required is relatively dispersed within this area and is a small area restricted primarily to temporarily cleared areas, such as the laydown footprint. Areas requiring revegetation will be adjacent to the internal roads, as well as surrounding WTG footprint areas and within laydown and site camp areas that fall outside the infrastructure footprints (Figure 3).

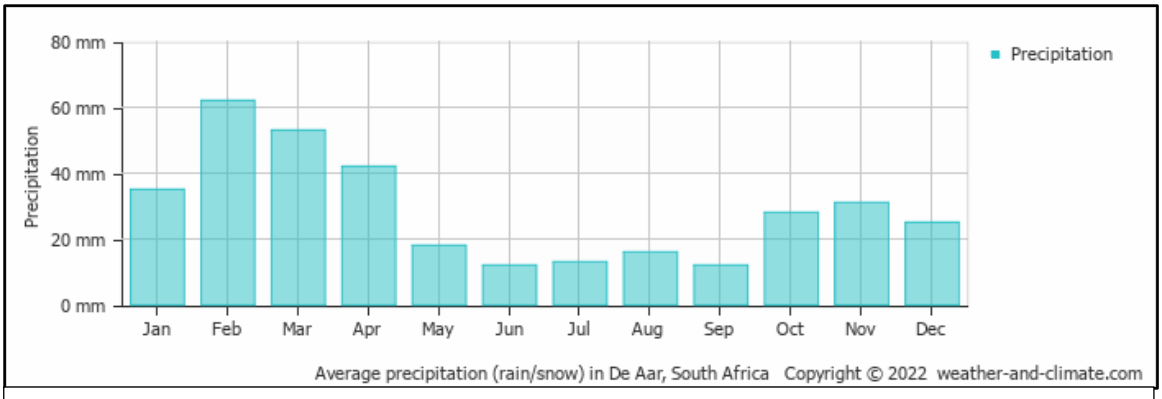

Figure 7: Average precipitation per month for De Aar.

Climate seasonality

The proposal area is in an arid area but where rainfall is moderately predictable and seasonal. However, the amount of rainfall is a limiting factor. These are not expected to be significant constraints to successful revegetation. However, any seeding or planting that is required will have to take place during the rainy season. The average rainfall amounts per month in De Aar are shown in Figure 7 but may vary from year to year. The best strategy is to sow in November or December after rainfall and take advantage of a full summer season of rainfall to promote further growth. Alternatively, moisture limitations can be countered using some form of irrigation during initial revegetation.

Weeds

The project study area has low incidence of weeds on site and in neighbouring areas, although several invasive alien species are known to occur in the general geographical area, for example, *Prosopis glandulosa*. There are, therefore, various species from surrounding areas that could become established on site. The revegetated and disturbed areas are most at risk because they provide the best conditions for the establishment of weeds and invasive plants. The potential risks are moderate, but controllable with the rigorous implementation of the Alien and Invasive Plant Management Plan for the project.

Seed availability

Based on analysis of other nearby rehabilitated areas, it is recommended that some form of re-seeding is used to establish an initial vegetation cover. Indigenous seed is commercially available for various grass species. It is common practice to use a seed mix when sowing in areas for re-vegetation. The main risks associated with this approach are that the seeds available are usually for combinations of species that are not necessarily present or dominant on site. The risks are, however, considered to be relatively low for successful rehabilitation of disturbed areas since a combination of methods can be employed to encourage growth of indigenous vegetation. The main objective of seeding a cover crop is to stabilize the soil surface to control erosion and to create conditions that will promote natural successional processes. Grasses occurring on site and nearby that may possibly be considered (depending on seed availability) include the following:

- *Aristida adscensionis*
- *Aristida congesta*
- *Aristida diffusa*
- *Cenchrus ciliaris*
- *Chloris virgata*
- *Cynodon dactylon*
- *Digitaria argyrograpta*
- *Digitaria eriantha*
- *Enneapogon cenchroides*

- *Enneapogon desvauxii*
- *Enneapogon scaber*
- *Eragrostis bergiana*
- *Eragrostis curvula*
- *Eragrostis lehmanniana*
- *Eragrostis obtusa*
- *Eragrostis superba*
- *Eustachys paspaloides*
- *Fingerhuthia africana*
- *Heteropogon contortus*
- *Hyparrhenia hirta*
- *Melica decumbens*
- *Melinis nerviglumis*
- *Sporobolus africanus*
- *Stipagrostis ciliata*
- *Stipagrostis obtusa*
- *Stipagrostis uniplumis*
- *Tetrachne dregei*
- *Themeda triandra*
- *Tragus berteronianus*
- *Tragus koelerioides*

Soil management

Topsoil is arguably the single most important revegetation resource in the project area. Topsoil and subsoil that currently occurs in areas to be cleared must be recovered to be used in rehabilitation areas. Topsoil must be carefully managed and stockpiled to ensure that it does not become degraded. The success of this process is one of the biggest risks associated with successful rehabilitation of disturbed areas. However, rehabilitation programmes have been successfully undertaken through effective soils management.

