GA Environment

REHABILITATION PLAN

FOR THE PROPOSED UPGRADE OF NATIONAL ROAD R101 SECTION 8 FROM BELA BELA (KM 0.0) TO MODIMOLLE (KM 26.8), WATERBERG DISTRICT MUNICIPALITY, LIMPOPO PROVINCE

DFFE REFERENCE: 14/12/16/3/3/1/2354

AUGUST 2021

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PROJECT INFORMATION

Title:	Rehabilitation Plan for the Proposed Upgrade of National Road R101 Section 8 from Bela Bela (km 0.0) to Modimolle (km 26.8), Waterberg District Municipality, Limpopo Province
Competent Authority:	Department of Forestry, Fisheries and Environmental (DFFE)
DEA Reference No.:	14/12/16/3/3/1/2354
Applicant:	South African National Roads Agency SOC Ltd
Environmental Assessment Practitioner:	GA Environment (Pty) Ltd.
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SIGNING OF THE ORIGINAL DOCUMENT

Original	Prepared by	Reviewed by	Approved by
Date: **8th June 2021**	Name: **Vukosi Mabunda**	Name: **Kirthi Peramaul**	Name: **Nkhensani Khandlhela**
Version 0	Signature: 	Signature: 	Signature: 

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1 INTRODUCTION

GA Environment (Pty) Ltd has been appointed by BVi Consulting Engineers Western Cape (Pty) Ltd (BVi Engineers hereafter) on behalf of the South African National Roads Agency SOC Ltd or (SANRAL) as independent Environmental Consultants to undertake the Basic Assessment process for the proposed upgrade of National Road R101 Section 8 from Bela Bela (km 0.0) to Modimolle (km 26.8), Waterberg District Municipality, Limpopo Province.

R101-8 is approximately 27km long road extending between Bela Bela and Modimolle. R101-8 consists of a two lane, single carriageway road with gravel shoulders along most of the route. The road has an average surfaced width of 7.0 m. Climbing/passing lanes are provided from km 6.2 to km 7.5 and km 14.4 to km 15.7. Road R101-8 has an average road reserve width of approximately 35 meters and an average traffic flow speed of 100km/hr. In both Bela Bela and Modimolle, the road widens to a four lane undivided single carriageway. Road R101-8 falls within the interurban collector and rural roads category and can therefore be classified as a Category B Road.

The broad goals of the road upgrade is to relieve traffic congestion to an acceptable level of service, improve road geometry and road safety, widen bridges and other structures where required for hydraulic and traffic capacity improvement, and provide adequate pavement capacity for the design period. Road R101 Section 8 is defined as a mobility road, connecting development centres over long distances. Road R101 Section 8 falls within the interurban collector and rural roads category and can therefore be classified as *a Category B Road*. This road category is seen as strategically important and is expected to deliver a good Level of Service to its users. It also connects other collector roads and can therefore be classified as a Class 2 rural major arterial.

The National Environmental Management Act 107 of 1998, as amended (NEMA) and the Environmental Impact Assessment Regulations 2014 (as amended) requires that listed activities warrant an Environmental Authorisation (EA) from the competent authority. Since SANRAL is a parastatal, the competent authority is the Department of Forestry, Fisheries and Environment (DFFE). Based on the triggered listed activities as indicated in the basic assessment report, a basic assessment process is required for the proposed road upgrade.

As part of the Basic Assessment (BA) process for the clearance of indigenous vegetation, a rehabilitation plan must be compiled to support the application. This document will provide the contractor, the developer, and the ECO with guidelines on how to plan revegetation and rehabilitation work and assists in understanding the concepts behind successful rehabilitation. This plan must be implemented in

conjunction with the approved EMPr as well as other management plans prepared for this proposed development. The exact details of the rehabilitation plan will depend on the extent of rehabilitation that will have to be undertaken, available funding, and the desired end state of the vegetation after rehabilitation.

1.1 Site location

The R101 Section 8 is situated within two Local Municipalities (Bela Bela and Modimolle) both situated within the Waterberg District Municipality in the Limpopo Province. Bela-Bela and Modimolle Local Municipalities are located in the south-eastern part of the district and are the least populated municipalities within the Waterberg District Municipality. According to the Waterberg District Municipality Environmental Management Framework (Waterberg EMF), the biggest contributors to employment in the Waterberg District are mining and quarrying, wholesale and retail trade, agriculture, hunting and fishing, as well as the manufacturing sectors, with the percentage representation of the different sectors being 6.5%, 5.5%, 4.6%, and 3.7% (Waterberg EMF).

Nation Road R101 Section 8 (R101-8) extends from Bela Bela at the intersection of the R101 and Voortrekker Road/Chris Hani Drive (km 0.0) and ends in Modimolle at the intersection of the R101 and R33 (km 26.8). R101-8 starts at coordinates 24°53'5.16"S and 28°17'56.88"E in Bela Bela and ends at coordinates 24°42'0.33"S and 28°24'21.10"E in Modimolle. This section of the national road is defined as a mobility road, connecting development centres over long distances. It falls within the interurban collector and rural roads category and can therefore be classified as a Category B Road. This road category is seen as strategically important and is expected to deliver a good Level of Service to its users. It also connects other collector roads and can therefore be classified as a Class 2 rural major arterial. Refer to **Figure 1** and **Figure 2** for the locality and chainage maps

