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LIST OF ABBREVIATIONS

CARA: Conservation of Agricultural Resources Act 43 of 1983
DEA: Department of Environmental Affairs
EA: Environmental Authorisation
ECO: Environmental Control Officer
EMP: Environmental Management Plan
NEMA: National Environmental Management Act 107 of 1998
LFA: Landscape Functional Analysis (Tongway and Hindley 2004)
IP: Invasive Plant (indigenous or alien)

LIST OF DEFINITIONS:

Accelerated soil erosion: Soil erosion induced by human activities.
Acceptable cover: An acceptable cover shall mean that not less than 40% (in regions receiving less than 400 mm rain per annum), of the area rehabilitated and/or planted shall be covered with grass and other species and that there shall be no bare patches of more than 500 cm in maximum dimension.
Alien: originating from another country or continent and originally different environment, commonly used to describe plants that are not indigenous to South Africa and have become problematic (spreading rapidly, threatening existing biodiversity)
Allelopathic components: one or more biochemical compound produced by a plant and released through leaf litter or roots that suppresses the growth, survival, and reproduction of other surrounding vegetation
Bare soil: Un-vegetated soil surface, unaltered by humans
Bush encroachment: means stands of plants of the kinds specified in CARA Table 4, where individual plants are closer to each other than three times the mean crown diameter
Compacted soil surface: A soil surface that has been hardened by an outside source, causing the soil to be more compacted than the surrounding area.
Container plants: Container plants include all vegetation which are bought or supplied in acceptable containers from nurseries or vegetation lifted out of their natural position and placed in containers.
Desirable end state: the future condition or target on which the rehabilitation is designed and that will serve later as a basis for rehabilitation success evaluation. This can be based on a reference site or modelled according to available information on historic vegetation
Ecological rehabilitation: The process of assisting the recovery of a degraded or damaged ecosystem in a trajectory that renders the ecosystem fully functional, stable, and able to develop further, but not necessarily returning to the original historic state.
**Ecological restoration:** The process of assisting the recovery of an ecosystem that has been degraded damaged or destroyed, in a trajectory that ultimately returns the ecosystem to its natural successional stage.

**Ecosystem:** The combination of biota within a given area, together with a suitable environment that sustains the biota and the interactions between biota. It can have a spatial unit of any size, but shows some degree homogeneity as far as structure, function and species composition is concerned. Small-scale ecosystems typically link up to larger scale ecosystems and all contribute to the ecosystem function and services at the landscape-scale.

**Establishment of grass:** All procedures necessary to produce an acceptable cover of grass on an area.

**Establishment Period:** The Establishment Period is defined as the period beginning from the actual planting or placing of vegetation until three months thereafter, unless otherwise specified or unless grass cover is unacceptable or unless plants have not taken.

**Extinction debt:** is a concept that describes the future extinction of species due to events in the past. Extinction debt occurs because of time delays between impacts on a species, such as destruction of habitat or reduction of population size, and the species' ultimate disappearance.

**Geophytic:** resprouting during the growing season from an underground storage organ such as bulbs, corms, tubers or rhizomes, and dying back completely during unfavourable seasons

**Indigenous:** refers to a plant or animal that occurs naturally in the place in which it is currently found

**Invasive plant:** a kind of plant which has under section 2 (3) of CARA been declared an invader plant, and includes the seed of such plant and any vegetative part of such plant which reproduces itself asexually

**Landscape:** Consists of a mosaic of two or more ecosystems that exchange organisms, energy, water, and nutrients.

**Nursery conditions:** These are the necessary conditions to maintain healthy growth of rescued and/or container plants. This includes protection of such plants against wind, frost, direct sunlight, pests, rodents, diseases, and drought. It also includes the provision of suitable water, fertilizer and any other measures required to maintain the container plants.

**Period of Maintaining:** The Period of Maintaining is defined as the period following directly after the Establishment Period until the end of the Period of Maintenance for the whole Contract as defined in the General Conditions of Contract, unless otherwise specified.

**Revegetation:** The process of establishing a vegetative cover on exposed soils, regardless of species composition or structure, as long as the species are non-invasive and their presence will not impede the gradual process of ecological rehabilitation or –restoration.
**Soil Erosion:** is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of inter alia chemical processes and or physical transport on the land surface.

**Scarifying:** To roughen the surface of soil as a preparation for seeding or topsoil addition.

**Trimming:** To neatly round off the levels of existing or previously shaped earthworks to blend in with the levels of other earthworks, constructed works, or natural landforms.

**Transformation:** The conversion of an ecosystem to a different ecosystem or land use type.

**Topsoil:** uppermost layer of soil, in natural vegetation maximally 30 cm, in cultivated landscapes the total depth of cultivation, containing the layer with humus, seeds and nutrients. Topsoils that are applied to landscapes to be rehabilitated must be free of refuse, large roots and branches, stones, alien weeds and/or any other agents that would adversely affect the topsoils suitability for re-vegetation.

**Weed:** a plant that grows where it is not wanted, and can therefore be an indigenous or alien species. An unwanted plant growing in a garden is just called a weed, but the 198 listed IPs are called “declared weeds and invaders”.