Landform stability

The existing slope of the areas that will require rehabilitation varies from flat to gently inclining. Particular attention will have to be paid to maintaining surface stability during the early stages of rehabilitation. Minimizing surface water runoff from any small catchment areas that currently exist or that will be created from construction activities will be an important strategy, especially when these occur at elevated points in the landscape. Possible strategies that can be employed include the following:

- Contouring topsoil to match the slope of the surrounding landscape.

- Using rocks and boulders to provide stable obstructions.
- Spreading a thin layer of cleared vegetation debris from cleared areas over re-contoured topsoil; and
- Rapid re-instatement of soil into holes and trenches dug for infrastructure components.

Rehabilitation implementation strategy

The rehabilitation process should form an integral part of site and construction activities. The ECO, who will be responsible for ensuring that the Revegetation and Habitat Rehabilitation Plan is implemented, must be appointed and on-site at project inception. This person should form an integral part of the project team.

The following descriptions, in the subsections below, outline the various stages and processes of the Revegetation and Habitat Rehabilitation Plan.

Cleared plant material

Surface plant material that is cleared during construction activities can be stockpiled and/or bagged to be used as mulch during rehabilitation. Mulching is the covering of the soil with a layer of organic matter including leaves, twigs, bark or wood chips. The main purpose of mulching is to protect and cover the soil surface, as well as serve as a source of seed for re-vegetation purposes. The following principles should be adhered to:

- During local site clearing the standing vegetation should not be cleared and mixed with the soil, but should be cleared separately, either mechanically or by hand using a brush-cutter. The cleared vegetation should be stockpiled and used whole or shredded to protect the soil in disturbed areas and promote the return of indigenous species.
- Mulch is to be harvested from areas that are to be denuded of vegetation during construction activities. No harvesting should take place outside the area to be disturbed by construction activities.
- Brush-cut mulch should be stored for as short a period as possible.
- Seed released from stockpiles should be collected for use in the rehabilitation process.

Seed collecting

The re-application of topsoil and cleared vegetation (as mulch) will be sufficient for rehabilitation at this site. However, the rehabilitation specialist can consider, as an option, to collect indigenous seed to sow. This measure is therefore not required, but is a possibility, if found necessary. If needed, indigenous seed can be collected from plants present on site, and should be used immediately, or stored appropriately, and used at the start of the following wet season. Seed can be broadcast onto the soil but should preferably be applied in conjunction with measures to improve seedling survival, such as scarification of the soil surface, or simultaneous application of mulch. The following principles apply:

- Indigenous seeds may be harvested for the purposes of re-vegetation in areas that are free of alien invasive plants, either at the site or prior to clearance of vegetation from suitable neighbouring sites.
- Seed may be harvested by hand and, if necessary, dried or treated appropriately.
- Seed gathered by vacuum harvester, or other approved mass collection method, from suitable shrubs, or from plant litter surrounding the shrubs, must be kept apart from individually harvested seed.
- No alien or foreign species seed is to be used or brought onto the site.

Commercial seeding

In some areas the natural regeneration of the vegetation may be poor, and the application of seed to enhance vegetation recovery may be required. The use of commercial seed mix is at the discretion of the ECO. Mixed seed is available from commercial suppliers. A typical seed mix varies from place to place and may depend on availability and location.

As a principle, the mixture of seeds should include the following:

1. A mixture of annual and perennial plants.
2. Includes pioneer species.
3. Selected species must be able to grow in the area where they are being used.
4. Roots must have a binding effect on the soil.
5. The final mixture must not cause an ecological imbalance in the area.

For the current site, any of the tabulated species can be used (page 15 - 16 above), depending on commercial availability.

