
**A PLANT AND MAMMAL SPECIES RICHNESS AND HABITAT ASSESSMENT OF
THE SAPS TRAINING INSTITUTE, THABAZIMBI**

by

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DECLARATION OF INDEPENDENCE

I, George Johannes Bredenkamp declare that I:


- Am the owner of Eco-Agent CC, CK 95/37116/23

and we (George Johannes Bredenkamp Id4602105019086 and Ignatius Lourens Rautenbach Id4212015012088) furthermore declare that we:

- are committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas we appreciate the opportunity to also learn through the processes of constructive criticism and debate, we reserve the right to form and hold our own opinions and therefore will not willingly submit to the interests of other parties or change our statements to appease them;
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Profession;
- Act as independent specialist consultants respectively in the fields of ecology, vegetation science and botany, as well as in mammalogy;
- Are assigned as specialist consultants by Interdesign Landscape Architects for the project "*A Plant and Mammal Species Richness and Habitat Assessment of the SAPS Training Institute, Thabazimbi*" described in this report;
- Do not have or will not have any financial interest in the undertaking of the activity other than remuneration for work performed;
- Have or will not have any vested interest in the proposed activity proceeding;
- Have no and will not engage in conflicting interests in the undertaking of the activity;
- Undertake to disclose to the client and the competent authority any material information that have or may have the potential to influence the decision of the competent authority required in terms of the Environmental Impact Assessment Regulations 2006;
- Our intellectual property in this report will only be transferred to the client (the party/ company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, we recognise that written consent of the client will be required for release of any part of this report to third parties.



GJ Bredenkamp



IL Rautenbach

ABSTRACT

The intended developments will be restricted and the footprint of the development sites will be insignificant measured against the total size of the approximately 9000 hectares site. In most instances development and alterations will be on sites already developed, and these therefore do not qualify for serious consideration with regard to the biodiversity.

Wetlands are considered as sensitive, but none of the proposed developments will affect this habitat type.

The intended development will not result in a loss of ecological sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), loss of mammal habitat, nor of loss/displacement of threatened or protected species.

Care should be taken to avoid encroaching into riparian zones or mountain slopes. There are no need for buffer zones at or near of any of the development sites.

From a mammal perspective, no compelling reason can be offered why the proposed developments and improvements can not proceed.

ASSIGNMENT – Eco-Agent Protocol

Eco-Agent CC Ecological Consultants were appointed by Interdesign Landscape Architects, on behalf of the Department of Public Works, to assess the vegetation and mammal species richness and habitat scan on the sites proposed for additions and alterations at Thabazimbi (Verdrag) SAPS Training Institution. This assignment is in accordance with the 2010 EIA Regulations (No. R. 543-546, Department of Environmental Affairs and Tourism, 18 June 2010) emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998).

The assignment is interpreted as follows: Compile a study of the vegetation and mammals of the site, with emphasis on Red Data plant and vertebrate species that occur or may occur on the site. In order to compile this, the following had to be done:

1.1 Initial preparations:

- Obtain all relevant maps and information on the natural environment of the concerned area.
- This includes information on Red Data plant and vertebrate species that may occur in the area.

1.2 Vegetation and habitat survey:

- List the plant species (trees, shrubs, grasses and herbaceous species) present for plant community and ecosystem delimitation.
- Identify potential red data plant species, alien plant species, and medicinal plants.

1.3 Plant community delimitation and description

- Process data (vegetation and habitat classification) to determine vegetation types (= plant communities) on an ecological basis.
- Describe the habitat and vegetation.
- Determine the sensitivity of the site on basis of biodiversity, veld condition and presence of rare or protected species.
- Prepare a vegetation map of the area **if more than one plant community is present.**

- Prepare a sensitivity map of the plant communities present, **if relevant**.
-

1.4 Mammal assessment

- Compile lists of the mammals that can be expected in the area.
- Describe the Red Data species that occur (or may occur) on the site.
- Assess the quantitative and qualitative condition of suitable habitat for the Red Listed mammals that may occur in the area.

1.5 General

- Identify and describe particular ecologically sensitive areas.
- Identify problem areas in need of special treatment or management, e.g. bush encroachment, erosion, water pollution, degraded areas, reclamation areas.
- Make recommendations on aspects that should be monitored during development.

2. RATIONALE

It is widely recognised that it is of utmost importance to conserve natural resources in order to maintain ecological processes and life support systems for plants, animals and humans. To ensure that sustainable development takes place, it is therefore important that the environment is considered before relevant authorities approve any development. This led to legislation protecting the natural environment. The Environmental Conservation Act (Act 73 of 1989), the National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998) and the National Environmental Management Biodiversity Act, 2004. (Act 10 Of 2004) ensure the protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment. It also ensures the protection of the environment against disturbance, deterioration, defacement or destruction as a result of man-made structures, installations, processes or products or human activities. A draft list of Threatened Ecosystems was published (Government Gazette 2009) as part of the National Environmental Management Biodiversity Act, 2004. (Act 10 Of 2004). These Threatened Ecosystems are described by SANBI & DEAT (2009).

All components of the ecosystems (physical environment, vegetation, animals) of a site are interrelated and interdependent. A holistic approach is therefore imperative

to effectively include the development, utilisation and where necessary conservation of the given natural resources in an integrated development plan, which will address all the needs of the modern human population (Bredenkamp & Brown 2001).

It is therefore necessary to make a thorough inventory of the plant communities and biodiversity on the relevant sites and transects, in order to evaluate the biodiversity and possible rare species. This inventory should then serve as a scientific and ecological basis for the planning exercises.

The conduct of natural scientists is directed by the Natural Scientific Professions Act (Act 27 of 2003). Nowadays a development prerogative is to precede new constructions by a multidisciplinary environmental investigation to assess the conservation costs. This is to ensure that best conservation practices are applied during the planning, construction and operational phases of new developments.

SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the habitat components and current general conservation status of the site;
- To comment on ecological sensitive areas;
- To comment on connectivity with natural vegetation and habitats on adjacent sites;
- To recommend suitable buffer zones if relevant;
- To provide a list of plants and mammals that occur or might occur or may be affected, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the plants and mammals of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

4. STUDY AREA

4.1 General

The Thabazimbi (Verdrag) SAPS Training Institution (the site) is an approximately 9000 hectares property located on the farms Groenfontein 458 KQ and Buffelskloof 452 KQ in the Thabazimbi District (2427DA and 2427DB). The site is bisected by the D928 Alma Road whereas about 2400 hectares on Groenfontein has been secured with game fencing.

The site has been used as an advanced training institute for SAPS personnel. Training and accommodation is located in a number of small and well circumscribed localities whereas the greatest portion of the site is, for all intents and purposes, managed as a game reserve. There is thus a strong parallel between the site and a conventional nature reserve, with only a difference between tourist rest camps in the latter and training facilities in the former. It is planned to upgrade some of the training facilities denoted as, and spatially located as follows:

1. Existing A Training Camp (to be upgraded) 24° 32' 57"S; 27° 44' 37"E
2. New Residential Extension to Existing Housing 24° 33' 01"S; 27° 44' 58"E
3. Groenfontein Residential Area 24° 33' 47"S; 27° 46' 24"E
4. Existing D Training Camp (to be upgraded) 24° 31' 20"S; 27° 43' 43"E
5. New Ammunition Safe at existing safe 24° 33' 10"S; 27° 43' 43"E
6. Existing B Training Camp to be replaced *in situ* 24° 34' 08"S; 27° 44' 24"E
7. New Shooting Range and Admin. Block 24° 34' 59"S; 27° 45' 36"E
8. New A Training Camp 24° 33' 48"S; 27° 45' 36"E
9. New Admin. Building & extension to Landing strip 24° 33' 20"S; 27° 47' 00"E
10. Additionally a new gravity feed sewer line is planned between the exiting A Training Camp (1) and the existing Sewage works and also between the new A Training Camp and the existing Sewage Works (2).
11. All training facilities are interconnected by farm roads.

This report assesses the vegetation and mammals of the 11 sites proposed for development or upgrade. Additionally, should any of the sites be close to a river or spruit, the riparian zones are also assessed, to ensure that the proposed developments do not impact on the river or spruit.

The site is located in a wooded valley between mountain ranges to the north and south, with the site boundaries along the summits. The mountain ranges are characterized by impressive rock faces and wooded slopes.

A major feature of the site is the Rookpoort Dam located in a mountain gorge close to the southern boundary. The dam provides bulk water to most of the training facilities.

The substrate in the valley consists mostly of red sandy soil, in places with fine gravel. Termitaria are common.

The 500 meters zone of adjoining properties is similar in appearance and land-use practices. Boundaries consist mostly of regular cattle fences, in some cases game fence, implying that connectivity is high (near-normal).