Declaration of Consultant’s Independence

I, Gerhard Botha, as the appointed specialist hereby declare that I:

» act/ed as the independent specialist in this application;
» regard the information contained in this report as it relates to my specialist
  input/study to be true and correct, and
» do not have and will not have any financial interest in the undertaking of
  the activity, other than remuneration for work performed in terms of the
  NEMA, the Environmental Impact Assessment Regulations, 2014 and any
  specific environmental management Act;
» have and will not have no vested interest in the proposed activity
  proceeding;
» have disclosed, to the applicant, EAP and competent authority, any material
  information that have or may have the potential to influence the decision of
  the competent authority or the objectivity of any report, plan or document
  required in terms of the NEMA, the Environmental Impact Assessment
  Regulations, 2014 and any specific environmental management Act;
» am fully aware of and meet the responsibilities in terms of NEMA, the
  Environmental Impact Assessment Regulations, 2014 (specifically in terms
  of regulation 13 of GN No. R. 326) and any specific environmental
  management Act, and that failure to comply with these requirements may
  constitute and result in disqualification;
» have provided the competent authority with access to all information at my
  disposal regarding the application, whether such information is favourable
  to the applicant or not; and
» am aware that a false declaration is an offence in terms of regulation 48 of
  GN No. R. 326.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
February 2018
1. PURPOSE

The purpose of a search and rescue and rehabilitation plan is to address the need to mitigate impacts leading to a loss of species due to the Kruisvallei Hydroelectric Power Generation Scheme and to furthermore ensure that areas cleared or impacted during construction activities are rehabilitated with a plant cover that reduces the risk of erosion from these areas as well as restores some ecosystem function.

The objectives for search and rescue are to provide:
» Protocols for the removal, temporary storage and replanting of different plant species of conservation concern.
» Criteria for evaluating search and rescue success.

The purpose of the rehabilitation plan for the site can be summarised as follows:
» Achieve long-term stabilisation of all disturbed areas to minimise erosion potential.
» Re-vegetate all disturbed areas with suitable local plant species.
» Minimise visual impact of disturbed areas.
» Ensure that disturbed areas are safe for future uses.

This plan should be closely aligned with other site-specific plans, which may include an erosion management plan, soil management plan and an alien plant management plan.

2. SCOPE

This plan, as a requirement to obtain an authorisation, is a legally authorised document that must be implemented to fullfil the requirements to obtain such an Environmental Authorisation (EA). However, the management plan is an evolving guideline that needs to be updated or adapted as progress is made with the rehabilitation and revegetation of the project area, and successes and failures of procedures identified.

The objectives of rescuing animals and plants, rehabilitation and revegetation in the project area are:
» Preventing the loss of species either directly or through future extinction debts and minimising impacts of development on population dynamics of species of conservation concern.
» Preserving the natural configuration of habitats as part of ecosystems, thus ensuring a diverse but stable hydrology, substrate and general environment for species to be able to become established and persist.
» Where the natural configuration of habitats have been significantly altered but will not be permanently transformed, recreate as near-natural habitats as practically possible to re-establish ecosystem functionality to those habitats.
» Preserving or recreating the structural integrity of natural plant communities.
» Actively aid the improvement of indigenous biodiversity according to a desirable end state according to a previously recorded reference state
  o This reference state, if healthy, will be dynamic and able to recover after occasional disturbances without returning to a degraded state.
» Improving the ecosystem function of natural landscapes and their associated vegetation.

3. LEGISLATION AND STANDARDS

Relevant legislation:
» Conservation of Agricultural Resources Act 43 of 1983.
» Species listed as protected under the Free State Nature Conservation Ordinance (FSNCO), Act No. 8 of 1969.

4. SITE DESCRIPTION RELATING TO HISTORIC AND CURRENT VEGETATION COVER

The site is located approximately 13km north-west of the Clarens which is situated within the Dihlabeng Local Municipality and the greater Thabo Mofutsanyane District Municipality. The Kruisvallei Hydroelectric Power Generation Scheme and associated infrastructure will be distributed over the following farms:

» The Proposed Middle Kruisvallei Hydroelectric Facility:
  o Kruisvallei 190

» The Proposed Lower Kruisvallei Hydroelectric Facility:
  o Kruisvallei 190
  o Middelvallei 130

» The proposed 22kV power line
  o Middelvallei 130
  o Kruisvallei 190
  o Spioenkop A1259
  o Portion 0 of Node 77
  o Portion 2 of Node 77
  o Portion 0 of Goedehoop 743
  o Portion 1 of Goedehoop 743
  o Drupfontein 710
  o Kleinzonderhout 289
  o Remainder of Modderina 1116
  o Portion 1 of Modderina 1116
4.1. Grasslands overview

Grasslands are one of the most productive landscapes of South Africa and the backbone of a large portion of the local agricultural sector. The dense herbaceous layer holds typically dispersive soils together and preserves it from erosion. Grasses are considered to be highly efficient binders of CO2 which keeps carbon in the soil instead of in the air, and are therefore a potent tool for combating climate change. The loss of the herbaceous layer, associated loss of soil organic matter and clay minerals during accelerated erosion reduces the water holding capacity of soil, exacerbating drought conditions substantially and leading to an overall reduced productivity and resilience of the vegetation.

The name ‘grassland’ is generally misleading and conceals the fact that South African Grasslands are host to an exceptional species richness. Considering vegetation alone, more than 3000 plant species are found within the grassland biome – of which only one in six is a grass species. Many of the succulents and geophytes found in these grasslands are endemic to their area of occurrence – some of the more unique species are of the families Euphorbiaceae and Orchidaceae.

Grassland ecosystems in South Africa are severely threatened – the largest threats being transformation to alternative land uses, reduction of basal cover and associated unstable soil conditions due to continued heavy grazing, and Invasive Alien Plant (IAP) infestations (Tainton 1999). Accelerated soil erosion as a result of land use patterns and associated degradation are a wide-spread concern, with the high-lying areas of the Eastern Cape regarded as some of the most erodible soils in South Africa (Hoffman and Ashwell 2001). Areas within the grasslands that will be particularly prone to erosion are localised, very shallow soils that provide a more arid environment to plants and thus only have a low basal cover of grasses, with a significant presence of dwarf shrubs. In addition, soils with a high clay content are prone to high erosion rates once they become bare, and recovery on such soils may be slow or limited. These ecosystem threats have not only led to habitat loss and species extinction, but also loss of ecosystem services – the latter with detrimental consequences to the end-users of those ecosystem services – humans.