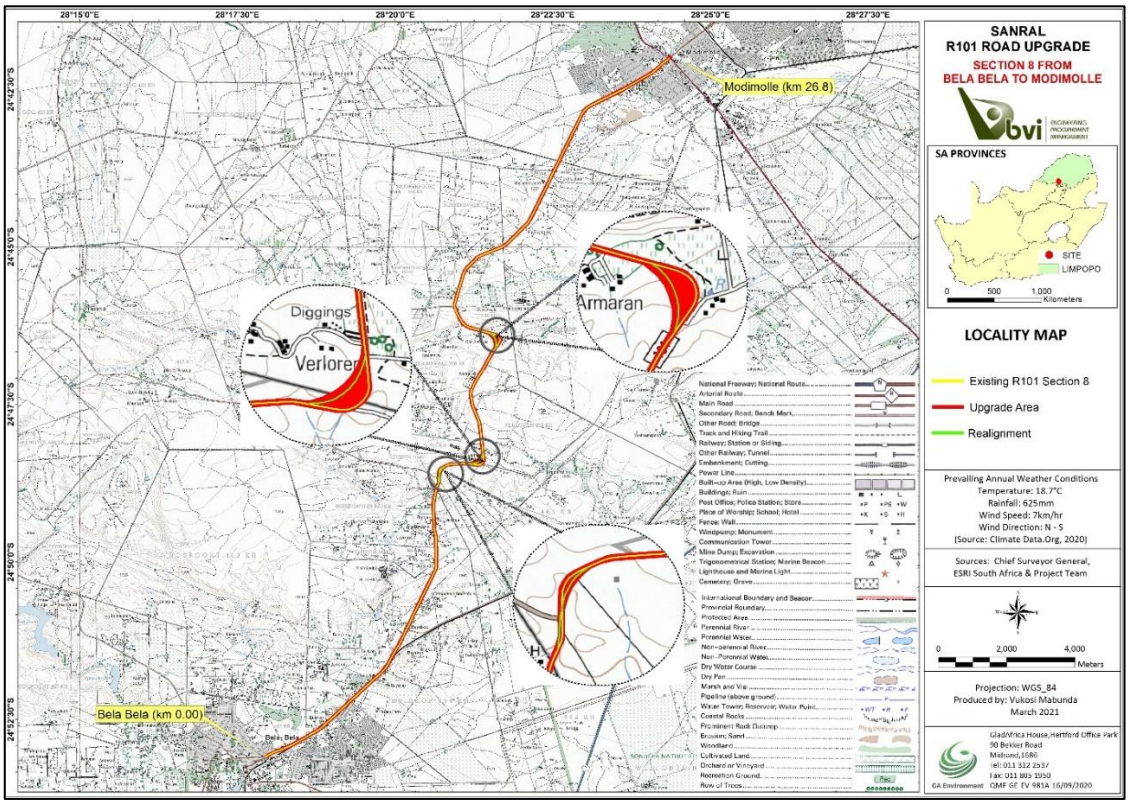

Figure 1: SANRAL R101 Section 8 Locality Map

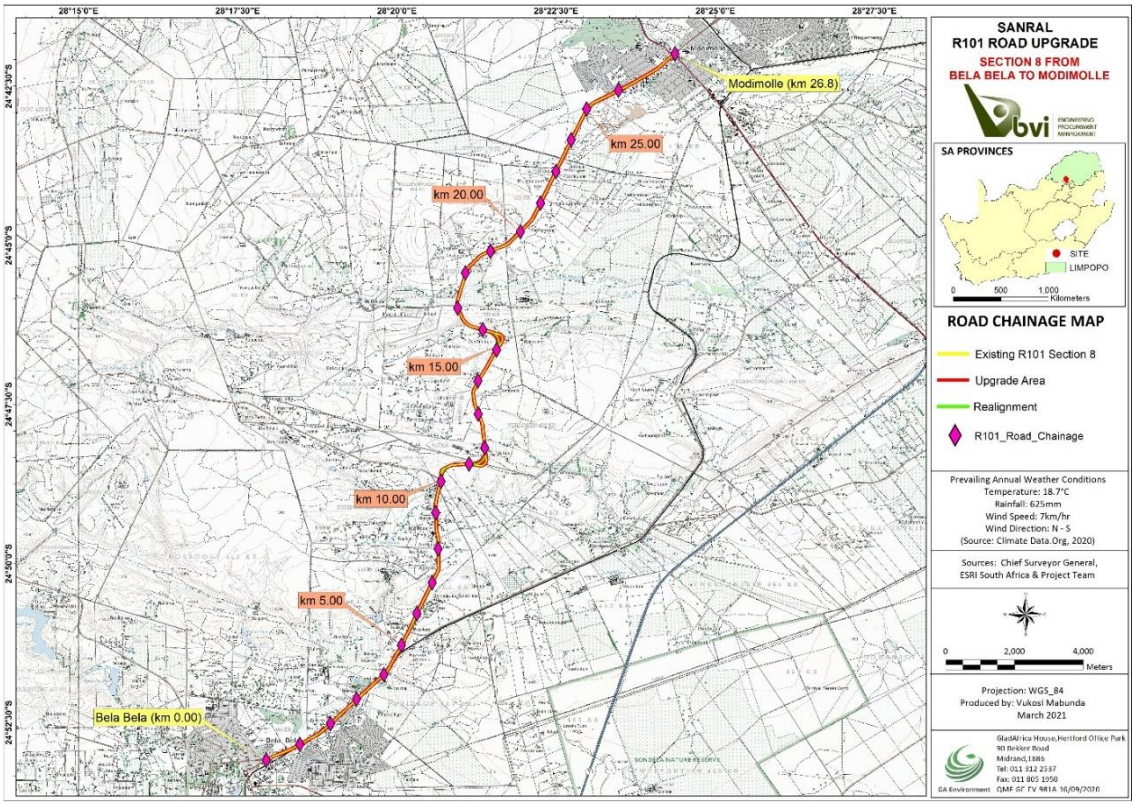

Figure 2: Road Chainage Map

This road category is seen as strategically important and is expected to deliver a good Level of Service to its users. The proposed road upgrade is categorized into three (3) sections:

a. Bela Bela Urban Section:
    - Bela Bela (km 0.0) to Klein Kariba (km 5.5).
    - Proposed upgrade will include a 4 x 3.7m wide lanes, kerbed median and sidewalks.

b. Rural Section:
    - Klein Kariba (km 5.5) to Modimolle entrance (km 24).
    - Proposed upgrade will include a 2 x 3.7m wide lanes and 3m wide surfaced shoulders (climbing and bypass lanes).

c. Modimolle Urban Section:
    - Modimolle (km 24) to limit of contract (km 26.8).
    - Proposed upgrade will include a 4 x 3.7m wide lanes, kerbed median and sidewalks.

Drainage along Road R101-8 is effected through culverts and bridges. The proposed road upgrade intends to replace bridges and other structures where required for hydraulic and traffic capacity improvement and provide adequate pavement capacity for the design period. The riparian area of the Bad se Loop, Klein Kariba and Groot Nyl Rivier forms part of the study area and impacts on the rivers are anticipated during the replacement of the bridges and major culverts. **Figure 3** presents the locations and type of hydraulic infrastructure which will be replaced as part of the upgrades.