Well-studied caves are known from two farms away in the Rooiberg area. It can be taken for granted that these bats commute to hawk for insects over the Rookpoort Dam and wetlands. It is also very likely that smaller caves and rock crevices along the mountains on the site provide sanctuary for cave bats.

The site is not commercially farmed, and the carrying capacity is probably higher than the grazing / browsing pressure exerted by herbivores. The footprint of the training facilities and road infrastructure is small. Conservation status of the site is ranked as “excellent”.

4.2 Vegetation Types

Acocks (1953) classified the plant associations of the site and region as Sour Bushveld veld type. Low and Rebelo (1996) defined the plant assemblage in the district as Waterberg Moist Mountain Bushveld veld type. More recently Mucina and Rutherford (2006) identified the area as answering to the definition of their Waterberg Mountain Bushveld vegetation type, probably with elements of the Central Sandy Bushveld vegetation type.

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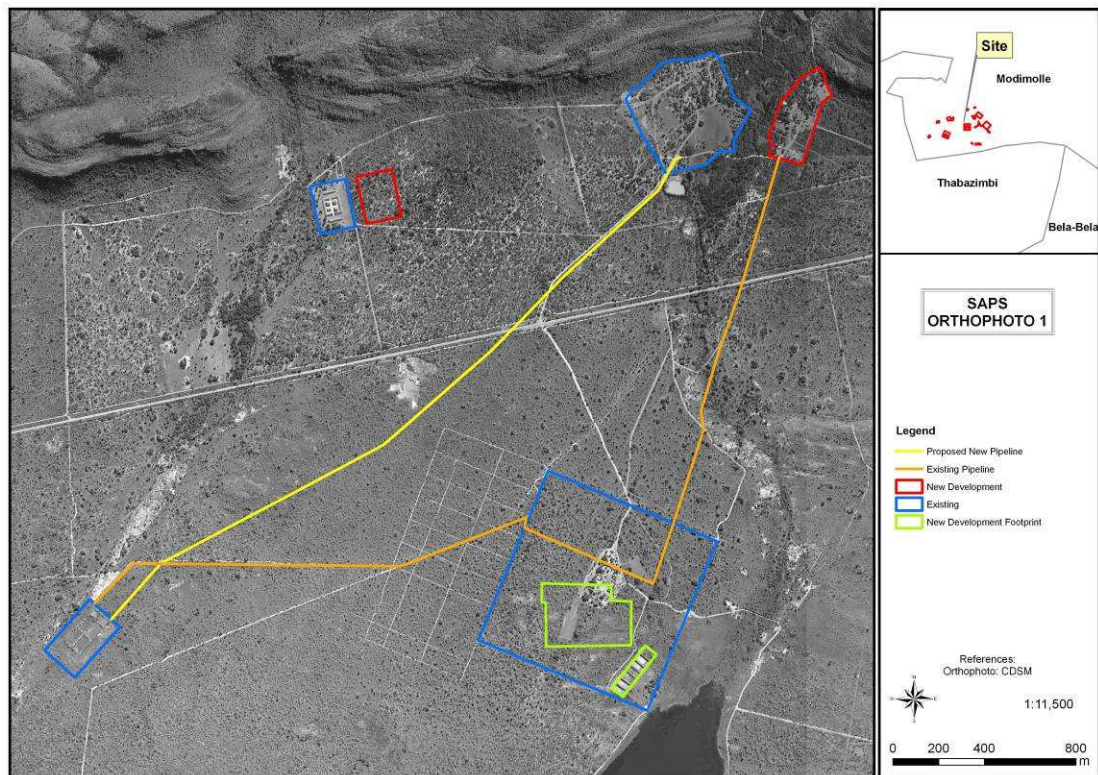


Figure 2: Aerial image of the western part of the study site

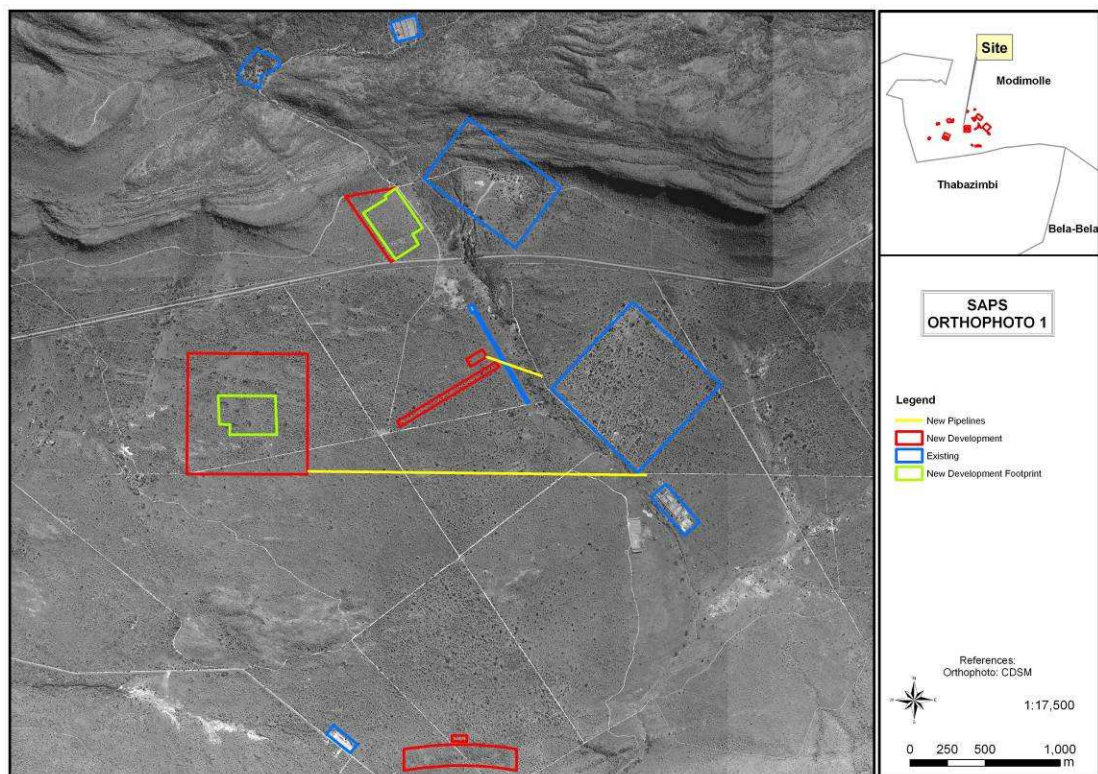


Figure 3: Aerial image of the eastern part of the study site

5. METHODS

5.1 Vegetation and flora survey

The site was visited on 5 December 2011 by Prof GJ Bredenkamp and Dr IL Rautenbach of EcoAgent.

The vegetation of the eleven sites where the training facilities are planned was identified a recent aerial image of the area. At several sites within each site a description of the dominant and characteristic species was made. These descriptions were based on total floristic composition, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). Data recorded included a list of the plant species present, including trees, shrubs, grasses and forbs. Comprehensive species lists were therefore derived for each plant community / ecosystem present on the site. These vegetation survey methods have been used as the basis of a national vegetation survey of South Africa (Mucina *et al.* 2000) and are considered to be an efficient method of describing vegetation and capturing species information. Notes were additionally made of any other features that might have an ecological influence.

The identified systems are not only described in terms of their plant species composition, but also evaluated in terms of the potential habitat for red data plant species.

Red data plant species for the area were obtained from the SANBI data bases, with updated threatened status, (Raimondo *et al.* 2009). These lists were then evaluated in terms of habitat available on the site, and also in terms of the present development and presence of man in the area.

Alien invasive species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) as listed in Henderson (2001), are indicated.

Medicinal plants are indicated according to Van Wyk, Van Oudthoorn & Gericke (1997),

The field observations were supplemented by literature studies from the area (Coetzee *et al.* 1994, 1995).

5.2 Conservation Priority / Sensitivity

The following **conservation priority** categories were used for each site:

- High:** Ecologically sensitive and valuable land with high species richness and/or sensitive ecosystems or red data species that should be conserved and no developed allowed.
- Medium-high:** Land where sections are disturbed but which is in general ecologically sensitive to development/disturbances.
- Medium:** Land on which low impact development with limited impact on the vegetation / ecosystem could be considered for development. It is recommended that certain portions of the natural vegetation be maintained as open space.
- Medium-low:** Land of which small sections could be considered to conserve but where the area in general has little conservation value.
- Low:** Land that has little conservation value and that could be considered for developed with little to no impact on the vegetation.