4.1.1. Species of special concern

The maintenance of biodiversity is a prerequisite to maintain ecosystem health and functioning; once extinct, species cannot be brought back. The local extinction of species, no matter how small or insignificant a species may appear to be, constitutes the gradual transformation of an ecosystem. The cumulative effects of this contribute to further transformation, often degradation and loss of resilience, of the ecosystem. Unfortunately, very little is known about the cumulative effects of local extinctions, and the time scale over which these occur. Extinction debts thus often occur many years
after a landscape transformation has been brought about, as the prerequisites of a viable population of a species were not known at the time of the transformation. Good environmental management therefore requires the application of the "Precautionary Principle", aiming to minimise the risk of current and future extinctions, to compensate for uncertainties about the full potential of impacts that could be detrimental to ecosystem functioning, and thus to human quality of life. One way of ensuring this is to protect and manage populations of plants and animals within an area, and make sure they do not fall below a minimum viable size. This is the smallest number of individuals which can reproduce and function normally, even under stressful conditions such as drought. It is often not known what this minimum viable population size for individual species is, but it is widely recognised that population numbers of species of special concern are decreasing. Hence, it will always be important to rescue and retain as many individuals of such species in their native environments as possible.

4.1.2. Effect of removing individuals of species of conservation concern

Species of conservation concern are declining either due to overexploitation, their natural re-establishment rates after destruction are extremely low, or because their range of occupancy is limited and further infringed on by development. Most plant populations require a certain minimum number of individuals within a population or metapopulation to allow for sufficient genetic transfer between individuals. This prevents genetic erosion and hence weakening of the ability of individuals to persist in their environments. Similarly, where the distance between metapopulations is significantly increased due to fragmentation and the resultant loss of some populations, populations may suffer genetic decline due to restricted movement of pollen. Pollinators or other species that depend on a particular plant species for a specific microhabitat or food source may be equally affected because of the reduction of available resources. Therefore, the aims of plant rescue actions are always to maintain as many individuals of a plant population in as close proximity to the original habitat as possible, to minimise loss of individuals and fragmentation of populations, and to prevent the creation of future extinction debts of the development.

4.1.3. Current vegetation cover on the project area

The study area can be described as a concave landscape consisting of a gradual valley-bottom section, with the Ash River forming the lowest part of the valley, and steeper, more undulating slopes to the west and east. The western boundary of the study area can be described as relatively rugged, comprising of moderate to steep east facing talus slopes of a low mountain. The south-eastern boundary is also relatively undulating with steep west facing talus slopes of a small mesa. The remainder of the eastern portion of the study area (central and north-eastern portion) is more gradual, comprising of moderate steep slopes.
The Ash River has a relatively low gradient (less than 0.2%), sloping in a largely northern direction. Similarly, the valley is relatively flat with gentle slopes (less than 1.36%) towards the Ash River. The low gradient valley varies greatly in size throughout the study area and may become as broad as 408m (central portion of the study area). To the south, the valley bottom section becomes slightly narrower, but to the north the valley is very narrow and confined between the rocky outcrops (less than 30m). The morphology of the Ash River has been severely altered due to the impacts associated with the Ash River outfall. Throughout most of this portion of the river, the banks have been severely eroded, creating steep, almost vertical drops of more than 4 meters in some areas. Subsequently the river bed has been lowered increasing channelization throughout most of the river.

The study area is situated in the Grassland biome and Mesic Highveld Grassland Bioregion. The vegetation in and surrounding the study area is predominantly Eastern Free State Sandy Grassland (Gm4) with the more undulating hills and small mountains covered by Basotho Montane Shrubland. During the Ecological survey conducted by Botha (2017) the following habitats were identified:

- **Valley Bottom Wetland**: Relative small wetland bodies located in the lower lying portions of an undulating landscape. These wetlands are typically perpendicular to the Ash River and terminate into this river. These wetlands are mostly seasonal. Channel erosion is a prominent feature with vegetation regarded as semi-natural to slightly disturbed due to overgrazing, trampling and erosion. These wetlands are characterized by a strongly developed graminoid layer; especially grass species and some sedges including; *Imperata cylindrica*, *Paspalum dilatatum*, *Bromus catharticus*, *Helictotrichon turgidulum*, *Eragrostis planiculmis*, *Isolepis dioabolica*, *Kyllinga erecta* and *Juncus rigidus*.

- **Seepage Wetland**: This seepage is predominantly surface water fed due to underlying shallow geology. This seepage wetland is saturated for extended periods of time. The vegetation of this seepage is in a relative natural condition characterized by *Phragmites australis*, *P. dilatatum*, *Andropogon appenduculatus*, *H. turgidulum*, *Bulbostylis schoenoides*, *Isolepis costata*, *I. sepulcralis* and *Juncus dregeanus*.

- **Back flooded pools**: These permanent inundated pools form behind the weirs due to the damming effects of these structures. These back flooded areas are characterised by hydrophytic graminoids and rushes with some aquatic herbs. This artificially created habitat is characterized by *P. australis*, *Typha capensis*, *Carex acutiformis*, *Isolepis diabolica* and *Juncus rigidus*.

- **Permanent wet (saturated) habitats (including sand bars and islands) associated with the Ash River**: The lower elevated regions fringing the Ash River and areas of sand deposition within the channel. These areas are permanently saturated with inundation occurring during the wet period and may be prevalent for extended periods of time. This habitat has been greatly affected by the Ash River Outfall, with impacts associated with the Outfall, most notable erosion and the increase in
flow velocity, causing a notable reduction in size and presence of this habitat type. Typically, these areas are characterised by sedges and rushes such as; *I. diabolica*, *Jucus oxycarpus* and *C. acutiformis*, as well as relative large stands of *P. australis* and *T. capensis*.