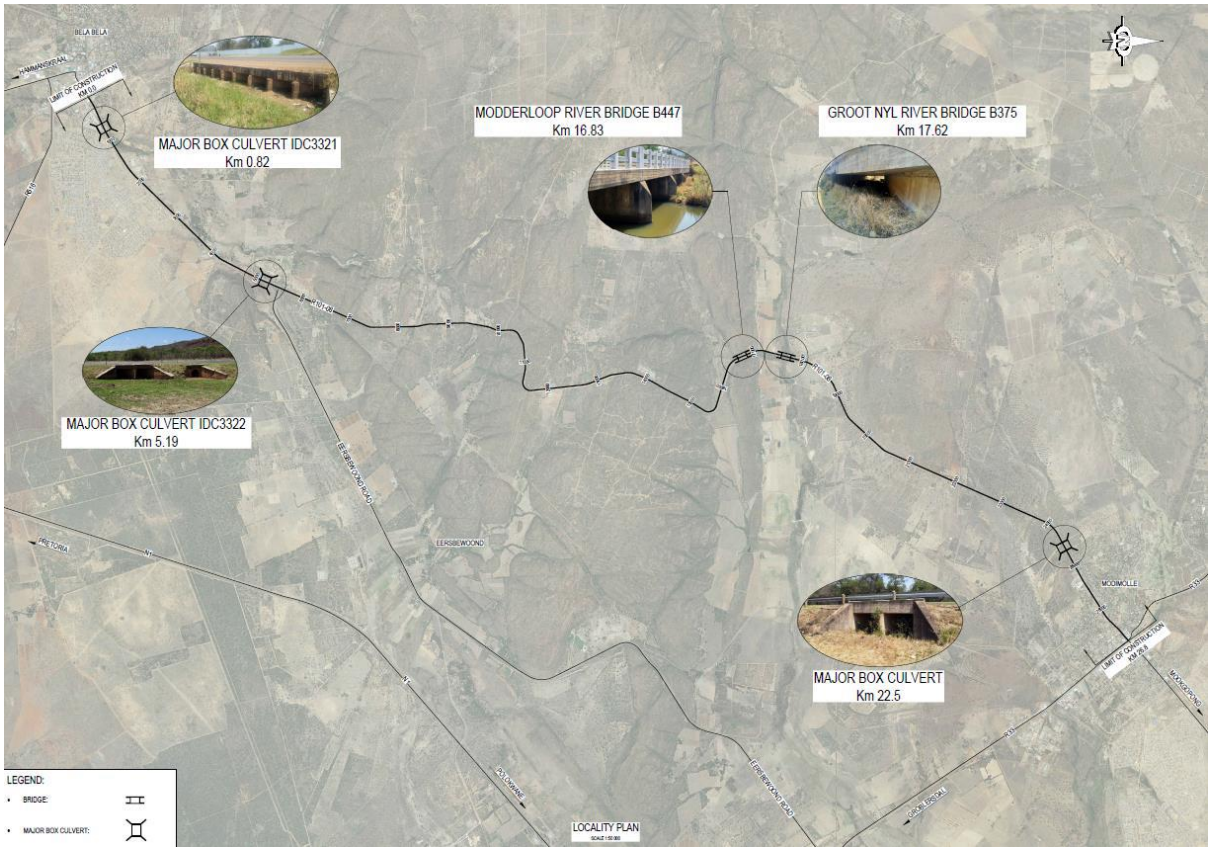

Figure 3: Hydraulic upgrade locations (BVi Consulting Engineers, 2020)

1.2 Definition of Environmental rehabilitation

Rehabilitation does not necessarily refer to the restoration of vegetation to its natural state but to a specific predetermined status that is as close as possible to the original state or suitable for the area to mainly ensure the restoration of ecosystem functions as far as possible and reduce the likelihood of erosion and provide necessary (Hoare, 2014). Information on the biophysical environment and the ecological species that are likely to be impacted in the project site is detailed in the Terrestrial Biodiversity Report attached as **Appendix F** of the Basic Assessment report**.**

As indicated in the Terrestrial Biodiversity Assessment Report undertaken by the Biodiversity Company (2021), the vegetation that occurs within the study area is the Central Sandy Bushveld, Springbokvlakte Thornveld and the Waterberg Moist Mountain Bushveld as indicated on **Table 1** below.

Table 1: Summary of Vegetation Types along R101 Section 8

Vegetation Unit	Road Chainage	NEMBA Protection Status	Environmental Implication
Springbokvlakte Thornveld	• km 0.0 – 5.3.	• Endangered. • Protected ecosystem.	GNR 985 Listing Notice 3 - Activity 12
Central Sandy Bushveld	• km 5.4 – 6.2; • km 7.2 – 9.1; • km 11.8 – 14.9; • km 15.5 – 16.3; and • km 17.2 – 26.8.	Not Protected	Environmental Management Programme
Waterberg Moist Mountain Bushveld	• km 6.3 – 7.1; • km 9.2 – 11.7; • km 15 – 15.4; • km 16.4 – 17.1; and • km 20 – 21.4.	• Not Protected. • Part of Waterberg Biosphere Reserve (UNESCO conservation project).	Environmental Management Programme

According to Mucina & Rutherford (2006), the Springbokvlakte Thornveld vegetation is found in the north north-eastern parts of South Africa occurring in Limpopo, Mpumalanga, North West and Gauteng Provinces. The vegetation type is characterised by open to dense, low thorn savanna dominated by Acacia species or shrubby grassland with a very low shrub layer. Occurs on flat to slightly undulating plains. This vegetation type is considered to be 'endangered' (Driver *et al*., 2005 and Mucina & Rutherford, 2006). However, as according to the NEMBA 2004, the Springbokvlakte Thornveld vegetation is listed as a 'vulnerable ecosystem' essentially not triggering GNR 985 Listing Notice 3. Nevertheless, this vegetation unit is protected under Act No. 10 of NEMBA 2004.

The Central Sandy Bushveld vegetation type is located in undulating terrain, occurring mainly from the Pilanesberg in the west to GaMasemola in the east (Mucina & Rutherford (2006). The habitat conforms to low undulating areas, sometimes between mountains, sandy plains and. The Central Sandy Bushveld

endemic grass species include *Mosdenia leptostachys* and *Oxygonum dregeanum* subsp. *canescens var. dissectum*. This vegetation type is regarded 'vulnerable' with less than 3% statutorily conserved in nature reserves (Mucina and Rutherford, 2006). However, according to NEMBA 2004, the Central Sandy Bushveld vegetation is not a listed ecosystem and does not trigger GNR 985 Listing Notice 3. Approximately 24% of the vegetation area is transformed, comprising of 19% cultivated and 4% urban and built-up areas. Much of the unit is heavily populated by rural communities.

The last vegetation unit consists of plains that have three types of habitats that include wetlands, sour bushveld, and mountain slopes. This vegetation unit is referred to as the 'Waterberg Moist Mountain Bushveld and forms part of the Waterberg Biosphere Reserve (UNESCO conservation project). Habitats are sufficiently represented to ensure that the current high biodiversity is maintained in this Biosphere. The Waterberg Moist Mountain Bushveld vegetation is a landscape that exhibits rugged mountains with vegetation grading from bushveld on higher slopes through broad-leaved deciduous bushveld on rocky mid and foot slopes to savanna in the lower lying valleys as well as on deeper sands of the plateaus. The grass layer is moderately developed or well developed. Contrary to the Waterberg Biosphere Reserve, the Waterberg Moist Mountain Bushveld vegetation is regarded as 'least threatened ecosystem' with about 9% statutorily conserved in Nature Reserves (Mucina and Rutherford, 2006). In addition, this vegetation unit is not a listed nor protected ecosystem and does not triggering GNR 985 Listing Notice 3 (NEMBA, 2004). This is primarily due to the low human population density in the area. The vegetation area is mainly transformed by cultivation

According to the Terrestrial Assessment (Fauna and Flora) Report (2021), the road is surrounded by a number of game farms and a protected area. In these areas including the areas of the realignments, one avifauna and seven mammal species of conservation concern are known to occur. This habitat is mostly mountain bushveld that is in pristine condition. Two different types of protected trees (*Sclerocarya birrea subsp. caffra* (Marula) and *Combretum imberbe* (Leadwood)) were also observed in the area. The ecological integrity, importance and functioning of the ecosystem is still intact. The preservation of this habitat and associated species of conservation concern is of utmost importance. Therefore, the proposed development of the R101 Section 8 from Bela Bela to Modimolle will result in the destruction and fragmentation of intact and functional CBA areas, areas rated "Very High".

1.3 Scope and Objectives of the Rehabilitation Plan

Since the proposed development will require the removal of indigenous vegetation, it is critical that rehabilitation plan be developed, and restoration must be undertaken as soon as possible after completion of construction activities. It is anticipated that this plan will assist in mitigating the impacts caused by the

construction activities and will attempt to restore the disturbed site back to a satisfactory standard. This report is intended to serve the following purposes:

- Maintain and minimise impacts to the ecosystem within the study area;
- Addresses the need to mitigate all impacts leading to disturbed fauna and flora, loss of species potential, disturbed soil surfaces, and generally bare soils prone to erosion;
- Provide a detailed roles and responsibilities involved in ensuring effective implementation of the rehabilitation programme;
- Re-establish vegetation cover with suitable indigenous plant species;
- Prevent adverse environmental impacts that may arise from areas that are not rehabilitated;
- Present a rehabilitation implementation strategy;
- Describe proposed rehabilitation methods;
- Present a rehabilitation and monitoring programme;
- Support the Environmental Management Programme for the project; and
- Guide SANRAL to make Financial Provisions for the rehabilitation for the site, this document must be included in the Contractor ‘s tender document.