5.3 Status

Plant species recorded in each plant community with an indication of the status of the species by using the following symbols:

A = Alien woody species

D = Dominant

d = subdominant

G = Garden or Garden Escape

M = Medicinal plant species

P = Protected trees species

p = provincially protected species

RD = Red data listed plant

W = weed

5.4 Species Richness

Species Richness is interpreted as follows: Number of indigenous species recorded in the sample plots representing the plant community. Alien woody species and weeds are not included.

No of species	Category
1-24	Low
25-39	Medium
40-59	High
60+	Very High

5.5 Wetlands, spruits and rivers

This report should not be considered as a wetland specialist report, however, the possible presence of wetlands, spruits and rivers were investigated as part of the vegetation and flora survey.

5.2 Mammal Survey

A site visit was conducted on 5 December 2011. During this visit the observed and derived presence of mammals associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African mammals, coupled to the qualitative and quantitative nature of recognized habitats.

The 500 meters of adjoining properties was scanned for important fauna habitats.

5.2.1 Field Survey

During the site visit mammals were identified by visual sightings through random transect walks and patrolling with a vehicle. No trapping or mist netting was conducted, as the terms of reference did not require such intensive work. In addition, mammals were also identified by means of spoor, droppings, burrows or roosting sites. Locals were interviewed to confirm occurrences or absences of species.

Three criteria were used to gauge the probability of occurrence of vertebrate species on the study site. These include known distribution range, habitat preference and the qualitative and quantitative presence of suitable habitat.

5.2.2 Desktop Survey

As many mammals are either secretive, nocturnal, hibernators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and data bases. This can be done with a high level of confidence irrespective of season. During the field work phase of the project, this derived list of occurrences is audited.

The probability of occurrences of **mammal** species was based on their respective geographical distributional ranges and the suitability of on-site habitats. In other words, *high* probability would be applicable to a species with a distributional range

overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorized as *medium* normally do not occur at high population numbers, but cannot be deemed as rare.

A *low* probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorized as *low* are generally deemed to be rare.

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5.2.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of Red Data and/or wetland-associated species such as:

Juliana's golden mole (*Neamblosomus juliana*), Highveld golden mole (*Amblysomus septentrionalis*), Rough-haired golden mole (*Chrysospalax villosus*), African marsh rat (*Dasymys incomtus*), Angoni vlei rat (*Otomys angoniensis*), Vlei rat (*Otomys irroratus*), White-tailed rat (*Mystromys albicaudatus*), a number of shrews such as the Forest shrew (*Myosorex varius*), Southern African hedgehog (*Atelerix frontalis*), a number of bats such as the Short-eared trident bat (*Cloeotis percivali*), African clawless otter (*Aonyx capensis*), Spotted-necked otter (*Lutra maculicollis*), Marsh mongoose (*Atilax paludinosus*), Brown hyena (*Parahyaena brunnea*), etc.

6. RESULTS: VEGETATION AND FLORA

In general the vegetation of the eleven sites are very similar, representing Central Sandy Bushveld. The vegetation and plant species composition of the eleven sites are, however, described separately.

1. Existing Camp A (to be upgraded).

This camp is situated at approximately 24° 32' 57"S; 27° 44' 37"E. The area is already developed and the natural vegetation has partly been cleared and altered. Although the shrubby bush and ground cover have been cleared, many tree species still remained. The site was initially probably chosen for the camp due to the large trees that occurred there.

The following plant species were noted in this area:

Trees and Shrubs

<i>Acacia caffra</i>		<i>Faurea saligna</i>	
<i>Acacia erioloba</i>	P	<i>Ficus thonningii</i>	
<i>Acacia galpinii</i>		<i>Grewia occidentalis</i>	
<i>Acacia nilotica</i>		<i>Gymnosporia buxiifolia</i>	
<i>Acacia robusta</i>		<i>Lannea discolor</i>	
<i>Bridelia mollis</i>		<i>Mundulea sericea</i>	
<i>Celtis africana</i>		<i>Mystroxydon aethiopicum</i>	
<i>Clerodendrum glabrum</i>		<i>Olea europaea subsp africana</i>	M
<i>Combretum apiculatum</i>		<i>Peltophorum africanum</i>	
<i>Combretum zeyheri</i>		<i>Sclerocarya birrea</i>	PM
<i>Dichrostachys cinerea</i>		<i>Searsia leptodictya</i>	
<i>Diospyros lycioides</i>		<i>Searsia pyroides</i>	
<i>Dombeya rotundifolia</i>	M	<i>Terminalia brachystemma</i>	
<i>Ehretia rigida</i>		<i>Terminalia sericea</i>	M
<i>Euclea crispa</i>		<i>Vitex rehmannii</i>	
<i>Euphorbia ingens</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Cynodon dactylon</i>	<i>Hyparrhenia hirta</i>
<i>Eragrostis curvula</i>	<i>Melinis repens</i>
<i>Eragrostis rigidior</i>	<i>Setaria sphacelata</i>
<i>Eragrostis superba</i>	

Forbs

<i>Agathisanthemum bojeri</i>	<i>Felicia muricata</i>
<i>Elephantorrhiza elephantina</i>	M <i>Gomphocarpus fruticosus</i>

Haplocarpha scaposa
Helichrysum miconiifolium
Helichrysum nudifolium
Hypoxis multiceps
Pavonia burchellii
Sida alba

Stoebe vulgaris
Verbena braziliensis W
Wahlenbergia caledonica
Waltheria indica
Zornia linearis

1 Existing Camp A			
Status	Transformed		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Medium	Need for rehabilitation	Low
Dominant spp.	<i>Peltophorum africanum</i> , <i>Terminalia sericea</i> , <i>Combretum zeyheri</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-9	40-50
Shrubs	0.5-3	5-10
Grass	1.3	40
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	32	0	32	0	2	5
Grasses	7	0	7	0	0	0
Forbs	14	1	15	0	0	0
Total	53	1	54	0	2	5

Discussion

The species richness of this area is high, with 2 protected tree species but no red data species present.

The area is already developed and the upgrade can be supported.



Figure 4: A scene at the existing A Training Camp

2. New Residential Extension to Existing Housing

This area is situated directly east of the Existing Training Camp A, across the spruit at approximately 24° 33' 01"S; 27° 44' 58"E.

The area is already developed and the natural vegetation has partly been cleared and altered, for the construction of housing. The site is adjacent to the spruit, though the newly proposed Extension is located east of the existing houses, away from the spruit into bushveld. The steep slopes of the mountain are situated directly north of the proposed development. The vegetation is dense bush, about 5-6 m tall, covering 60% and dominated by *Dichrostachys cinerea*.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia caffra</i>		<i>Heteropyxis natalensis</i>	M
<i>Burkea africana</i>		<i>Lannea discolor</i>	
<i>Combretum apiculatum</i>		<i>Mundulea sericea</i>	
<i>Combretum hereroense</i>		<i>Olea europaea subsp africana</i>	M
<i>Combretum molle</i>		<i>Peltophorum africanum</i>	
<i>Combretum zeyheri</i>		<i>Pseudolachnostylis maprouneifolia</i>	
<i>Dichrostachys cinerea</i>	D	<i>Searsia leptodictya</i>	
<i>Diospyros lycioides</i>		<i>Searsia pyroides</i>	
<i>Dombeya rotundifolia</i>	M	<i>Terminalia brachystemma</i>	
<i>Ehretia rigida</i>		<i>Terminalia sericea</i>	M
<i>Euclea crispa</i>		<i>Vitex rehmannii</i>	
<i>Grewia flava</i>		<i>Ziziphus mucronata</i>	M
<i>Gymnosporia buxiifolia</i>			

Grasses

<i>Aristida adscendens</i>		<i>Heteropogon contortus</i>	
<i>Aristida congesta</i>		<i>Hyparrhenia hirta</i>	
<i>Bothriochloa insculpta</i>		<i>Hyperthelia dissoluta</i>	
<i>Cynodon dactylon</i>		<i>Melinis repens</i>	
<i>Eragrostis heteromera</i>		<i>Perotis patens</i>	
<i>Eragrostis rigidior</i>	d	<i>Setaria sphacelata</i>	
<i>Eragrostis superba</i>		<i>Themeda triandra</i>	

Forbs

<i>Agathisanthemum bojeri</i>		<i>Pavonia burchellii</i>	
<i>Evolvulus alsinoides</i>		<i>Pellaea calomelanos</i>	M
<i>Felicia muricata</i>		<i>Pellaea viridis</i>	
<i>Indigofera hedyantha</i>		<i>Waltheria indica</i>	
<i>Lippia javanica</i>	M		

2 New Residential Extension to Existing Housing Existing Camp A			
Status	Transformed		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Terminalia sericea</i> , <i>Combretum apiculatum</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-5	20
Shrubs	0.5-3	20-30
Grass	1.3	40
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	25	0	25	0	0	5
Grasses	14	0	14	0	0	0
Forbs	9	0	9	0	0	2
Total	48	0	48	0	0	7

Discussion

The species richness of this area is high, with no protected tree species and no red data species present.