Soil, wetland and vegetation management

The following soil, wetland and vegetation management measures are proposed to aid in limiting impacts, as well as to assist with successful rehabilitation:

1. Soil must only be stripped from areas that are to be disturbed during construction or maintenance and not from any adjacent or other areas.
2. Erosion control measures must be included in the design of linear infrastructure.
3. Vehicles must be restricted to travelling only in designated roadways to limit the ecological footprint of the proposed development activities.
4. All disturbed areas must be rehabilitated using stockpiled soils, as required. This should be done within the shortest possible time after completion of construction activities to reduce the amount of habitat converted at any one time and to speed up the recovery of natural habitats.

5. The extent of all local construction sites must be demarcated, and no vegetation is to be removed outside of this zone.
6. If vegetation is to be cleared on site, erosion control measures must be kept in place to ensure that excessive scarring of the landscape is limited.
7. Adequate storm water management must be incorporated into the design of the project in order to prevent erosion. This will be contained in the Stormwater Management Plan.
8. Stripping and clearing of vegetation must ideally be planned to be done during the dry season.
9. No structures are to be constructed within the riparian areas or within the active stream channel as far as possible. If possible, all support structures should be developed above the 1:100-year flood line. Or, if that is not possible, above the 1:50 year flood line.
10. Sensitive areas in the vicinity of construction works must be fenced for the duration of the construction phase and designated as 'no-go' area.
11. For larger revegetation areas, such as laydown areas, these should be fenced for a few years after revegetation to limit grazing impacts.
12. Where possible, revegetated areas should, where appropriate, also be the target habitat for rescued plants.

General considerations

- Progressive rehabilitation is an important element of the rehabilitation strategy and should be implemented where feasible. Rehabilitation of disturbed areas should therefore be carried out concurrently with construction, as far as possible. Current disturbed footprint areas must be kept to a minimum.
- Once re-vegetated, areas should be protected to prevent trampling and erosion of the rehabilitated area.
- No construction equipment, vehicles or unauthorized persons should be allowed onto areas that have been re-vegetated.
- Any runnels, erosion channels or wash-aways developing after re-vegetation should be backfilled and consolidated to restore them back to a proper condition.
- Material removed from the excavation that is not suitable or not required for backfill may be spread evenly over the disturbed area. However, spreading of subsoil is not permitted.
- The local topography must be returned to as close to its original state as possible. If possible, sites should not be levelled.
- Where necessary, re-vegetation can take place using seed, rescued plant material, or mulching. Where the affected area is less than 1 m across, passive re-vegetation can be employed, where natural ecological processes are relied upon to promote vegetation growth, but it is preferable to actively restore vegetation cover, as this reduces the risk of erosion.
- Compacted ground must be rehabilitated by ripping to a minimum depth of 600 mm.
- Rock piles should be deployed in a heterogenous way to mimic habitat variability on site.

Rehabilitation programme

The following table has been prepared as a guideline to the various activities required. The table provides general information and is to be read in conjunction with the Revegetation and Habitat Rehabilitation Plan detailed in the sections above.

Preconstruction actions

Action	Responsibility	***Frequency***
Identify and protect sensitive areas	ECO	Once-off
Comprehensive photographic record of areas to be cleared	ECO	Once-off

Construction phase actions

Action	Responsibility	***Frequency***
Vegetation clearing, stockpiling of plant material & topsoil	Contractor	Ongoing
Seed collecting, if required	Rehabilitation specialist	Ongoing
Landscaping	Contractor	Ongoing
Fence off rehabilitation areas, if necessary	Contractor	Ongoing
Implementation of rehabilitation measures (terracing, fascine work, mulching, etc.)	Contractor	Ongoing
Soil levelling, seeding into rehabilitation areas, etc. to establish new vegetation.	Contractor	Ongoing
Photographic record of rehabilitation actions	ECO	Ongoing as part of normal ECO monitoring

Post-construction phase actions

Action	Responsibility	***Frequency***
Monitor site for erosion, alien plants, vegetation growth	ECO / Rehabilitation Specialist	3-monthly and ad hoc for one year, thereafter annually for three years
Remediation in areas where rehabilitation is progressing poorly. If necessary, sow grass mix into bare patches.	Contractor	Ad hoc

Monitoring programme

In order to determine the effectiveness of rehabilitation activities, monitoring must be undertaken. This section provides a description of a possible monitoring programme that will provide an assessment of the success of the rehabilitation activities.

The objective of monitoring is to ensure that the agreed rehabilitation process is successful, and that the prescribed rehabilitation objectives are met. There is therefore a need to monitor the progress of the physical aspects of rehabilitation during the construction, operational and closure phases, and to ensure that the desired final land use is successfully established. Maintenance of rehabilitated sites is often the difference between the ultimate success or failure of rehabilitation – monitoring of rehabilitation will determine whether rehabilitation objectives and requirements are being achieved, and whether there are any residual impacts.