1.4 Details of Environmental Assessment Practitioner

This rehabilitation plan was compiled by:

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This Rehabilitation Plan was prepared by **Mr Vukosi Mabunda** an Environmental Assessment Practitioner (EAP) employed by GA Environment. Vukosi is currently a Geographic Information Systems (GIS) Specialist and Environmental Assessment Practitioner with 4 years’ working experience. He is one of the few dual registered professionals with THE South African Council for Natural Scientific Professions (SACNASP) as a Certified Geospatial Scientist and Certified Environmental Scientist. He is currently in the process of acquiring his third professional registration, with the South African Geomatics Council for a GISc Technologist. Vukosi has dual professional background in Geographic and Environmental Sciences having academic qualifications which focused on these disciplines as well as work experience gained from previous organizations. He has extensive GIS knowledge and application skills with a Master’s Degree in

Geography focusing on the applications of GIS on groundwater and having worked within a GIS environment (ArcGIS) for 8 years and a post-graduation GIS experience of 4 years.

1.5 Key role players and responsibility matrix

In order for the rehabilitation plan to be successfully implemented, all the role players involved in the project need to co-operate. As a result, each role player must clearly understand the roles and responsibility in execution of the rehabilitation plan.

Key role players for the rehabilitation phase and the post rehabilitation monitoring phases are as follows:

- Developer/Project Manager;
- Engineer;
- Contractor;
- Environmental Control Officer; and
- Environmental Assessment Practitioner.

The functions and responsibilities of each of these role players are outlined in **Table 2**.

Table 2: Functions and responsibilities of the project team for the implementation of the Rehabilitation Plan

ROLE	PHASE OF INVOLVEMENT	RESPONSIBILITIES
Developer and Project Manager *SANRAL*	Rehabilitation and post rehabilitation Monitoring	• Appointing project team; and • Ensuring that the Rehabilitation Plan, is circulated to the project team. • Ensuring overall compliance with the rehabilitation plan • Ensure that environmental control activities are undertaken to restore environmental conditions as outlined in the rehabilitation plan *The Project manager has overall responsibility for managing the project, Contractors, and Consultants and for ensuring that the environmental management requirements are met. All decisions regarding environmental procedures must be approved by the PM. The PM has the authority to stop any construction activity in contravention of the Rehabilitation Plan in accordance with an agreed* warning procedure.
Contractor *To be appointed*	Rehabilitation	• Undertakes Rehabilitation Plan; and • Addresses all non-compliances raised by the Consulting Engineer or Environmental Control Officer

ROLE	PHASE OF INVOLVEMENT	RESPONSIBILITIES
Environmental Control Officer *To be appointed*	Rehabilitation	• Ensuring that the Contractor undertakes all rehabilitation activities in line with the Rehabilitation Plan • Assess environmental performance of the rehabilitation plan i.e. auditing as required by Competent Authority
CONSULTING ENGINEER *BVi Consulting Engineers Western Cape (Pty) Ltd*		• The Consulting Engineer (CE) is contracted by the developer to design and specify the project engineering aspects. Generally, the engineer runs the works contract and oversee the overall implementation of the project as well as the compliance of the EMPr and incorporate any environmental consideration recommended in the EMPr and this rehabilitation plan into the design.
ENVIRONMENTAL ASSESSMENT PRACTITIONER *GA Environment (Appointed by BVi Engineers)*		• The definition of an Environmental Assessment Practitioner (EAP) in Section 1 of NEMA is “the individual responsible for the planning, management and coordination of environmental impact assessments, strategic environmental assessments, environmental management plans or any other appropriate environmental instruments introduced through regulations”. • The Environmental Assessment Practitioner is generally responsible for undertaking environmental processes necessary to authorise the project activities proposed. The Developer can also appoint the Environmental Assessment Practitioner to act an Environmental Control Officer during the post-construction or rehabilitation phase of the project to ensure the environment is remediated as far as possible.

2 REHABILITATION IMPLEMENTATION STRATEGY

For effective rehabilitation purposes, it is crucial that a strategy must be implemented by the Contractor in consultation with the ECO. *It must be highlighted that rehabilitation on site must as far as possible be progressive and not wait until the end of the overall construction activities.*

2.1 Principles to be ensure successful rehabilitation with the use of vegetation

The overall objectives for the re-vegetation of disturbed areas include the prevent erosion on areas exposed during construction, restoration of all disturbed areas in order to allow for the reestablishment of the ecosystem processes and restoration of biodiversity of the as far as possible. In order to ensure successful rehabilitation of vegetation, the following must be adhered to:

- It will also be important to review the recommendation regarding the management of vegetation on site highlighted in the BAR, Terrestrial Biodiversity Assessment report, the EMPr and the Alien Invasive Management compiled during the Basic Assessment process;
- Where necessary, a Horticulturist must compile a landscape design plan for areas that have been affected by removal vegetation or change of landscape and as a result require restoration;
- The ECO may also undertake this task should they have a background in Landscape Architecture, Horticulture or Botany;
- Only indigenous plant species must be used for rehabilitation. Under no circumstances should alien species may be used;
- Ensure that all site personnel are educated about the importance of rehabilitation and maintenance of rehabilitated areas.

The steps below must guide the rehabilitation. Each of these will be discussed further below:

1. Site Preplanning and Preparation
2. Design of the Rehabilitation Plan and required interventions
3. Design an Implementable Rehabilitation action plan
4. Implementation of the Rehabilitation Plan
5. Rehabilitate all affected areas with suitable plant species
6. Demarcate rehabilitated areas that must be rehabilitated and ensure maintenance of the fence throughout the rehabilitation phase
7. Ensure that photographic records of all sites intended for rehabilitation are kept during rehabilitation and post rehabilitation phases. (i.e. monitoring).
8. Ensure ongoing monitoring of rehabilitated areas

2.1.1 Site Preplanning and Preparation

It is of critical importance that the Contractor understand the site in order to implement successful rehabilitation. The first step in compiling and implementing a successful rehabilitation and re-vegetation plan is to understand the site in question and be aware of the interactions between the biophysical environment and infrastructure on site. It will also be important to review the Terrestrial Biodiversity report, and the EMPr compiled during the Basic Assessment process. In order to achieve this, a map should be created of the development area clearly showing the following.

- Areas of natural and indigenous vegetation.
- Areas that will be cleared for construction purposes and may be invaded by invasives.
- Infrastructure within the development area.
- Roads within the development area.
- Indigenous vegetation transformed through land use activities.

2.1.2 Design of the Rehabilitation Plan and required interventions

The Contractor in consultation with SANRAL will have to decide what intervention will be necessary, desirable, and feasible to enable the development to occur as well as the long-term maintenance of infrastructure. For each area, an operational guideline must be compiled and may cover the following:

- What will happen in each area (no-go, some rehabilitation or extensive rehabilitation)?
- What needs to be mitigated (this includes stormwater and erosion management)?
- Which areas need priority intervention/mitigation?
- How will this mitigation/intervention be undertaken (method statements)?
- What is the realistic and desirable end state for each area following rehabilitation?