» Seasonal Wet (saturated) habitats associated with the Ash River: Similarly, to the permanent wet habitat, this habitat has been greatly impacted by the Ash River Outfall, reducing the extent of this habitat type. Other disturbances within this habitat include the invasion of *Salix babylonica* which may form dense patches, overgrazing through livestock (mainly cattle) and some ploughing (minimal encroachment into this habitat). The seasonal wet zone is characterised by a vegetation coverage dominated by graminoids comprising of a more or less equal relationship between sedges and graminoids such as *C. acutiformis, I sepulcaris, B. catharticus, I. cylindrica* and *P. dilatatum*. Exotic and Invasive Alien Herbaceous Plants are also a prominent feature of disturbed areas within this habitat type.

» Temporary Wet (saturated) habitats associated with the Ash River: As for the previously two described habitats, this habitat has also been greatly impacted by the Ash River Outfall, reducing the extent of this habitat type. Probably the most significant impacts within the remaining habitats include grazing (high intensity) and transformation of land through ploughing. Overgrazing has led to the replacement of palatable species with largely unpalatable, more resistant species. Furthermore, these areas are prone to invasion with invasive alien trees and shrubs such as *Salix babylonica, Pyracantha angustifolia* and *Rosa rubiginosa*. This habitat is predominantly dominated by a dense tufted grassland, comprising of species such *B. catharticus, P. dilatatum, Pennisetum thunbergii, Aristida junciformis, H. turgidulum, Eragrostis plana, E. planiculmis* and *E. patentissima*.

» Riparian fringes: A riparian tree community dominate a few localities along the stream bank, especially within clayey areas of the alluvial deposition zone. These riparian patches are dominated by the exotic tree *Salix babylonica* and is associated with shrubs such as *Leucosidea sericea* and *Diospyros lycioides*.

» Moist grassland habitat: These moist grasslands resemble a semi-natural to transformed form of Eastern Free State Sandy Grassland and cover gently undulating slopes and lowlands fringing the hydrological zones associated with the Ash River. The majority of this habitat type has undergone some form of transformation due to excessive long-term grazing. Overgrazing has led to the replacement of palatable species with largely unpalatable, more resistant species. Large portions of vegetation have furthermore been ploughed for cultivation purposes. Soil capping and sheet erosion is present within this habitat, although the extent of these disturbances are regarded as low to moderate low. This habitat type is characterised by a largely continual grass cover with a high diversity of forbs/herbs, especially belonging to the plant families of Asteraceae and Fabaceae. Dominant species of this habitat includes; *A. junciformis, H. turgidulum, Eragrostis curvula, E. chloromelas, Cymbopogon dieterlenii, Tristachya leucothrix* and various *Helichrysum* and *Senecio* species.
Sandstone terraces (Outcrops), mesas and talus slopes: These habitats resemble Basotho Montane Shrubland. The main ecological driving force for these similar habitat types are soil depth, or the lack thereof as well as the micro habitat and protection provided by boulders and large stones against veldfire, frost and solar radiation. These habitats comprise of a mixture of dense wiry and tufted grass species and forb species. Furthermore, these areas comprise of various micro habitats (e.g. soil pockets, cracks, shaded areas, moist areas and gravelly patches) and subsequently have a relative high diversity of species inhabiting this habitat. The majority of this habitat type has undergone some form of transformation due to excessive long-term grazing. Overgrazing has led to the replacement of palatable species with largely unpalatable, more resistant species. Large portions of vegetation have furthermore been ploughed for cultivation purposes. Dominant species of this habitat includes; *A. junciformis*, *E. chloromelas*, *Elionurus muticus*, *Cymbopogon dieterlenii*, *Tristachya leucothrix*, *Eragrostis racemose*, *Felicea muricata*, *Monsonia angustifolia*, *Lotonis listii*, *Gnidia krassiana*, *Helichrysum pilosellum*, *H. cepahloideum*, *Lessertia perennants*, *Delosperma spp* and *Argyrolobium spp*.

### 4.1.4. Understanding Dynamics in Grasslands

Healthy grassland dynamics are best understood using the concept of functional landscapes (Tongway and Hindley 2004). Grassland landscapes contain a series of interconnected patches. Nutrients and moisture move from one patch to another, mainly transported by water during rainfall events. Patches are considered basal obstructions such as tufted grasses. The denser such patches, the larger these run-on patches are and the higher their capability to capture and retain nutrients and moisture that channelled their way via runoff zones. In a degrading landscape, the size of run-on (vegetated) zones decreases while runoff (bare) zones increase. This leads to less interception and an increased speed of runoff, and hence an increase in the loss of resources from an ecosystem – referred to by Tongway and Hindley (2004) as a leaking ecosystem.

The exposure of bare areas to the elements causes soil surfaces to crust, further reducing moisture infiltration into the system, and a further loss in nutrients and moisture. The resultant drier and nutrient-depleted system will not be able to support a highly productive grass layer, only a hardier, less palatable dwarf shrub layer, eventually no vegetation.

The first step in any rehabilitation effort will thus be to ‘plug the holes’ of the leaking ecosystem by creating physical barriers as initial run-on zones. Depending on the nature and severity of degradation, such physical barriers can be complemented by overseeding with grass species. Initial revegetation with rescued plant material to create run-on zones is also considered an optimal method to start rebuilding the patch dynamics necessary for a healthy ecosystem.
5. **INTEGRATION WITH EROSION-, STORMWATER- AND IP MANAGEMENT PLANS**

The landscape of the project area consists mostly of grassland used for livestock farming and extensive areas of ploughed lands for the cultivation of predominantly Maize, Sunflower and Lucerne. Current threats to the local ecosystem includes transformation due to ploughing and cultivation practices, long term overgrazing (predominantly cattle), relative high diversity of alien plants including some highly invasive plants and accelerated erosion, especially within habitats associated with the Ash River (indirect impact of the Ash River Outfall) and within smaller wetland systems. All of these forms of degradation occur due to significant alteration and/or weakening of the graminoid layer, slightly to strongly reduced basal pant cover and hence less stable soil conditions.