The area is partly already developed and the dense bush is degraded and encroached by *Dichrostachys cinerea*. the upgrade can be supported, though no development closer to the spruit or closer to the mountain slopes will be supported.



Figure 5: The dense bush at the site proposed for new residential development at A Training Camp

3. New Groenfontein Residential Area

This area is situated at approximately 24° 33' 47"S; 27° 46' 24"E, on Groenfontein, at the current cross-roads leading to the D Training Camp.

The vegetation is dense bush, similar to that of Site 2, about 5-6 m tall, covering 60-70% and dominated by *Dichrostachys cinerea*. A power / telephone line transects the site, where the vegetation has been cleared. The general impression is that the vegetation is degraded and encroached by *Dichrostachys cinerea*.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia caffra</i>		<i>Diospyros lycioides</i>	
<i>Combretum apiculatum</i>		<i>Dombeya rotundifolia</i>	M
<i>Combretum molle</i>		<i>Ehretia rigida</i>	
<i>Combretum zeyheri</i>		<i>Euclea crispa</i>	
<i>Dichrostachys cinerea</i>	D	<i>Grewia bicolor</i>	

<i>Grewia flava</i>		<i>Peltophorum africanum</i>	
<i>Gymnosporia buxiifolia</i>		<i>Searsia leptodictya</i>	
<i>Heteropyxis natalensis</i>	M	<i>Searsia pyroides</i>	
<i>Lannea discolor</i>		<i>Terminalia sericea</i>	dM
<i>Lannea edulis</i>	M	<i>Ziziphus mucronata</i>	M

Grasses

<i>Andropogon</i> sp		<i>Eragrostis gummiiflua</i>	
<i>Aristida adscendens</i>		<i>Eragrostis heteromera</i>	
<i>Aristida congesta</i>		<i>Eragrostis rigidior</i>	D
<i>Aristida stipitata</i>		<i>Eragrostis superba</i>	
<i>Cynodon dactylon</i>		<i>Heteropogon contortus</i>	
<i>Digitaria eriantha</i>		<i>Melinis repens</i>	
<i>Elionurus muticus</i>		<i>Setaria sphacelata</i>	

Forbs

<i>Agathisanthemum bojeri</i>		<i>Pellaea viridis</i>	
<i>Felicia muricata</i>		<i>Sida chrysantha</i>	
<i>Lippia javanica</i>	M	<i>Stylosanthes fruticosa</i>	
<i>Pellaea calomelanos</i>	M	<i>Waltheria indica</i>	

3 New Groenfontein Residential			
Status	Degraded Bushveld		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Eragrostis rigidior</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-5	15
Shrubs	0.5-3	20-40
Grass	1.3	40
Forbs	0.4	5

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	20	0	20	0	0	5
Grasses	14	0	14	0	0	0
Forbs	8	0	8	0	0	0
Total	42	0	42	0	0	5

Discussion

The species richness of this area is high, with no protected tree species and no red data species present. The dense bush is degraded and encroached by *Dichrostachys cinerea*. The development can be supported.



Figure 6: The disturbed vegetation at the proposed Groenfontein Residential Area

4. Existing D Training Camp (to be upgraded)

There is an existing Training Camp (D), situated towards the north on Groenfontein, at approximately 24° 31' 20"S; 27° 43' 43"E. This Camp is located in a small kloof into the mountain. A small spruit drains down the kloof. There is also an existing shooting range a bit further east into the mountain. The area in general would be regarded as sensitive, though the existing facilities are already in use for a long time. Fortunately the existing development covers a very small area. The camp area is for training of senior police officers; the camp terrain is well developed, neat and well kept. The existing buildings have thatched roofs. It is planned to upgrade the existing facilities at D Camp.

The site is located between the tributaries of two small spruits, within the mountains, which causes the site to be ecologically sensitive. The natural vegetation has partly been cleared and altered, for the construction of the existing camp. Within the area of the camp the vegetation has partly been cleared, lawn grass established with mainly large indigenous trees remaining. Some exotic (alien) trees and other garden plants have been planted in the gardens. These are not all recorded for the survey. Little grass and forb species remained due to the maintenance of the gardens.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia ataxacantha</i>		<i>Euclea crispa</i>	
<i>Acacia caffra</i>		<i>Faurea saligna</i>	
<i>Acacia karroo</i>	M	<i>Ficus thonningii</i>	
<i>Acacia robusta</i>		<i>Gymnosporia buxiifolia</i>	
<i>Acacia tortilis</i>		<i>Heteropyxis natalensis</i>	M
<i>Berchemia discolor</i>		<i>Ilex</i> sp	A
<i>Celtis africana</i>		<i>Lannea discolor</i>	
<i>Combretum erythrophyllum</i>	G	<i>Olea europaea subsp africana</i>	M
<i>Combretum apiculatum</i>		<i>Pappea capensis</i>	
<i>Combretum molle</i>		<i>Peltophorum africanum</i>	
<i>Dichrostachys cinerea</i>		<i>Pseudolachnostylis maprouneifolia</i>	
<i>Diospyros lycioides</i>		<i>Rhoicissus tridentata</i>	M
<i>Dombeya rotundifolia</i>	M	<i>Searsia lancea</i>	
<i>Ehretia rigida</i>		<i>Searsia leptodictya</i>	

Searsia pyroides
Vitex rehmannii

Ximenia caffra
Ziziphus mucronata M

Grasses

Cynodon dactylon
Eragrostis curvula
Eragrostis rigidior
Hyparrhenia hirta

Pennisetum clandestinum A
Setaria sphacelata
Themeda triandra

Forbs

Felicia muricata
Hermannia depressa

Lepidium bonariense W
Waltheria indica

4 Existing D Training Camp			
Status	Transformed		
Soil	Sandy loam, rocky	Rockiness %	5-10
Conservation priority:	High	Sensitivity:	High
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Combretum apiculatum</i> , <i>Searsia leptodictya</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	35
Shrubs	0.5-3	10
Grass	1.3	10
Forbs	0.4	5

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	31	1	32	0	0	6
Grasses	6	1	7	0	0	0
Forbs	3	1	4	0	0	0
Total	40	3	43	0	0	6

Discussion

In spite of the bush clearing and the well kept garden, the species richness of indigenous species is high, particularly for the tree species, but no protected tree species and no red data species were recorded.

The area is already partly developed and the area is well maintained. It is strongly recommended that the new developments must not go closer to the spruits, remaining outside the riparian zone with a buffer zone. It is further suggested to avoid developing on to the mountain hillsides, try to avoid clearing large areas of natural bush. Furthermore, try to keep as many as possible of the large trees, to maintain the bush atmosphere. Should these mitigation measures be adhered to, the upgrade of the facility can be supported.



Figure 7: The existing D Training Camp – developed area



Figure 8: Natural vegetation in the vicinity of D Training Camp

5. New Ammunition Safe at existing safe

There is an existing ammunition safe towards the west of the main A Camp. This area is situated at approximately 24° 33' 10"S; 27° 43' 43"E, on Buffelskloof. A new additional safe is planned directly east of the existing safe.

The vegetation is tall tree veld 5-7 m tall and covering about 50%. For this facility all vegetation will have to be cleared (safety measures). The vegetation is dominated by *Burkea africana* and *Dichrostachys cinerea*.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia robusta</i>		<i>Grewia flava</i>	
<i>Berchemia discolor</i>		<i>Grewia flavescens</i>	
<i>Burkea africana</i>	d	<i>Gymnosporia buxiifolia</i>	
<i>Combretum apiculatum</i>		<i>Heteropyxis natalensis</i>	M
<i>Combretum zeyheri</i>		<i>Lannea discolor</i>	
<i>Clerodendrum glabrum</i>		<i>Mundulea sericea</i>	
<i>Dichrostachys cinerea</i>	D	<i>Olea europaea</i> subsp <i>africana</i>	M
<i>Diospyros lycioides</i>		<i>Peltophorum africanum</i>	
<i>Dombeya rotundifolia</i>	M	<i>Searsia lancea</i>	
<i>Euclea crispa</i>		<i>Searsia leptodictya</i>	
<i>Euclea natalensis</i>		<i>Searsia pyroides</i>	
<i>Faurea saligna</i>		<i>Terminalia sericea</i>	dM
<i>Gardenia volkensii</i>		<i>Vitex rehmannii</i>	
<i>Grewia bicolor</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Aristida adscendens</i>	<i>Heteropogon contortus</i>
<i>Cynodon dactylon</i>	<i>Melinis repens</i>
<i>Eragrostis gummiflua</i>	<i>Perotis patens</i>
<i>Eragrostis heteromera</i>	<i>Setaria sphacelata</i>
<i>Eragrostis rigidior</i>	<i>Themeda triandra</i>

Forbs

<i>Agathisanthemum bojeri</i>	<i>Asparagus</i> sp
<i>Asparagus falcatus</i>	<i>Cyperus obtusiflorus</i>

Evolvulus alsinoides

Sida alba

Lantana rugosa

Stoebe vulgaris

Lippia javanica M

Wahlenbergia caledonica

Pellaea calomelanos M

Waltheria indica

3 New Groenfontein Residential			
Status	Degraded Bushveld		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Eragrostis rigidior</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-5	15
Shrubs	0.5-3	20-40
Grass	1.3	40
Forbs	0.4	5

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	28	0	28	0	0	5
Grasses	10	0	10	0	0	0
Forbs	12	0	12	0	0	2
Total	50	0	50	0	0	7

Discussion

The species richness of this area is high, with no protected tree species and no red data species present. The dense bush is well developed with many large trees. The

development can be supported, considering that this type of vegetation is not rare and conserved within the larger area of the site.