2.1.3 Design an Implementable Rehabilitation action plan

Rehabilitation efforts typically aim at improving ecosystem function that consists of a series of processes, which can be evaluated against a desired outcome or referenced state of the environment. Attainable goals of rehabilitation should be possible and viable to cover at least the following:

- Stabilisation of soils on site.
- Stabilisation of previously disturbed sensitive area on site
- Storm water reduction from constructed infrastructure.
- Clearing of invasive plants.

The degree of rehabilitation, which takes place on site, should be determined according to available project funding, personnel and project requirements. It is important to note that the rehabilitation measures should at least result in an improvement to the current conditions on site and the condition of the environment should never be worse than prior to project implementation.

2.1.4 Implementation of the Rehabilitation Plan

The plan must include the specific management actions required to ensure successful rehabilitation of the site. The Plan must also make provision for the rehabilitation of all areas of the site and the short- and long-term maintenance thereof. This plan must include the following actions, which should be updated based on site conditions and construction progress at the time:

- Bare soil should be kept to a minimum.
- Exposed areas on the site are particularly prone to wind erosion and, thus, precautions should be taken to avoid excessive disturbance. Any cleared areas within the development footprint that are no longer or not required for construction or operational activities should be re-seeded with locally-sourced seed of suitable species (e.g. refer to revegetation options below). Brush-packing with locally cleared indigenous vegetation will allow local plant seed to enter the topsoil and allow the re-establishment/re-generation of vegetation on these bare areas, as well as limit erosion.
- The edges of hardened surfaces must be re-seeded with locally-sourced seed of suitable species to encourage vegetation re-generation and to limit erosion.
- Regular monitoring for erosion must be conducted across the site (particularly near hardened surfaces and infrastructure) to ensure that no erosion problems are occurring. Rectification of erosion problems should include brush-packing and re-vegetation as far as possible.
- Regular monitoring must be undertaken to ensure that alien plants do not establish or increase in numbers on site as a result of construction and operational disturbances.
- Final levels of all disturbed areas are, where feasible, to be consistent with the natural topography of the area.
- The area from which this material is taken must be approved by the ECO and must not result in environmental degradation.
- Only in exceptional circumstances will sourcing of plant material from further afield or grass seed mixes be considered and approved by the ECO.
- Reinstatement and rehabilitation are required for all areas disturbed by the project. This includes the entire development site, access roads (temporary and permanent), servitudes for any services that may have been established.

- The contractor shall reinstate and rehabilitate all disturbed areas outside the demarcated working area at his own cost and to the satisfaction of the ECO. The cost of rehabilitation must be included in the Contractor tender document.
- All areas disturbed by contract activities are to be revegetated to the satisfaction of the ECO.
- Methods of vegetation removal and re-establishment, where required, shall be specified by the ECO, in terms of:
  - Removal and storage of vegetation.
  - Source of vegetative material.
  - Ground preparation.
  - Weed removal.
  - Irrigation.
  - Planting times.
- Fertilisers and compost may not be used unless agreed to by the ECO.
- All sites disturbed by construction activities shall be monitored for colonisation by invasive alien plant species as per the EMPr presented in **Appendix G**.
- The ECO shall identify those plants that require removal during both the construction and maintenance period, for the contractor's action.
- The ECO shall provide advice as to effective methods of removal and control of alien plant species. Existing alien plants are to be removed and their spread prevented.

2.1.5 Rehabilitation with suitable plant species

The main aim of re-vegetation of the disturbed area is to restore the area to the indigenous Central Sandy Bushveld, Springbokvlakte Thornveld and the Waterberg Moist Mountain Bushveld vegetation status. It is advised to restore the study area as far as possible to a stable and sustainable ecosystem. Vegetation is useful in rehabilitation as it binds and stabilises soil and slows the velocity of stormwater water. This reduces soil erosion and in turn prevents the deposition of sediment in the nearby watercourses (Bad se Loop, Klein Kariba and Groot Nyl River riparian areas). Despite this however, measures such as Erosion Control Blankets must be used to provide immediate protection to soil after the soil has been left bare. It is crucial that all areas from which plants have been removed must be revegetated with indigenous plant species endemic to the area. Alien plant species must not be utilised. Once the final topsoil layer has been placed on site, suitable vegetation must be replanted. Each of these are further discussed below.

a) Grasses

The rehabilitated areas need to be stabilised with vegetation, mainly grasses at first. It is crucial that all grassing be undertaken by a suitably qualified Contractor, making use of the appropriate equipment.

Where seed is used in grassing, all seed supplied should be labelled in accordance with the Government Seed Act (Act No. 20 of 1961). One of the ways in which grassing can be undertaken is through hydroseeding or sodding. Each of these will be discussed in the next sections. It is expected that the Contractor on behalf of SANRAL will use the most cost and time effective method for the revegetation of areas cleared of vegetation. A minimum grass cover of 80% is required. Grassing can be undertaken by either **hydroseeding** or **sodding** as discussed below.

b) Hydroseeding

Hydroseeding entails adding a specified seed mix to a slurry containing water, seed, fertilizer and other approved materials to enhance plant growth potential. This mixture is applied by means of a spraying device onto the prepared ground areas to be seeded. Hydroseeding is a quick and cost-effective method of seeding and is especially suited to slopes. It provides homogenous cover which is key in rehabilitation efforts and also prevents possible erosion. The following must however be borne in mind for hydroseeding:

- The soil should be loose and uniformly wet to a specified depth before any seeding commences.
- Add the specified seed mix and necessary fertiliser to the required amount of water and apply using an approved hydro-seeding machine.
- Unless otherwise specified, the rate of application of the slurry will not be less than 30 cubic metres per hectare and will be applied in such a manner as to ensure even distribution of seed and fertiliser throughout.
- Additional ingredients to be added to the slurry may be specified.
- In certain cases, the specification may require that mulch be applied by hand to the area to be hydro-seeded, prior to hydro-seeding.
- If possible, keep the seedbed moist after hydro-seeding, to ensure good germination.
- Irrigate as required until the grass is able to survive independently (i.e. depending on the rainfall).

c) Sodding

Sodding is defined as the laying of grass sods. Sodding may be done at any time of the year but seeding must be done during the summer when the germination rate is better. The following is key for sodding:

- The soil should be uniformly wet to a depth of at least 150 mm before planting of grass sods;
- Protect sods against drying out: keep these moist from the time of harvesting until final placement;
- Rake or spike the area to give a loose surface to a depth of 100 mm;
- Lay the first row of sods in a straight line, starting at the bottom of a slope, where possible;
- Place the next row of sods in the same way, tightly against the bottom row with the joints staggered, until the full area is covered with sods;

- Tightly butt sods together, taking care not to stretch or overlap sods;
- Where a good fit cannot be obtained, the intervening spaces may be filled with parts of sods or topsoil;
- On steep slopes the sods must be secured using timber stakes of at least 300 mm in length;
- After planting, water sods to prevent drying out; and
- Irrigate as required until the grass is able to survive independently (i.e. depending on the rainfall).
- Ensure 100% cover for sodding.