Thus, regardless of impact of any development in an area, to ensure that the development itself is not, in the long term negatively affected by ‘nature gone wrong’, restoration and/or rehabilitation actions are required.

The most important aspect about any rehabilitation programme is that prior to the initiation of the programme, possible causes of ecosystem degradation must be identified and first removed or mitigated. For this reason, it is imperative that this Plan is conducted in conjunction with other Plans included in the EMPr, specifically focussing on erosion control, stormwater management and clearing of IPs.

Failure to adequately control erosion and inadequate drainage is a major contributor of rehabilitation projects.

6. **ANIMAL SEARCH AND RESCUE**

Several animal burrows, as well as sightings of animals have been made during the investigation of the proposed site (Ecological survey conducted by Botha, 2017). Hares, most rodents and smaller insectivores as well as larger mammals will be able to move away rapidly from construction activities IF vehicles adhere to speed limits set on access roads (60 km/h maximally) and on construction sites (40 km/h maximally). However, smaller burrowing animals and slower-moving reptiles will have to be moved to outside the construction area if and where necessary.

During induction, staff must be made aware of and requested to always be on the lookout for animals, active burrows or nests, and report such sightings on the construction site immediately to the EO and ECO for action. The EO will also be responsible to inspect all surfaces just ahead of construction to detect active burrows and nests, for which professional contractors will have to be brought in to extract the animals and release them outside the footprint area.
Trenches, while open, must also be inspected on a daily basis, especially before being closed, for the presence of fauna that may have become trapped in them. Deep trenches (deeper than 1.5 meters) left open overnight should be visibly barricaded as an effort to prevent larger animals from falling into the trenches. Any animals found must be removed in a safe manner, unharmed, and placed in an area where the animal will be comfortable. If the ECO or contractor is unable to assist in the movement of a fauna species, ensure a member of the conservation authorities assists with the translocation.

No snake species found within trenches or the rest of the development footprint area may be handled by the ECO, contractor or any other staff member. If noted, the conservation authorities should be contacted for assistance or to recommend a qualified snake handler.

All mammal, large reptiles and avifauna species found injured during construction will be taken to a suitably qualified veterinarian or rehabilitation centre to either be put down in a humane manner or cared for until it can be released again.

7. PLANT SEARCH AND RESCUE

Prior to construction, once all the areas where topsoil will be removed or areas will be transformed have been demarcated, the contractor or appointed subcontractor, monitored by the ECO/EO, will be responsible to remove as many bulbous species from the topsoil as possible, and if possible any potential succulents and small indigenous shrubs and graminoids (especially sedges that can be used in the rehabilitation of any wetland areas) that can be transplanted. These are to be kept in a raised, protected position in a designated area until they can be replanted again as part of the rehabilitation process.

Search and rescue for Red data species and those listed within NEM:BA (Act NO. 10 of 2004) – Threatened or Protected Species Regulation are compulsory, whilst search and rescue of other conservation worthy species (e.g. those protected within the Free State Nature Conservation Ordinance, and/or listed within CITES) is highly recommended or at the least a percentage of the occurring species.

*Please take note that none of these species may be impacted/disturbed/removed/destroyed without the necessary authorisation (permit) from the relevant authority (Free State Province: Department of Economic, Small Business Development, Tourism and Environmental Affairs).

The general species listed for potential search and rescue are those species that are not compulsory for search and rescue but may aid in a more effective and faster rehabilitation tempo.
Plant species that must be located and replanted include ALL Red data species:
  » *Boophone disticha* (Declining) – confirmed.

Plant species that should be located and replanted as part of the rehabilitation process, include ALL protected plants:
  » *Gladiolus* spp. (Likely *G. dalenii*) – confirmed
  » *Crinum bulbispermum* – potential species
  » *Eucomis autumnalis* – potential species
  » *Kniphofia linearifolia* – potential species
  » *Gladiolus papilio* – potential species

Plant species that would be useful to keep for transplanting:
  » All species of the family *Crassulaceae* (*Crassula, Cotyledon, Tylecodon, Kalanchoe*)
  » All bulbous species not mentioned above
  » *Pelargonium alchemilloides*
  » *Helichrysum aureonitens*
  » *Helichrysum cymosum*
  » For the wetland habitats associated with Ash River:
    o *Typha capensis*
    o *Carex acutiformis*
    o *Bulbostylis schoenoides*
    o *Eleocharis dregeana*
    o *Fuirena hirsute*
    o *Juncus rigidus*
    o *Juncus exertus*
    o *Juncus oxycarpus*

### 7.1. General: Plant rescue and protection

Successful plant search and rescue (S & R) can only be achieved if:
  » Species can be removed from their original habitat with minimal damage to the plant, especially the roots.
  » All plants removed are safely stored and treated according to their specific requirements prior to being transplanted again.
  » They are relocated into a suitable habitat and protected from further damage and all disturbances to aid their re-establishment.
  » Timing of planting activities is planned with the onset of the growing season.
  » Steps are taken where necessary to aid the initial establishment of vegetation, including occasional watering.
  » The vegetation map provided within the Ecological Assessment Report should be used as a guideline to replant/re-establish the rescued plants in a similar habitat.
7.2. **Plant Relocation Methods**

1. **Geophytes with bulbs, corms, rhizomes or tubers:**
   - These are often difficult to locate during dormant seasons. It is recommended that staff dedicated for plant Search and Rescue be present when topsoil is being removed, and rake through the topsoil at regular intervals to remove bulbs.
   - Store bulbs in paper bags in a protected, dark and dry area until they can be replanted on landscaped topsoil.