6. Existing B Training Camp (to be demolished and replaced)

This area is situated south of the Thabazimbi-Alma road, just north of the Rookpoort Dam, on Buffelskloof, at approximately 24° 34' 08"S; 27° 44' 24"E.

The area is already developed and the natural vegetation has partly been cleared and altered, for the construction of housing and other facilities. All these facilities are temporary, though some alien plants have been planted in the gardens. The existing camp is surrounded by natural, though somewhat disturbed, bushveld. This camp will be demolished and replaced by a new facility. Currently the facility closest to the Rookpoort dam edge is about 200 m. The new facility will not be closer to the dam than the current facility. The vegetation has partly been cleared for the existing facility, though the new camp will extent into natural bush.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia burkei</i>		<i>Faurea saligna</i>	
<i>Acacia erubescens</i>		<i>Grewia bicolor</i>	
<i>Acacia karroo</i>	M	<i>Grewia flava</i>	
<i>Acacia nilotica</i>		<i>Grewia hexamita</i>	
<i>Acacia robusta</i>		<i>Gymnosporia buxiifolia</i>	
<i>Berchemia discolor</i>		<i>Lannea discolor</i>	
<i>Burkea africana</i>		<i>Peltophorum africanum</i>	
<i>Combretum zeyheri</i>		<i>Searsia leptodictya</i>	
<i>Dichrostachys cinerea</i>	d	<i>Terminalia brachystemma</i>	
<i>Diospyros lycioides</i>		<i>Terminalia sericea</i>	dM
<i>Dombeya rotundifolia</i>	M	<i>Vitex rehmannii</i>	
<i>Euclea crispa</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Aristida adscendens</i>	<i>Eragrostis heteromera</i>
<i>Cynodon dactylon</i>	<i>Eragrostis rigidior</i>
<i>Eragrostis gummiiflua</i>	<i>Eragrostis superba</i>

Heteropogon contortus
Hyperthelia dissoluta
Melinis repens

Perotis patens
Setaria sphacelata
Themeda triandra

Forbs

Agathisanthemum bojeri
Evolvulus alsinoides
Felicia muricata

Lippia javanica M
Pavonia burchellii
Waltheria indica

2 B Training Camp			
Status	Transformed		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Terminalia sericea</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	25
Shrubs	0.5-3	15
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	24	0	24	0	0	4
Grasses	12	0	12	0	0	0
Forbs	6	0	6	0	0	1
Total	42	0	42	0	0	5

Discussion

The species richness of this area is high, with no protected tree species and no red data species present.

The area is partly already developed and the dense bush is degraded. The upgrade can be supported.



Figure 9: The existing B Training Camp



Figure 10: Natural vegetation in the vicinity of B Training Camp

7. New Shooting Range and Administration Block

This area is situated at approximately 24° 34' 59"S; 27° 45' 36"E, on Buffelspoort, at the foot of the north-facing slopes of the mountain. The mountain forms a safe background for the shooting.

The vegetation is dense bush, about 3-5 m tall, the taller trees cover about 5% while the denser shrub layer covers about 30%. *Combretum apiculatum* and *Acacia caffra* are prominent trees. The protected trees *Sclerocarya birrea* (marula) and *Philenoptera violacea* (apple-leaf) are present on this site.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia burkei</i>		<i>Combretum molle</i>	
<i>Acacia caffra</i>	d	<i>Combretum zeyheri</i>	
<i>Bauhinia petersiana</i>		<i>Dichrostachys cinerea</i>	
<i>Burkea africana</i>		<i>Diospyros lycioides</i>	
<i>Combretum apiculatum</i>	d	<i>Dombeya rotundifolia</i>	M

<i>Ehretia rigida</i>		<i>Olea europaea</i> subsp <i>africana</i> M
<i>Euclea undulata</i>	M	<i>Peltophorum africanum</i>
<i>Gardenia volkensii</i>		<i>Philenoptera violacea</i> P
<i>Grewia bicolor</i>		<i>Sclerocarya birrea</i> PM
<i>Grewia flava</i>		<i>Searsia leptodictya</i>
<i>Gymnosporia buxiifolia</i>		<i>Searsia pyroides</i>
<i>Gymnosporia tenuispina</i>		<i>Vitex rehmannii</i>
<i>Heteropyxis natalensis</i>	M	<i>Ziziphus mucronata</i> M
<i>Lannea discolor</i>		

Grasses

<i>Chrysopogon serrulatus</i>	<i>Eragrostis superba</i>
<i>Digitaria eriantha</i>	<i>Helictotrichon turgidulum</i>
<i>Elionurus muticus</i>	<i>Heteropogon contortus</i>
<i>Eragrostis nindensis</i>	<i>Melinis nerviglume</i>
<i>Eragrostis heteromera</i>	<i>Setaria sphacelata</i>
<i>Eragrostis rigidior</i>	<i>Themeda triandra</i>

Forbs

<i>Crabbea angustifolia</i>	<i>Rhynchosia minima</i>
<i>Fadogia homblei</i>	<i>Sida chrysantha</i>
<i>Indigofera hedyantha</i>	<i>Sphedamnocarpus pruriens</i>
<i>Melhania prostata</i>	<i>Tephrosia longipes</i>
<i>Pellaea calomelanos</i> M	<i>Waltheria indica</i>
<i>Polygala</i> sp	

7 New Shooting Range and administration Block			
Status	Bushveld		
Soil	Rocky sandy loam	Rockiness %	5-15
Conservation priority:	Medium	Sensitivity:	Medium
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Combretum apiculatum</i> , <i>Acacia caffra</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-5	10
Shrubs	0.5-3	30
Grass	1.3	60
Forbs	0.4	5

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	27	0	27	0	2	6
Grasses	12	0	12	0	0	0
Forbs	11	0	11	0	0	1
Total	50	0	50	0	0	7

Discussion

The species richness of this area is high, with two tree species and no red data species present. The dense bush merges into mountain bushveld. Care should also be taken to avoid encroachment of the development onto the mountain slope. It should further be investigated whether it would be feasible to move the development slightly northwards to move further from the mountain slope. The development can be supported, though permits from the Dept of Agriculture and Forestry must be obtained to remove the protected species.



Figure 11: Vegetation on the foot slope at the site of the proposed new Shooting Range

8. New A Training Camp

This new camp is situated on an existing tented camp, south of the Thabazimbi-Alma road, on Buffelskloof, at approximately 24° 33' 48"S; 27° 45' 36"E.

The temporary tented camp was built in an area with clumps of large Tamboti trees and an unique plant species composition. Typical bushveld vegetation surrounds the tall tree clumps. The vegetation has partly been cleared for the existing tented facility, though the new camp will extend into natural bush.

The following plant species were recorded in this area:

Trees and Shrubs

Acacia galpinii

Acacia erubescens

Acacia permixta

Acacia nilotica

Acacia robusta

Berchemia discolor

Combretum zeyheri

Commiphora angolense

Dichrostachys cinerea

Diospyros lycioides

Dombeya rotundifolia M

Euclea undulata M

Gardenia volkensii

Grewia bicolor

Grewia flava

Gymnosporia buxiifolia

Lannea discolor

Peltophorum africanum

Searsia leptodictya

Searsia sp

Spirostachys africana p

Terminalia sericea dM

Vitex rehmannii

Ziziphus mucronata M

Grasses

Aristida adscendens

Cynodon dactylon

Eragrostis gummiflua

Eragrostis heteromera

Eragrostis rigidior

Eragrostis superba

Heteropogon contortus

Melinis repens

Setaria sphacelata

Themeda triandra

Forbs

Agathisanthemum bojeri

Asparagus suaveolens

Commelina benghalensis

Evolvulus alsinoides

Felicia muricata

Lantana rugosa

Lippia javanica M

Pavonia burchellii

Waltheria indica

8. New A Training Camp			
Status	Bush clumps with protected trees		
Soil	Loamy	Rockiness %	0
Conservation priority:	Medium-High	Sensitivity:	Medium-High
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Spirostachys africana</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	25
Shrubs	0.5-3	15
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	24	0	24	0	0	4
Grasses	10	0	10	0	0	0
Forbs	9	0	9	0	0	1
Total	43	0	43	0	0	5

Discussion

The species richness of this area is high, with a protected tree species and no red data species present. The area is already partly developed. It is suggested to move the position of the new camp slightly into the surrounding bushveld in order to protect the tall tree bush clumps of Tamboti trees. The development can be supported.