2.1.6 Grassing mix and Herbs/Forbs for vegetative cover

The vegetative cover must comprise grasses that are indigenous to the site. According to the Flora Fauna assessment (Biodiversity Company, 2021), the vegetation that occurs within the study area is the Central Sandy Bushveld, Springbokvlakte Thornveld and the Waterberg Moist Mountain Bushveld as indicated (see **Appendix 1**). The Graminoids that naturally grow in this area as per Mucina and Rutherford (2006) which can form part of the grassing mix include the following:

Table 3: Natural growing Graminoids in the area

Central Sandy Bushveld Graminoids	Springbokvlakte Thornveld Graminoids	Waterberg Moist Mountain Bushveld Graminoids
Brachiaria nigropedata	*Aristida bipartita,*	*Loudetia simplex*
Eragrostis pallens	*Dichanthium annulatum var. papillosum,*	*Schizachyrium sanguineum*
E. rigidior	*Ischaemum afrum,*	*Trachypogon spicatu*
Hyperthelia dissolute	*Setaria incrassata,*	*Brachiaria serrata*
Panicum maximum	*Aristida canescens,*	*Digitaria eriantha subsp. Eriantha*
Perotis patens	*Brachiaria eruciformis*	*Elionurus muticus*
Anthephora pubescens		*Enneapogon scoparius*
Aristida scabrivalvis subsp. scabrivalvis		*Setaria sphacelata*
Brachiaria serrata		*Themeda triandra*
Elionurus muticus		*Tristachya leucothrix*
Eragrostis nindensis		
Loudetia simplex		
Schmidtia pappophoroides		
Themeda triandra		
Trachypogon spicatus		

The only other graminoid that can be included in the mixture based on the site field assessment undertaken by a by the Biodiversity Company (2021) as presented in **Appendix F1** is *Mosdenia leptostachys*.

Local nurseries must be consulted to check the availability of seeds, sods or cuttings for any of the above. Where these are not available, equivalent and suitable indigenous species can be used subject to the approval of a reputable nursery and/or Contractor or Hydroseeding Company. Instructions for application must also be checked with these persons prior to the commencement of grassing.

2.2 Maintenance of rehabilitation

The general conditions for the maintenance of rehabilitation are as follows.

- Control access to rehabilitated areas;
- Allow for a maintenance period of at least one year following completion of rehabilitation;
- Re-vegetation must match the vegetation type which previously existed;
- In the case of sodding, acceptable cover entails that 100% cover is attained by the specified vegetation;
- Bare areas that show no specified vegetation growth after three months of the Rehabilitation Work are to be spread with additional topsoil, ripped to a depth of 100 mm and re-planted, re-sodded, re-hand sown or re-hydroseeded.

2.2.1 Access Control

Areas under rehabilitation must be cordoned off as no-go areas to prevent vehicular, pedestrian and animal access. Danger tape, steel droppers, fences or other or suitable measures must be used as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. All site employees must be notified of the importance of rehabilitation and the need to avoid unauthorised entry into rehabilitated areas.

2.2.2 Maintain photographic records

This is important to indicate the progress of rehabilitation. Photographs must be taken immediately prior to the undertaking of rehabilitation as well as weekly until vegetation has become fully established.

2.2.3 Erosion control

Erosion is one of the major sources of damage to rehabilitated areas. Erosion on can be caused by detachment and movement of soil particles due to water, wind as well as other factors such as uncontrolled movement in rehabilitated areas. Specification for protection of the site from erosion may include but not limited to the following:

- Complete vegetative cover;
- Selection of non-erodible and non-dispersive topsoil to avoid erosion.

2.2.4 Post Rehabilitation Monitoring

A post rehabilitation monitoring plan is used to ensure that critical aspects of rehabilitation are monitored. These aspects may include but are not limited to those listed in **Table 4.**

Table 4: Specifications for monitoring

Environmental Aspect	Description	Frequency and record keeping method
Re-establishment of plants /Biodiversity of Monitoring	Biodiversity assessments should be undertaken by a qualified ecologist / botanist to monitor the rehabilitation progress with regards to flora. This must be undertaken where plants were not successfully established	Weekly inspection for the first 2-3 months after establishment of vegetation
Soil erosion	Monitoring of the site to ensure that topsoil is not eroded especially on the slopes of the capped cells and in other vulnerable areas. Identification of possible areas of poor vegetation cover which might lead to erosion. Any evidence of erosion should be addressed.	• Weekly inspection for the first 2-3 months after establishment of vegetation • Photographic record
Fire break	A 5-meter fire break must be maintained around the site	• Monthly inspection • Photographic record
Alien vegetation	Alien vegetation must be eradicated from the site	• Monthly inspection • Photographic record
Access control	Cordoned off areas should remain intact and the site must not be accessed by unauthorized persons.	• Monthly inspection • Photographic record

2.3 Monitoring and Auditing

Throughout the lifecycle of the development, regular monitoring and adaptive management must be in place to detect any impacts to the environment caused by the proposed development and to remedy these as soon as detected. During the construction phase, the ECO and contractor will be responsible for initiating and maintaining a suitable monitoring system. 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 in identifying both the impacts and causes of the impacts observed on site.

In order to monitor the rehabilitation of the affected areas, SANRAL must ensure that adequate auditing is undertaken to sure that the rehabilitation objectives are met. A checklist relevant to the aspects that will be monitored must be created and used during the audit. Furthermore, photographs must be taken to indicate site conditions. In order to record the findings of the audits, monthly reports with photographic records must be compiled. The reports must indicate the following minimum information:

- Date/s of audit;

- Name of auditor;
- Areas audited;
- Areas of concern and suggested corrective measures accompanied by timeframes;
- Feedback on previous requests for the implementation of corrective measures;

3 CONCLUSIONS AND RECOMMENDATIONS

Vegetation rehabilitation is crucial for environmental protection and to address or prevent erosion. The revegetation for all affected areas from which vegetation will be cleared to allow for the proposed upgrade of National Road R101 Section 8 must be guided by the following key requirements:

- The Rehabilitation Plan must be adhered to and must be read along with all conditions of the Environmental Authorisation as well as the Environmental Management Programme and the Alien Invasive Plant Management Plan;
- The rehabilitated areas site must be demarcated to prevent disturbances to the rehabilitation as this can compromise the rehabilitation process;
- Ongoing monitoring and maintenance of rehabilitated areas must be undertaken as per the timeframes specified in this report;
- If the plants have not established and the 80% is not achieved within the specified maintenance period, maintenance of these areas shall continue until at least 80% cover is achieved (excluding alien plant species);
- Additional seeding or planting may be necessary to achieve 80% cover;
- Any plants that die, during the maintenance period, shall be replaced by the contractor (at the contractor's cost);
- Succession of natural plant species should be encouraged on site;
- Monitoring of rehabilitation success and follow-up adaptive management, together with clearing of emerging invasives shall be carried out during the operational phase of the proposed development; and
- A detailed cost breakdown for the proposed activities must be undertaken prior to the commencement of the activities.

4 REFERENCES

1) Hoare, D. (2014). Vegetation Rehabilitation Plan Longyuan Mulilo Maanhaarberg Wind Energy Facility, De Aar, Northern Cape.

2) Mucina, L., and Rutherford, M. C. 2006. The vegetation of South Africa, Lesotho and Swaziland. South Johannesburg. South African National Biodiversity Institute, Pretoria.

3) The Biodiversity Company. 2021. Terrestrial Biodiversity Assessment for the Proposed Upgrade of SANRAL R101 from Bela Bela (km 0.0) to Modimolle (km 26.8).

4) Waterberg District Municipality Environmental Management Framework. https://screening.environment.gov.za/ScreeningDownloads/EMF/WDEMF_Final_EMF_Report.pdf (Accessed 10 March 2021).