2. **Dwarf shrubs and forbs:**
   - Soil around these plants should be carefully loosened and the plant then taken out. This plant material will have to be bagged after removal and kept in cultivation until they can be replanted. This will require the services of either a local nursery, or staff and a protected area will have to be designated to look after these plants for up to 12 months until replanting can take place.

3. **Wetland graminoids:**
   - Relocation may not always be successful – it is recommended that an estimate of the total area to be rehabilitated be determined, and then decided at which density it will be feasible to replant rescued plant material. This plant material will have to be bagged (typical nursery plastic bags or the roots with soil can simply be wrapped in hessian) after removal and stored in artificially created ponds (e.g. low trough with a pond liner) with an appropriate water level to avoid desiccation. These plants should be kept in cultivation until they can be replanted. This will require the services of either a local nursery, or staff and a protected area will have to be designated to look after these plants for up to 12 months until replanting can take place.

8. **TIME OF PLANTING**

   » All planting shall be carried out as far as is practicable during the period most likely to produce beneficial results but as soon as possible after completion of a section of earthworks.
   » The seasonal period for planting at the Kruisvallei Hydroelectric Power Generation Scheme site will be from mid-August to the end of February.

9. **REHABILITATION AND RE-VEGETATION**

9.1. **General**

Successful rehabilitation can only be achieved with:

» A long-term commitment;
» Ensuring final landscaping is completed by the onset of the rainy season;
» Practical, adaptive management; and
» Viable goals of desired outcomes.
Prior to vegetation rehabilitation, all stakeholders involved should be consulted to determine:

» What the rehabilitation is ultimately aiming for where – rehabilitation of grazing lands or rehabilitation of indigenous vegetation,

» A clear definition of incompatible and compatible vegetation on and in the immediate surroundings of the development must be defined and maintained as such.

» Who will take long-term ownership and hence responsibility for the rehabilitation and its subsequent monitoring and management?

The ultimate objective for rehabilitation should focus on the stabilisation of soil erosion, the establishment of a dense and protective plant cover where permissible and the maintenance of habitats to enable vegetation to persist and flourish on rehabilitated areas indefinitely, ultimately relying only on environmental resources.

9.2. Planning Rehabilitation work

Rehabilitation work must be planned in conjunction with timing of various components of the construction process. Thus for every construction section where rehabilitation must be done (e.g. batching plant, topsoil stock pile, road reserves), there must be an operational outline on:

» What needs to happen there – S & R, topsoil salvage, final landscaping, removal of foreign objects, etc.;

» what needs to be mitigated – including storm water- and erosion management.

» how will this intervention be done (method statements):
  o including schedule of work;

» realistic and desirable end states:
  o including list of species that should be established and/or replanted to initiate rehabilitation after initial revegetation;

» approximate timeframes;

» monitoring protocol to evaluate success or failures of interventions:
  o establish permanently marked transects and monitor with fixed-point photography coupled with LFA;

» who will be responsible for each action/task; and

» how will different actions be integrated to achieve and maintain the desirable end state of the environment of that management unit.

9.3. Setting realistic rehabilitation goals

Rehabilitation efforts typically aim at improving ecosystem function that consists of a series of processes, which can in the end be evaluated against a desired outcome or reference state of the vegetation and environment.
Attainable goals of rehabilitation on the project area should be possible and viable for at least the following:

» Stabilisation of soils;
» Stabilisation of riparian areas;
» Storm water reduction through management and wetland integrity;
» Clearing of IPs:
   o The degree to which IPs can be cleared from the project area needs to be determined according to available project funding, personnel and project requirements;
» Restoring and/or rehabilitating vegetative cover to obtain an acceptable vegetation cover that can be maintained or persists on its own indefinitely; and
» Successful re-establishment and continued survival of all plant species of special concern rescued prior to construction.

9.4. Remove or ameliorate the cause of degradation and transformation

Removal and/or amelioration of the cause of environmental degradation and transformation will include:

» Physical rehabilitation of topsoil where it has been removed.
» Topsoil on areas that have NOT been cultivated are considered as the upper 20 - 30 cm only. These contain the most important nutrients, micro flora and fauna essential for nutrient cycling processes. Topsoil are also an important source of seeds.
» Subsoils and overburden substrata lack the above elements and will first have to be used for physical rehabilitation of landscapes as and where necessary, and then overlain with topsoil.
» Stabilisation of topsoil and prevention of erosion.
» Removal of all invasive vegetation:
   o Where it is desirable to use brush or logs of the cleared vegetation for soil stabilisation, such material must be free of regenerative material – e.g. seeds or root suckers.
   o Extreme care will have to be taken to prevent the distribution and ensure the destruction of any vegetative propagules or any seeding material of the invasive species present within the project area.
   o Vegetative propagules are often involuntarily distributed by livestock or larger vertebrates.

9.5. Soil treatment for rehabilitation

9.5.1. Topsoil treatment

Topsoil conservation is an integral part of rehabilitation efforts and helps to maintain the productive capability of rangelands. Thus, all topsoil available must be treated as a valuable resource.
Removal of topsoil should be done where:

» Areas will be excavated;
» Areas will be severely compacted; and/or
» Areas will be buried with excavated material.

**Salvaging topsoil**

» Topsoil must always be salvaged and stored separately from subsoil and lower-lying parent rock or other spoil material.
» Topsoil stripping removes up to 30 cm or less of the upper soils.
» Topsoil should be removed (and stored) under dry conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year.