Figure 12: In the vicinity of A Training Camp

9. New Administration building and extension the existing Landing Strip

The existing landing strip is situated south of the Thabazimbi-Alma road, between the existing C Training Camp and the proposed new A Training Camp, on Buffelskloof, at approximately 24° 33' 20"S; 27° 47' 00"E. This landing strip stretches north-west to south-east. The new proposed extension will stretch north-east to south-west, at a right angle to the existing strip. The proposed administration building is close to the junction of the two landing strips. The natural vegetation is fairly open shrubby bushveld, more suitable for landing aircraft than the surrounding taller bushveld.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia nilotica</i>		<i>Euclea undulata</i>	M
<i>Combretum zeyheri</i>		<i>Faurea saligna</i>	
<i>Dichrostachys cinerea</i>	d	<i>Grewia flava</i>	
<i>Diospyros lycioides</i>		<i>Grewia hexamita</i>	
<i>Dombeya rotundifolia</i>	M	<i>Gymnosporia buxiifolia</i>	

Mundulea sericea
Searsia leptodictya
Searsia pyroides

Terminalia sericea
Vitex rehmannii
Ziziphus mucronata

dM

M

Grasses

Aristida stipitata
Cynodon dactylon
Eragrostis rigidior
Eragrostis superba
Heteropogon contortus

Hyparrhenia hirta
Melinis repens
Setaria sphacelata
Themeda triandra

D

Forbs

Agathisanthemum bojeri
Blepharis subvolubilis
Commelina africana
Evolvulus alsinoides
Felicia muricata

Geigeria burkei
Lippia javanica
Ocimum americanum
Stoebe vulgaris
Waltheria indica

M

9. New Administration Building and extension to the existing Landing Strip			
Status	Short Bushveld		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Terminalia sericea</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	25
Shrubs	0.5-3	15
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	16	0	16	0	0	4
Grasses	9	0	9	0	0	0
Forbs	10	0	10	0	0	1
Total	35	0	35	0	0	4

Discussion

The species richness of this area is medium, with no protected tree species and no red data species present. The development can be supported.



Figure 13: The area of the proposed new Landing Strip

10. New Sewer Lines

Three new gravity fed sewer lines are proposed. These are in addition to the existing sewer lines.

10.1 From the existing A Training Camp to the existing western Sewage Works A & B.

This line runs from the existing A Training Camp in a south-westerly direction through the bushveld vegetation on Groenfontein, and then crosses the Thabazimbi-Alma road to the Sewage Works situated on Buffelskloof. Two plant communities are crossed:

1. Tall Mixed Bushveld north of the Thabazimbi-Alma road

The following plant species were noted in this area:

Trees and Shrubs

<i>Acacia caffra</i>		<i>Faurea saligna</i>	
<i>Acacia erioloba</i>	P	<i>Ficus thonningii</i>	
<i>Acacia galpinii</i>		<i>Grewia occidentalis</i>	
<i>Acacia nilotica</i>		<i>Gymnosporia buxiifolia</i>	
<i>Acacia robusta</i>		<i>Lannea discolor</i>	
<i>Bridelia mollis</i>		<i>Mundulea sericea</i>	
<i>Celtis africana</i>		<i>Mystroxydon aethiopicum</i>	
<i>Clerodendrum glabrum</i>		<i>Olea europaea subsp africana</i>	M
<i>Combretum apiculatum</i>		<i>Peltophorum africanum</i>	
<i>Combretum zeyheri</i>		<i>Sclerocarya birrea</i>	PM
<i>Dichrostachys cinerea</i>		<i>Searsia leptodictya</i>	
<i>Diospyros lycioides</i>		<i>Searsia pyroides</i>	
<i>Dombeya rotundifolia</i>	M	<i>Terminalia brachystemma</i>	
<i>Ehretia rigida</i>		<i>Terminalia sericea</i>	M
<i>Euclea crispa</i>		<i>Vitex rehmannii</i>	
<i>Euphorbia ingens</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Cynodon dactylon</i>	<i>Hyparrhenia hirta</i>
<i>Eragrostis curvula</i>	<i>Melinis repens</i>
<i>Eragrostis rigidior</i>	<i>Setaria sphacelata</i>
<i>Eragrostis superba</i>	

Forbs

Agathisanthemum bojeri

Elephantorrhiza elephantina M

Felicia muricata

Gomphocarpus fruticosus

Haplocarpha scaposa

Helichrysum miconiifolium

Helichrysum nudifolium

Hypoxis multiceps

Pavonia burchellii

Sida alba

Stoebe vulgaris

Verbena braziliensis W

Wahlenbergia caledonica

Waltheria indica

Zornia linearis

10.1.1 Sewer line north			
Status	Tall Mixed Bushveld		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium	Sensitivity:	Medium-
Agricultural potential:	Medium Low	Need for rehabilitation	Low
Dominant spp.	<i>Combretum apiculatum</i> <i>Peltophorum africanum</i> . <i>Terminalia sericea</i> , <i>Combretum zeyheri</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-9	20-40
Shrubs	0.5-3	5-10
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	32	0	32	0	2	5
Grasses	7	0	7	0	0	0
Forbs	14	1	15	0	0	1
Total	53	1	54	0	2	6

Discussion

The species richness of this area is high, with 2 protected tree species but no red data species present.

Where-as this is a linear development, many species will be encountered, though this is a narrow transect and most larger trees can be avoided. Care should be taken to avoid the protected trees. Note that a permit from the Dept of Agriculture and Forestry will be needed should any protected tree be removed.

2. Bushveld south of the Thabazimbi-Alma road

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia burkei</i>		<i>Faurea saligna</i>	
<i>Acacia erubescens</i>		<i>Grewia bicolor</i>	
<i>Acacia karroo</i>	M	<i>Grewia flava</i>	
<i>Acacia nilotica</i>		<i>Grewia hexamita</i>	
<i>Acacia robusta</i>		<i>Gymnosporia buxiifolia</i>	
<i>Berchemia discolor</i>		<i>Lannea discolor</i>	
<i>Burkea africana</i>		<i>Peltophorum africanum</i>	
<i>Combretum zeyheri</i>		<i>Searsia leptodictya</i>	
<i>Dichrostachys cinerea</i>	d	<i>Terminalia brachystemma</i>	
<i>Diospyros lycioides</i>		<i>Terminalia sericea</i>	dM
<i>Dombeya rotundifolia</i>	M	<i>Vitex rehmannii</i>	
<i>Euclea crispa</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Aristida adscendens</i>	<i>Heteropogon contortus</i>
<i>Cynodon dactylon</i>	<i>Hyperthelia dissoluta</i>
<i>Eragrostis gummiflua</i>	<i>Melinis repens</i>
<i>Eragrostis heteromera</i>	<i>Perotis patens</i>
<i>Eragrostis rigidior</i>	<i>Setaria sphacelata</i>
<i>Eragrostis superba</i>	<i>Themeda triandra</i>

Forbs

<i>Agathisanthemum bojeri</i>	<i>Evolvulus alsinoides</i>
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Felicia muricata

Pavonia burchellii

Lippia javanica

M

Waltheria indica

10.1.2 Sewer line south			
Status	Transformed		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Terminalia sericea</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	25
Shrubs	0.5-3	15
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	24	0	24	0	0	4
Grasses	12	0	12	0	0	0
Forbs	6	0	6	0	0	1
Total	42	0	42	0	0	5

Discussion

The species richness of this area is high, with no protected tree species and no red data species present. Where-as this is a linear development, many species will be encountered, though this is a narrow transect and most larger trees can be avoided.

10.2 From the new A Training Camp and from the Administration Block at the Landing Strip to the existing eastern Sewage Works C, D & E

This sewage line is proposed to run from the new A Training Camp (currently the tented camp) directly eastwards, all along the Groenfontein-Buffelspoort boundary line, to the existing Sewage Works C, D & E. A short line is also planned from the proposed Administration Building at the Landing Strip to join the existing sewage line that runs from the existing E Training Camp to the existing Sewage Works C, D & E.