APPENDIX 1: VEGETATION TYPES

a) Central Sandy Bushveld (SVcb 12)

VT 18 Mixed Bushveld (44%), VT 19 Sourish Mixed Bushveld (32%) (Acocks 1953). LR 18 Mixed Bushveld (73%) (Low & Rebelo 1996).

Distribution Limpopo, Mpumalanga, Gauteng and North-West Provinces: Undulating terrain occurs mainly in a broad arc south of the Springbokvlakte from the Pilanesberg in the west through Hammanskraal and Groblersdal to GaMasemola in the east. A generally narrow irregular band along the northwestern edge of the Springbokvlakte (including Modimolle) extending into a series of valleys and lower-altitude areas within the Waterberg including the upper Mokolo River Valley near Vaalwater, the corridor between Rankins Pass and the Doorndraai Dam, and the lowlands from the Mabula area to south of the Hoekberge. Some isolated sandy rises are found on the Springbokvlakte. Altitude about 850–1 450 m.

Vegetation & Landscape Features Low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on deep sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broad-leaved *Combretum* woodland on shallow rocky or gravelly soils. Species of *Acacia*, *Ziziphus* and *Euclea* are found on flats and lower slopes on eutrophic sands and some less sandy soils. *A. tortilis* may dominate some areas along valleys. Grass-dominated herbaceous layer with relatively low basal cover on dystrophic sands.

Geology & Soils The large southern and eastern parts of this area are underlain by granite of the Lebowa Granite Suite and some granophyre of the Rashoop Granophyre Suite (both Bushveld Complex, Vaalian). In the north, the sedimentary rocks of the Waterberg Group (Mokolian Erathem) are most important. Specifically, sandstone, conglomerate and siltstone of the Alma Formation and sandstone, siltstone and shale of the Vaalwater Formation. Well-drained, deep Hutton or Clovelly soils often with a catenary sequence from Hutton at the top to Clovelly on the lower slopes; shallow, skeletal Glenrosa soils also occur. Land types mainly Bb, Fa, Ba, Bd and Ac.

Climate Summer rainfall with very dry winters. Effectively three seasons, namely a cool dry season from May to mid-August, a hot dry season from mid-August to about October and a hot wet season from about

November to April. MAP from about 500–700 mm. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Goedehoop (in the northern part of this vegetation unit) 35.3°C and –3.1°C for November and June, respectively. See also climate diagram for SVcb 12 Central Sandy Bushveld.

Important Taxa Tall Trees: *Acacia burkei* (d), *A. robusta*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Burkea africana* (d), *Combretum apiculatum* (d), *C. zeyheri* (d), *Terminalia sericea* (d), *Ochna pulchra*, *Peltophorum africanum*, *Rhus leptodictya*. Tall Shrubs: *Combretum hereroense*, *Grewia bicolor*, *G. monticola*, *Strychnos pungens*. Low Shrubs: *Agathisanthemum bojeri* (d), *Indigofera filipes* (d), *Felicia fascicularis*, *Gnidia sericocephala*. Geoxylic Suffrutex: *Dichapetalum cymosum* (d). Woody Climber: *Asparagus buchananii*. Graminoids: *Brachiaria nigropedata* (d), *Eragrostis pallens* (d), *E. rigidior* (d), *Hyperthelia dissoluta* (d), *Panicum maximum* (d), *Perotis patens* (d), *Anthephora pubescens*, *Aristida scabrivalvis* subsp. *scabrivalvis*, *Brachiaria serrata*, *Elionurus muticus*, *Eragrostis nindensis*, *Loudetia simplex*, *Schmidtia pappophoroides*, *Themeda triandra*, *Trachypogon spicatus*. Herbs: *Dicerocaryum senecioides* (d), *Barleria macrostegia*, *Blepharis integrifolia*, *Crabbea angustifolia*, *Evolvulus alsinoides*, *Geigeria burkei*, *Hermannia lancifolia*, *Indigofera daleoides*, *Justicia anagalloides*, *Kyphocarpa angustifolia*, *Lophiocarpus tenuissimus*, *Waltheria indica*, *Xerophyta humilis*. Geophytic Herb: *Hypoxis hemerocallidea*. Succulent Herb: *Aloe greatheadii* var. *davyana*.

Biogeographically Important Taxa (Central Bushveld endemics) Graminoid: *Mosdenia leptostachys*. Herb: *Oxygonum dregeanum* subsp. *canescens* var. *dissectum*.

Conservation Vulnerable. Target 19%. Less than 3% statutorily conserved spread thinly across many nature reserves including the Doorndraai Dam and Skuinsdraai Nature Reserves. An additional 2% conserved in other reserves including the Wallmansthal SANDF Property and a grouping of private reserves, which include most of the Nylsvlei freshwater wetlands. About 24% transformed, including about 19% cultivated and 4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plants are widely scattered but often at low densities; these include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion very low to high, especially in some places northeast of Groblersdal.

Remarks *Acacia sieberiana* occurs in the transition zone with grassland in the east, while *A. caffra* and *Faurea saligna* are dominant in the transition zone to SVcb 17 Waterberg Mountain Bushveld in the western parts of this unit. Central Sandy Bushveld is similar to SVcb 16 Western Sandy Bushveld, but the former is generally moister and cooler and generally lacks species such as *A. erubescens* and *A. nigrescens*.

The climate seasons described above also apply to many other vegetation units of the Central Bushveld Bioregion. This vegetation unit includes probably the most intensively studied South African savanna field site of the South African Savanna Ecosystem Programme in the Nylsvley Nature Reserve (Limpopo Province).

References Grunow (1965), Coetzee et al. (1976), Van der Meulen (1979), Van der Meulen & Westfall (1980), Lubke et al. (1983), Lubke & Thatcher (1983), Scholes & Walker (1993), Dörgeloh (1998, 1999a, b).

b) Springbokvlakte Thornveld (SVcb 15)

VT 12 Springbok Flats Turf Thornveld (48%), VT 18 Mixed Bushveld (42%) (Acocks 1953). LR 14 Clay Thorn Bushveld (55%) (Low & Rebelo 1996).

Distribution Limpopo, Mpumalanga, North-West and Gauteng Provinces: Flats from Zebediela in the northeast to Hammanskraal and Assen in the southwest as well as from Bela-Bela and Mookgophong in the northwest to Marble Hall and Rust de Winter in the southeast. Altitude about 900–1 200 m.

Vegetation & Landscape Features Open to dense, low thorn savanna dominated by *Acacia* species or shrubby grassland with a very low shrub layer. Occurs on flat to slightly undulating plains.

Geology & Soils Rocks are part of the volcano-sedimentary Karoo Supergroup. Most abundant in the area are the mafic volcanics (tholeitic and olivine basalts and nephelinites) of the Letaba Formation, then the mudstones of the Irrigasie Formation and the shale, with sandstone units, of the Ecca Group. Soils are red-yellow apedal, freely drained with high base status and self-mulching, black, vertic clays. The vertic soils, with a fluctuating water table, experience prolonged periods of swelling and shrinking during wet and dry periods, considerable soil cracking when dry, a loose soil surface, high calcium carbonate content and gilgai micro-relief. Land types mainly Ae and Ea.