**Salvaging topsoil**

» Viability of stored topsoil depends on moisture, temperature, oxygen, nutrients and time stored.
» Rapid decomposition of organic material in warm, moist topsoil rapidly decreases microbial activity necessary for nutrient cycling, and reduces the amount of beneficial micro-organisms in the soil.
» Stockpiles location if not adjacent to a linear development:
  o At least 5 m from higher vegetation (shrubs or trees);
  o At least 5 m from any drainage lines or natural water bodies;
  o Ideally a disturbed but weed-free area;
» Preparation of stockpile area:
  o Eradicate weeds and alien invasives if no weed-free areas are available;
  o Lay down geotextile;
  o Bund the area with sediment fences 1–2 m away on the downslope side, small earth bank on the upslope side;
» Topsoil is typically stored in berms with a width of 150 – 200 cm, and a maximum height of 100 cm, preferably lower:
  o Place berms along contours;
  o As a general rule would be – the larger the pile of topsoil storage needs to be, the shorter should be the time it is stored;
» Topsoil handling should be reduced to stripping, piling (once), and re-application. Between the piling and reapplication, stored topsoils should not undergo any further handling except control of erosion and alien invasive vegetation;
» Where topsoil can be reapplied within six months to one year after excavation, it will be useful to store the topsoil as close as possible to the area of excavation and re-application;
» In cases where topsoil have to be stored longer than 6 months or during the rainy season, soils should be kept as dry as possible and protected from erosion and degradation by:
Salvaging topsoil

» Spoil materials and subsoil must be back-filled first, then covered with topsoil.
» Generally, topsoils should be re-applied to a depth equal to slightly greater to the topsoil horizon of the respective reference site.
» The minimum depth of topsoil needed for revegetation to be successful is approximately 20 cm:
  o Where sods has been removed prior to clearing, re-applied topsoils can be reduced to about 10 cm before re-application of the sod.
» If the amount of topsoil available is limited, a strategy must be worked to out to optimise revegetation efforts with the topsoil available.
» Wherever possible, an organic mulch should be spread over topsoils, alternatively suitable geotextiles or organic erosion mats can be used.
» Reapplied topsoils should be landscaped in a way that creates a variable microtopography of small ridges and valleys that run parallel to existing contours of the landscape. The valleys become catch-basins for seeds and act as run-on zones for rainfall, increasing moisture levels where the seeds are likely to be more concentrated. This greatly improves the success rate of revegetation efforts.
» Seeding may be necessary where topsoils have been stored longer than six months.
» Topsoils should be removed (and stored) under dry conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year.

9.5.2. Tillage

Where:
» In areas where the original topsoil has been very shallow, or the subsoil has been excessively compacted, such as access roads or portions thereof, revegetation will be much more successful if subsoils are first tilled with suitable ripping or subsoiling machinery.

How:
If organic material from mulching operations is available, such organic material can be incorporated into these tilled subsoils. The objective will be to increase the depth of water infiltration and rooting space, as well as adding roughness to the surface that will better ‘bind’ to the topsoils when these are reapplied. The spacing, number, and depth of rips (tines) must be adjusted to ensure complete shattering of the compacted soils. Tillage equipment must be operated as parallel to topographical contours as possible to reduce the potential of downslope erosion along furrows.

### 9.5.3. Mulches

The application of mulch as part of the rehabilitation process is strongly recommended in the project area as existing soils are fine-textured and dispersive.

- Mulches should be suitable to localised goals of the rehabilitation efforts.
- Fine, pulp-like mulches from shredded succulents are better suited for incorporation in tilling compacted subsoils.
- Coarser, fibrous mulches and erosion mats are recommended to cover topsoils after these have been landscaped (and seeded).
- Where landscaped slopes are relatively steep, hydromulch with tackifier may be applied to stabilise topsoils. Such hydromulch applications are, however, not very favourable to seedling emergence and soil moisture retention.

### 9.6. Initial revegetation

Immediately after final landscaping, the soil surface must be stabilised as soon as possible, preferably with a plant cover. The different habitat types as identified within the initial Ecological Assessment Report should be regarded as management zones. Each management zone will require a specific set of plant species. The balance of these species should also be applicable for the specific management area. Typically for all temporary wet and adjacent upland areas a dense initial grass cover will be desirable to utilise the altered soil nutrient state, whilst suppressing annual weeds and ruderals that may otherwise become dominant and leave soils bare and exposed again after they have died back. For the wetter zones sedges will become more prominent. The aim of the first vegetation cover is to form a protective, relatively dense indigenous layer to slow runoff, increase moisture infiltration into the soil, and gradually change the soil nutrient status in order for it to be more favourable for other desirable indigenous vegetation to become established.

#### 9.6.1. Recommended plant species to use for rehabilitation

For upland areas (Moist grassland)

- >90 grass species and some potential pioneer herbs and forbs
  - Rescued plants and bulbs;
» Themeda triandra;
» Eragrostis curvula;
» Eragrostis chloromelas;
» Aristida junciformis subsp. galpinii;
» Cymbopogon pospischilii (or C. dieterlenii);
» Tristachya leucothrix;
» Pioneer herbs, forbs such as:
  o Felicia muricata;
  o Helichrysum rugulosum;
  o Helichrysum glomeratum;
  o Helichrysum inornatum;
  o Arctotis arctotoides;
  o Haplocarpha scaposa;
  o Gazania krebsiana;
  o Berkheya setifera.

For temporary saturated areas
Seed mix must comprise of at least 90% grass species with the remainder comprising of a mixture of sedge, rushes and moisture loving forbs.
» Rescued plants and bulbs;
» Themeda triandra;
» Eragrostis curvula;
» Pennisetum thunbergii;
» Cynodon dactylon;
» Setaria sphacelata;
» Harpochloa falx;
» Helictotrichon turgidulum;
» Panicum maximum;
» Panicum schinzii;
» Aristida junciformis subsp. Galpinii;
» Andropogon appendiculatus;
» Sedges, rushes and moisture loving forbs:
  o Cyperus denudatus;
  o Pycreus macranthus;
  o Juncus rigidus;
  o Helichrysum aureonitens;
  o Helichrysum cymosum;
  o Berkheya radula.