The following plant species were recorded in this area:

Trees and Shrubs

<i>Acacia nilotica</i>		<i>Grewia hexamita</i>	
<i>Combretum zeyheri</i>		<i>Gymnosporia buxiifolia</i>	
<i>Dichrostachys cinerea</i>	d	<i>Mundulea sericea</i>	
<i>Diospyros lycioides</i>		<i>Searsia leptodictya</i>	
<i>Dombeya rotundifolia</i>	M	<i>Searsia pyroides</i>	
<i>Euclea undulata</i>	M	<i>Terminalia sericea</i>	dM
<i>Faurea saligna</i>		<i>Vitex rehmannii</i>	
<i>Grewia flava</i>		<i>Ziziphus mucronata</i>	M

Grasses

<i>Aristida stipitata</i>	<i>Hyparrhenia hirta</i>	
<i>Cynodon dactylon</i>	<i>Melinis repens</i>	
<i>Eragrostis rigidior</i>	<i>Setaria sphacelata</i>	D
<i>Eragrostis superba</i>	<i>Themeda triandra</i>	
<i>Heteropogon contortus</i>		

Forbs

<i>Agathisanthemum bojeri</i>	<i>Geigeria burkei</i>	
<i>Blepharis subvolubilis</i>	<i>Lippia javanica</i>	M
<i>Commelina africana</i>	<i>Ocimum americanum</i>	
<i>Evolvulus alsinoides</i>	<i>Stoebe vulgaris</i>	
<i>Felicia muricata</i>	<i>Waltheria indica</i>	

10.2 Sewage line east			
Status	Short Bushveld		
Soil	Sandy loam	Rockiness %	0
Conservation priority:	Medium-Low	Sensitivity:	Medium-Low
Agricultural potential:	Low	Need for rehabilitation	Low
Dominant spp.	<i>Dichrostachys cinerea</i> , <i>Terminalia sericea</i>		

Vegetation structure		
Layer	Height (m)	Cover (%)
Trees	4-7	25
Shrubs	0.5-3	15
Grass	1.3	60
Forbs	0.4	10

Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	16	0	16	0	0	4
Grasses	9	0	9	0	0	0
Forbs	10	0	10	0	0	1
Total	35	0	35	0	0	5

Discussion

The species richness of this area is medium, with no protected tree species and no red data species present. The development can be supported.

11 Farm Roads

Some of the farm roads may have to be upgraded. The vegetation along the roads corresponds to the specific sections described above and are not repeated here. It should however be noted that should protected trees be in the way of the

construction, a permit for their removal will be have to be obtained from the Dept of Agriculture and Forestry.

12. Riparian Zones of Spruits

12.1 At A Training Camp

A spruit that originates in the mountains north of the existing A Training Camp runs southwards and feeds the Rookpoort Dam. This spruit runs between the existing A Training Camp and the Residential Area east of A Training Camp. It is proposed that both these two facilities be upgraded.



Figure 14: The riparian zone of the spruit between A Training Camp and The Residential Area

The spruit, including both western and eastern riparian zones, is about 100 m wide.

Care should be taken that the upgrade development of especially A training Camp does not encroach into the riparian zone or the buffer zone that should be at least 32 m. (Note: The buffer zone recommended for areas outside the urban edge is usually 100 m, but in this particular case this is not feasible, as the developed area, or at least the disturbed area of A Training Camp is already within 100 m of the riparian zone). The indicated foot prints of both the A Training Camp and the Residential Area are on the riparian zone and these should not encroach into the riparian zone.

Care should be taken that all the possible developments in this area should ensure that no degradation of the riparian zone and no enhanced erosion are caused by the development.

12.2 At D Training Camp

Training Camp D is located in the mountains, with two small drainage lines running west and south of the foot print area. Although these two drainage line are quite small, they form part of the spruit system and no development should encroach into the riparian zones. The existing developments are very close to the riparian zones. The new upgrade developments should not encroach into the riparian zones, and remain as indicated on the proposed development plans.



Figure 15: The location of D Training Camp with very small spruits directly west and south of the foot print area.

7. RESULTS: MAMMALS

Acoks (1988), Mucina and Rutherford (2006), Low & Rebelo (1996), Knobel and Bredenkamp (2006), SANBI & DEAT (2009) discuss the peculiar natural plant associations of the study area in broad terms. Rautenbach (1978 & 1982) found that mammal assemblages can at best be correlated with botanically defined biomes, such as those by Low and Rebelo (1996 & 1998), and latterly by Mucina and Rutherford (2006) as well Knobel and Bredenkamp (2006). Hence, although the former's work has been superseded by the work of the latter two, the definitions of biomes are similar and both remain valid for mammals and are therefore recognized as a reasonable determinant of mammal distribution.

The local occurrences of mammals are, on the other hand, closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupicolous (rock-dwelling) and wetland-associated vegetation cover. It is thus possible to deduce the presence or absence of mammal species by evaluating the habitat types within the context of global distribution ranges. Sight records and information from residents or knowledgeable locals audit such deductions.

7.1 Mammal Habitat Assessment

From a mammal habitat perspective, it should thus be reported that all four major habitats are present on the site, i.e. terrestrial, arboreal, rupicolous and wetland / aquatic. The development will not affect the mountainous terrain, or the dam and wetland areas.

The collective footprints of existing and future training facilities constitute a very small and hence an insignificant area relative to the 9000 hectares of the entire site.

The natural area of the site is in pristine condition. Adjacent properties are used for raising cattle or game farming, and are in a similar natural state of ecological repair.

It is taken for granted that the mountain ranges along the northern and southern boundaries of the site have caves, crevices and rock overhangs suitable for cave bats.



Figure 1: The Existing A Training Camp scheduled to be upgraded. Note the mountainous terrain in the background.



Figure 2: The terrain for additional staff housing. Existing residences can be discerned in the background.



Figure 3: The existing D Training Camp to be upgraded.



Figure 4: The site for the new ammunition safe is to the left of the road, and the terrain of the existing ammunition safe is to the right behind the security fence.



Figure 5: The existing B Training Camp, which is to be demolished entirely and replaced with new structures.



Figure 6: The existing B Training Camp.



Figure 7: A view over the Rookpoort Dam. The upper reaches of the dam have dense stands of hydrophilic vegetation.



Figure 8: The location of the new shooting range and administration block.



Figure 9: The existing landing strip. The new addition will connect to this strip at a right angle.

7.2 Observed and Expected Mammal Species Richness

Of the 86 mammal species expected to occur on the study site (Table 1), no less than 32 were confirmed during the site visit (Table 2). This remarkable species richness is only possible within savannahs with high vertical stratification, and is comparable to formal conservation areas in similar woodland ecotypes (viz. Marakele National Park) with all four habitat types amply present.

It should be noted that potential occurrences is interpreted as to be possible over a period of time as result of expansion and contractions of population densities and ranges which stimulate migration. All feral mammal species expected to occur on the study site (e.g. house mice, house rats, dogs and cats) were omitted from the assessment since these species normally associate with human settlements.

Mega carnivores and herbivores have long since been extirpated to favour livestock farming. Latterly large tracks of land in the district have been re-devoted to game

farming and eco-tourism. On the site itself many medium-sized mammals occur naturally (viz. primates, warthog, kudu impala, duiker, steenbok, leopard, and hyena) whereas others have been re-introduced (giraffe, zebra).

Most of the species of the resident diversity (Table 1) are common and widespread (viz. scrub hares, mole rats, grass mice, multimammate mice, gerbil, the bats listed, genets, yellow and slender mongooses, duiker, steenbok and others). The Rooiberg caves in the vicinity of the site are a well-known bat caves harbouring a number of cave-dwelling species (viz. *Miniopterus schreibersii* and *Rhinolophus clivosus*). Others mammal species are not common (such as leopards and brown hyenas: several large mammals have been reintroduced and there are a number of red Data mammals discussed below.

Relative high species richness is due to the extensive size of the natural areas on the site, and of the rural nature of the entire district. The conservation status of the site is deemed “**Excellent**”, which also contributes to species richness. The high species richness of the entire site is enhanced by high habitat diversity, and a high connectivity allowing near-to-natural migration. Veld fires are avoided or strictly controlled and this means that the quality of environmental conservation from a mammal perspective can be ranked a good. Connectivity with neighbouring areas is high and migration is virtually unhindered. The many drainage lines and especially the streams function as important dispersal corridors.

7.3 Red Listed Mammals

Twenty-one of the species assemblage is Red Listed. Those ranked as “Data Deficient” have not been adequately studied in their natural environment and quantitative data are lacking to express a reasoned opinion re their conservation status. They are therefore ranked as “Data Deficient” as a precautionary measure.