Climate Summer rainfall with very dry winters. MAP about 500–650 mm. Frost fairly infrequent in winter. Mean monthly maximum and minimum temperatures for Warmbaths–Towoomba are 35.2°C and –2.0°C for October and July, respectively. Corresponding values are 36.8°C and –1.2°C for Marble Hall for January and June, respectively. See also climate diagram for SVcb 15 Springbokvlakte Thornveld.

Important Taxa Small Trees: *Acacia karroo* (d), *A. luederitzii* var. *retinens* (d), *A. mellifera* subsp. *detinens* (d), *A. nilotica* (d), *Ziziphus mucronata* (d), *Acacia tortilis* subsp. *heteracantha*, *Boscia foetida* subsp. *rehmanniana*. Tall Shrubs: *Euclea undulata* (d), *Rhus engleri* (d), *Dichrostachys cinerea*, *Diospyros lycioides* subsp. *lycioides*, *Grewia flava*, *Tarchonanthus camphoratus*. Low Shrubs: *Acacia tenuispina* (d),

Ptycholobium plicatum. Succulent Shrub: *Kleinia longiflora*. Herbaceous Climbers: *Momordica balsamina*, *Rhynchosia minima*. Graminoids: *Aristida bipartita* (d), *Dichanthium annulatum* var. *papillosum* (d), *Ischaemum afrum* (d), *Setaria incrassata* (d), *Aristida canescens*, *Brachiaria eruciformis*. Herbs: *Aspilia mossambicensis*, *Indigastrum parviflorum*, *Nidorella hottentotica*, *Orthosiphon suffrutescens*, *Senecio apiifolius*.

Biogeographically Important Taxon (Central Bushveld endemic) Graminoid: *Mosdenia leptostachys*.

Conservation Endangered. Target 19%. Only 1% statutorily conserved, mainly in the Mkombo Nature Reserve. Roughly three times this area is conserved in a number of other reserves. At least 49% transformed, including about 45% cultivated and 3% urban and built-up. Dense rural populations in parts of the southern and eastern side of the unit. Very scattered alien plants over wide areas include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion is very low to moderate.

Remark The high clay content of the soil increases soil moisture stress and SVcb 15 Springbokvlakte Thornveld is more xeric than adjacent vegetation units (except for SVcb 27 Sekhukhune Plains Bushveld in the extreme northeast).

References Galpin (1926), Coetzee et al. (1976), Van der Meulen (1979), Van der Meulen & Westfall (1980), Winterbach (1998).

c) Waterberg Mountain Bushveld (SVcb 17)

VT 20 Sour Bushveld (73%) (Acocks 1953). LR 12 Waterberg Moist Mountain Bushveld (83%) (Low & Rebelo 1996).

Distribution Limpopo Province: Waterberg Mountains, including the foothills, escarpment and tablelands south of the line between Lephalale and Marken and north of Bela-Bela and west of Mokopane and with outliers in the southwest such as the Boshofsberge and Vlieëpoortberge near Thabazimbi. Altitude about 1 000–1 600 m and generally at a lower altitude than the Gm 29 Waterberg-Magaliesberg Summit Sourveld.

Vegetation & Landscape Features Rugged mountains with vegetation grading from *Faurea saligna–Protea caffra* bushveld on higher slopes (in turn grading into the Gm 29 Waterberg-Magaliesberg Summit Sourveld) through broad-leaved deciduous bushveld (dominated by *Diplorhynchus condylocarpon*) on

rocky mid- and footslopes to *Burkea africana–Terminalia sericea* savanna in the lower-lying valleys as well as on deeper sands of the plateaus. The grass layer is moderately developed or well developed.

Geology & Soils Mainly sandstone, subordinate conglomerate, siltstone and shale of the Kransberg Subgroup and medium- to coarse-grained sandstone, conglomerate, trachytic lava and quartz porphyry of the Swaershoek Formation, Nylstroom Subgroup (both Mokolian Waterberg Group). Dystrophic, acidic sandy, loamy to gravelly soil. Glenrosa and Mispah Forms. Land types mainly Ib, Ac, Fa and Ad.

Climate Summer rainfall with very dry winters. MAP from about 500 mm in the lower-altitude northwest to about 750 mm on the higher parts of the main east-west range. Frost fairly frequent in winter. See also climate diagram for SVcb 17 Waterberg Mountain Bushveld.

Important Taxa Tall Tree: *Acacia robusta*. Small Trees: *Acacia caffra* (d), *Burkea africana* (d), *Combretum apiculatum* (d), *Croton gratissimus* (d), *Cussonia transvaalensis* (d), *Faurea saligna* (d), *Heteropyxis natalensis* (d), *Ochna pulchra* (d), *Protea caffra* (d), *Albizia tanganyicensis*, *Combretum molle*, *Englerophytum magalismontanum*, *Ficus burkei*, *F. glumosa*, *Ochna pretoriensis*, *Pseudolachnostylis maprouneifolia*, *Rhus lancea*, *Terminalia sericea*, *Vangueria infausta*, *V. parvifolia*. Tall Shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Combretum moggii*, *C. nelsonii*, *Dichrostachys cinerea, Euclea crispa* subsp. *crispa*, *Gnidia kraussiana*, *Olea capensis* subsp. *enervis*, *O. europaea* subsp. *africana*, *Rhus pyroides* var. *pyroides*, *Strychnos pungens*, *Vitex rehmannii*. Low Shrubs: *Anthospermum rigidum* subsp. *rigidum*, *Barleria affinis*, *Felicia muricata*, *Helichrysum kraussii*, *Protea welwitschii* subsp. *welwitschii*, *Rhus rigida* var. *dentata*. Geoxylic Suffrutices: *Dichapetalum cymosum*, *Parinari capensis* subsp. *capensis*. Succulent Shrubs: *Aloe chabaudii*, *Lopholaena coriifolia*. Woody Climbers: *Ancylobotrys capensis* (d), *Rhoicissus revoilii*. Graminoids: *Loudetia simplex* (d), *Schizachyrium sanguineum* (d), *Trachypogon spicatus* (d), *Brachiaria serrata*, *Digitaria eriantha* subsp. *eriantha*, *Elionurus muticus*, *Enneapogon scoparius*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*. Herbs: *Berkheya insignis*, *Chamaecrista mimosoides*, *Geigeria elongata*, *Hibiscus meyeri* subsp. *transvaalensis*, *Xerophyta retinervis*. Geophytic Herbs: *Haemanthus humilis* subsp. *humilis*, *Hypoxis rigidula*.

Biogeographically Important Taxa ([CB]Central Bushveld endemic, [N]Northern Sourveld endemic) Small Tree: *Encephalartos eugene-maraisii*[N]. Tall Shrub: *Erythrophysa transvaalensis*[CB]. Soft Shrub: *Chorisochora transvaalensis*[N]. Graminoid: *Mosdenia leptostachys*[CB].

Endemic Taxa Tall Shrubs: *Grewia rogersii*, *Pachystigma triflorum*. Herb: *Oxygonum dregeanum* subsp. *canescens* var. *pilosum*.

Conservation Least threatened. Target 24%. About 9% statutorily conserved mainly in the Marakele National Park and Moepel Nature Reserve. More than 3% transformed, mainly by cultivation. Human population density is low. Erosion is generally very low to low.

Remark Carrying capacity of the vegetation for domestic stock animals is low, especially during the dry season.

References Coetzee et al. (1981), Westfall (1981), Westfall et al. (1983, 1985), Ben-Shahar (1988), Van Staden (2002), Van Staden & Bredenkamp (2005).