For seasonally saturated areas
Seed mix must comprise of at least 70% grass species with the remainder comprising of a mixture of sedge, rushes and moisture loving forbs.
» Rescued plants and bulbs;
» Imperata cylindrical;
» Pennisetum thunbergii;
» Andropogon appendiculatus;
» Eragrostis planiculmis;
» Helictotrichon turgidulum;
» Pennisetum thunbergii;
» Hemarthria altissima;
» Cynodon dactylon;
» Setaria sphacelata;
» Panicum schinzii;
» Sedges and rushes:
  » Cyperus denuudatus;
  » Carex rigidifolius;
  » Carex glomerabilis;
  » Pycreus macranthus;
  » Isolepis sepicralis;
  » Kylinga erecta;
  » Typha capensis.

For permanently saturated areas
Re-seeding permanently saturated and inundated habitats are challenging and should be combined with the planting of seedlings and adult species. This option should only be considered if natural rehabilitation of these habitats have not occurred to a satisficing level.

Seed mix comprising of a mixture of sedges and bulrush
» Typha capensis;
» Carex rigidifolius;
» Juncus oxycarpus;
» Isolepis diabolica;
» Eleocharis dregoana;
» Cyperus congestus.

9.7. Natural seed banks and improvement of plant structural and compositional diversity

It is expected that soil seed banks of indigenous vegetation will be present to initiate initial vegetation cover, but this will only happen if final landscaping is completed by the onset of the rainy season to allow natural germination and establishment. If the initial grass cover is too sparse, additional seed should be collected from around the project area site or an environmentally-matched site nearby.

Seed collection may be done throughout the year as seed ripens, but can also be restricted to summer, when a large amount of the perennial seed should have ripened. Seeds should be stored in paper or canvas bags dusted with insecticide, and sown at the onset of the rainy season.
The final vegetation cover should resemble the original grassland vegetation composition and structure as far as practicable possible.

For riparian and permanent wetland areas:
- First restore stream morphology following the guidelines of the Erosion and storm water management plans – without that ecological recovery cannot be initiated.
- Determine if natural seed sources may be present further upstream.
- If such upstream riparian seed sources are present, rehabilitation of riparian vegetation after clearing of IAPs and soil erosion management will most likely occur naturally, PROVIDED that follow-up clearing of IAPs is conducted frequently enough to control and gradually diminish alien invasive species. This can only be achieved with a long-term commitment (> 5 years minimum).
- If indigenous upstream riparian seed sources are not available, nodes of key riparian species will have to be manually recreated to initiate and facilitate rehabilitation.

9.8. Monitoring and follow-up action

Throughout the lifecycle of the development, regular monitoring and adaptive management must be in place to detect any new degradation of ecosystems affected by the development, and remedy these as soon as detected.

During the construction phase, the ECO/EO will have to ensure that the contractor will initiate and maintain a suitable monitoring system (conducted by an ecological subcontractor). Once the development is operational, the project proponent will have to identify a suitable entity that will be able to take over and maintain the monitoring cycle and initiate adaptive management as soon as it is required. Monitoring personnel must be adequately trained.

The following are the minimum criteria that should be monitored:
- Composition and density of replanted vegetation, distinguishing between species introduced for initial revegetation only and species that are part of the predetermined desirable end state.
- Associated nature and stability of surface soils:
  - It is recommended that permanent transects are marked and surveyed annually according to the LFA technique (Tongway and Hindley 2004), adapted to integrate both surface soil characteristics and the vegetation to be monitored.
- Re-emergence of IPs:
  - If noted, remedial action must be taken immediately according to the invasive management plan.
Nature and dynamics of intermittent pans, ephemeral drainage lines, washes and landscaped slopes:
  o Stability of vegetation
  o Any form of bank erosion, slumping or undercutting
  o Stability of channel form and width of streams – if this increases, it shows that vegetation on plains and/or riparian areas and upper drainage lines are not yet in a stable enough state to be fully functional in reducing excess runoff and the ecosystem overall is losing valuable resources

9.9. Timeframes and duration

  » Rehabilitation will occur during construction, as areas for the re-application of topsoil, final landscaping and revegetation become available or where revegetation can be initiated after clearing of invasives or to stabilise erosion.
  » The initial revegetation period post construction is estimated to be over a period of 6 (minimum) to 12 months (maximum), or a time period specified by the Horticultural Landscape Contractor, particularly if planting of trees and shrubs occurs.
  » The rehabilitation phase (including post seeding maintenance) should be at least 12 months (depending on time of seeding and rainfall) to ensure establishment of an acceptable perennial plant cover is achieved (excluding invasive plant species or weeds).
  » If the plants have not established and the acceptable plant cover is not achieved within the specified maintenance period, maintenance of these areas shall continue until at acceptable perennial plant cover is achieved (excluding alien plant species or weeds).
  » Additional seeding or planting may be necessary to achieve acceptable plant cover.
  » Any plants that die during the maintenance period, shall be replaced by the Horticultural Landscape Contractor (at the Horticultural Landscape Contractor’s cost if it was due to insufficient maintenance).
  » Succession of natural plant species should be encouraged.
  » Monitoring of rehabilitation success and follow-up adaptive management, together with clearing of emerging invasive species shall be continued until the decommissioning phase has been completed.

10. CONCLUSION

The Rehabilitation and Revegetation Plan is a document to assist the contractor, the developer, and the ECO with guidelines on how to plan and implement the required work, and understand the concepts behind successful rehabilitation. This plan will have to be implemented in conjunction with erosion-, stormwater- and IP plans. The exact details of the rehabilitation plan will depend on the determined extent of rehabilitation.
that will have to be undertaken, available funding, and desirable end state of the vegetation after rehabilitation.

11. BIBLIOGRAPHY AND FURTHER READING