During the construction phase, the ECO will be responsible for monitoring and inspecting contractor's written records to illustrate compliance with the EMPr. The aim of compliance monitoring is to verify that the responsible parties are adhering to the procedures, management conditions and specifications contained in the EMPr, and the conditions set out in the EA. Monitoring by the ECO will also include regular monitoring of:

1. Control of alien vegetation associated with the infrastructure; and
2. Rehabilitation of construction sites after construction.

Note: Monitoring requirements of the Alien and Invasive Management Programme are also applicable but are not repeated here.

Rehabilitated vegetation monitoring

One of the best indicators of successful rehabilitation is the status of the vegetation that emerges in rehabilitated areas, both in terms of cover/biomass and species composition. A possible method of monitoring vegetation requires annual collection of species compositional data and dominance measures of plant growth within both rehabilitated areas and in nearby benchmark areas (in which natural vegetation still occurs). A possible approach in which data can be analysed using standard ecological statistical methods is as follows:

Establish monitoring points in key locations spread across the range of rehabilitated areas, as well as in nearby undisturbed natural vegetation. The number and location of these can be determined using random, stratified random or subjective methods, but the number of sites should comply with basic statistic power requirements. Plant species compositional data must be collected in each rehab monitoring site as well as in a reference site adjacent to the rehabilitated area that have similar ecological characteristics. There are several important characteristics of the data collection strategy:

1. In comparison to collecting data on only key species or dominant species, total floristic composition data provides relatively complete ecological information on the vegetation that is being assessed. A total list of species in benchmark sites is also required to generate diversity indices (richness, evenness and functionality).
2. Analysis of floristic trends over time provides a valuable tool for determining whether successional changes in the rehabilitated site are converging on a natural state over time, i.e., whether a desired ecological state is being achieved, or whether there is divergence towards an alternative ecological state.
3. Comparison with a reference site provides scientific control that offsets external effects on floristic data due to factors such as rainfall and grazing effects.

A species list must be compiled of all species occurring within the rehabilitated site, treating the site as a vegetation sample plot. For each species, an estimate must be made of the aerial cover, using the Braun-Blanquet cover-abundance scale or similar method. This is a quick assessment technique that provides a measure of relative dominance of each species. It estimates cover visually, based on percentages at the top end of the scale and abundance estimates for species with a low plant cover. The cover-abundance scale is as follows (alternative methods can also be used):

Symbol	Cover range (%)	Analysis value (%)
r	<0.1	0.05
+	0.1 – 1	0.5
1a	1 – 3	2
1b	3 – 5	4
2a	6 – 15	10
2b	16 – 25	20
3	26 – 50	38
4	51 – 75	63
5	>75	88

A useful approach is to also collect photographic records of all plant species for reference purposes. These can be posted onto a citizen-science website, such as iNaturalist (https://www.inaturalist.org), where identifications can be obtained from knowledgeable botanists. This is an alternative method to collecting physical herbarium specimens for species identification purposes and also provides verifiable records of species that were encountered.

Pre-construction and construction phase monitoring

The following monitoring is required during the construction phase of the project:

Monitoring action	*Indicator*	*Timeframe*
Photographs of area prior to construction	Baseline condition / pre-construction state	Pre-construction

Operational phase monitoring

The following monitoring is optional during the operational phase of the project:

Monitoring action	*Indicator*	*Timeframe*
Document rehabilitation measures implemented, and success achieved in problem areas	Decline in vulnerable bare areas over time	Annually
Vegetation monitoring (as described in the text above)	Species compositional change over time	Annually

Concluding remarks

This Revegetation and Habitat Rehabilitation Plan must be included in the EMPr for the project and implemented during the construction and operational phases of the project. Rehabilitation must be undertaken within the shortest possible timeframe after completion of construction activities to reduce the amount of habitat converted at any one time and to speed up the recovery of natural habitats. The information in this document is intended to provide various options for revegetation and habitat rehabilitation that can be adapted for specific situations on the ground. The exact approach adopted for rehabilitation is dependent on local conditions and situations and is not meant to adhere strictly to a formula. The experience of the ECO, Project Manager, Rehabilitation Specialist, Contractor, and the construction crew are important for ensuring that a successful revegetation programme is implemented.

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