The main reason for species to become endangered is habitat destruction. Considering the extensive and pristine character of the site and district, habitat destruction is not a consideration and it can be assumed that Red Listed species occur at natural levels.

No other Red Data or sensitive species are deemed present on the site, either since the site is too disturbed, falls outside the distributional ranges of some species, or does not offer suitable habitat(s).

Table 1: Mammal diversity. The species observed or deduced to occupy the site. (Systematics and taxonomy as proposed by Bronner et.al [2003] and Skinner and Chimimba [2005])

	SCIENTIFIC NAME	ENGLISH NAME
DD√	<i>Elephantulus brachyrhynchus</i>	Short-snouted elephant shrew
√	<i>Elephantulus myurus</i>	Eastern rock elephant shrew
√	<i>Orycteropus afer</i>	Aardvark
√	<i>Procavia capensis</i>	Rock dassie
√	<i>Lepus saxatilis</i>	Scrub hare
√	<i>Pronolagus randensis</i>	Jameson's red rock rabbit
√	<i>Cryptomys hottentotus</i>	African mole rat
√	<i>Hystrix africaeaustralis</i>	Cape porcupine
√	<i>Thryonomys swinderianus</i>	Greater cane rat
√	<i>Paraxerus cepapi</i>	Tree squirrel
DD√	<i>Graphiurus platyops</i>	Rock dormouse
√	<i>Graphiurus murinus</i>	Woodland dormouse
DD√	<i>Lemniscomys rosalia</i>	Single-striped grass mouse
√	<i>Rhabdomys dilectus</i>	Four-striped grass mouse
NT√	<i>Dasymys incomtus</i>	African marsh rat
√	<i>Mus minutoides</i>	Pygmy mouse
√	<i>Mastomys natalensis</i>	Natal multimammate mouse
√	<i>Mastomys coucha</i>	Southern multimammate mouse
√	<i>Thallomys paedulus</i>	Acacia rat
√	<i>Thallomys nigricauda</i>	Black-tailed tree rat
√	<i>Aethomys ineptus</i>	Tete veld rat
√	<i>Aethomys namaquensis</i>	Namaqua rock mouse
√	<i>Otomys angoniensis</i>	Angoni vlei rat
√	<i>Otomys irroratus</i>	Vlei rat
DD√	<i>Gerbilliscus leucogaster</i>	Bushveld gerbil
√	<i>Saccostomus campestris</i>	Pouched mouse
√	<i>Dendromus melanotis</i>	Grey pygmy climbing mouse

√	<i>Dendromus mesomelas</i>	Brants' climbing mouse
√	<i>Dendromus mystacalis</i>	Chestnut climbing mouse
√	<i>Steatomys pratensis</i>	Fat mouse
√	<i>Galago moholi</i>	South African galago
√	<i>Papio hamadryas</i>	Chacma baboon
√	<i>Cercopithecus pygerythrus</i>	Vervet monkey
DD?	<i>Crocidura mariquensis</i>	Swamp musk shrew
DD?	<i>Crocidura fuscomurina</i>	Tiny musk shrew
DD√	<i>Crocidura cyanea</i>	Reddish-grey musk shrew
DD?	<i>Crocidura silacea</i>	Lesser grey-brown musk shrew
DD√	<i>Crocidura hirta</i>	Lesser red musk shrew
NT√	<i>Atelerix frontalis</i>	Southern African hedgehog
√	<i>Epomophorus wahlbergi</i>	Wahlberg's epauletted fruit bat
?	<i>Eidolon helvum</i>	Straw-coloured fruit bat
*	<i>Taphozous mauritanus</i>	Mauritian tomb bat
*	<i>Sauromys petrophilus</i>	Flat-headed free-tailed bat
?	<i>Tadarida aegyptiaca</i>	Egyptian free-tailed bat
NT*	<i>Miniopterus schreibersii</i>	Schreibers' long-fingered bat
NT*	<i>Pipistrellus rusticus</i>	Rusty pipistrelle
NT*	<i>Myotis tricolor</i>	Temminck's hairy bat
*	<i>Neoromicia capensis</i>	Cape serotine bat
*	<i>Scotophilus dinganii</i>	African yellow house bat
*	<i>Nycteris thebaica</i>	Egyptian slit-faced bat
NT*	<i>Rhinolophus clivosus</i>	Geoffroy's horseshoe bat
*	<i>Rhinolophus simulator</i>	Bushveld horseshoe bat
DD*	<i>Hipposideros caffer</i>	Sundevall's roundleaf bat
V√	<i>Manis temminckii</i>	Ground pangolin
?	<i>Proteles cristatus</i>	Aardwolf
NT√	<i>Parahyaena brunnea</i>	Brown hyena
√	<i>Panthera pardus</i>	Leopard
√	<i>Caracal caracal</i>	Caracal
*	<i>Felis silvestris</i>	African wild cat
√	<i>Civettictis civetta</i>	African civet
√	<i>Genetta genetta</i>	Small-spotted genet
√	<i>Genetta tigrina</i>	SA large-spotted genet

√	<i>Cynictis penicillata</i>	Yellow mongoose
√	<i>Galerella sanguinea</i>	Slender mongoose
√	<i>Atilax paludinosus</i>	Marsh mongoose
*	<i>Mungos mungo</i>	Banded mongoose
?	<i>Helogale parvula</i>	Dwarf mongoose
√	<i>Canis mesomelas</i>	Black-backed jackal
√	<i>Aonyx capensis</i>	African clawless otter
NT?	<i>Lutra maculicollis</i>	Spotted-necked otter
NT*	<i>Mellivora capensis</i>	Honey badger
DD?	<i>Poecilogale albinucha</i>	African weasel
*	<i>Ictonyx striatus</i>	Striped polecat
√	<i>Equus quagga</i>	Plains zebra
√	<i>Potamochoerus larvatus</i>	Bushpig
√	<i>Phacochoerus africanus</i>	Common warthog
√	<i>Giraffa camelopardalis</i>	Giraffe
√	<i>Tragelaphus strepsiceros</i>	Kudu
√	<i>Tragelaphus scriptus</i>	Bushbuck
√	<i>Sylvicapra grimmia</i>	Common duiker
?	<i>Redunca arundinum</i>	Southern reedbuck
?	<i>Redunca fulvorufula</i>	Mountain reedbuck
√	<i>Pelea capreolus</i>	Grey rhebuck
√	<i>Raphicerus campestris</i>	Steenbok
√	<i>Aepyceros melampus</i>	Impala
√	<i>Oreotragus oreotragus</i>	Klipspringer

√ **Definitely there or have a high probability to occur;**

* *Medium* probability to occur based on ecological and distributional parameters;

? *Low* probability to occur based on ecological and distributional parameters.

Red Data species rankings as defined in Friedmann and Daly's S.A. Red Data Book / IUCN (World Conservation Union) (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, LR/cd = Lower risk conservation dependent, LR/nt = Lower Risk near threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 2: Mammal species positively confirmed from the study site, observed indicators and habitat.

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
<i>O. afer</i>	Aardvark	Burrows	Sandy plains
<i>P. capensis</i>	Rock dassie	Reported	Rock faces
<i>L. saxatilis</i>	Scrub hare	Faecal pellets	Short grassveld
<i>P. randensis</i>	Jameson's red rock rabbit	Faecal pellets	Rocky slopes
<i>T. swinderianus</i>	Greater cane rat	Reported	Verdant riparian vegetation
<i>G. moholi</i>	South African galago	Reported	Savannah
<i>P. hamadryas</i>	Chacma baboon	Reported	Universal
<i>C. pygerythrus</i>	Vervet monkey	Sight record	Woodlands
<i>E. wahlbergi</i>	Wahlberg's epauletted fruit bat	Reported	Tall woodland & riparian forests
<i>M. temminckii</i>	Ground pangolin	Reported	Savannah
<i>P. brunnea</i>	Brown hyena	Reported	Universal
<i>P. pardus</i>	Leopard	Reported	Universal
<i>C. caracal</i>	Caracal	Reported	Universal
<i>C. civetta</i>	African civet	Reported	Riparian forests
<i>G. genetta</i>	Small-spotted genet	Reported	Universal
<i>G. tigrina</i>	Large-spotted genet	Reported	Universal
<i>C. penicillata</i>	Yellow mongoose	Reported	Universal
<i>G. sanguinea</i>	Slender mongoose	Sight record	Universal
<i>A. paludinosus</i>	Marsh mongoose	Reported	Riparian conditions
<i>C. mesomelas</i>	Black-backed jackal	Reported	Universal
<i>A. capensis</i>	African clawless otter	Reported	Streams & dams
<i>E. quagga</i>	Plains zebra	Sight record	Grasslands
<i>P. larvatus</i>	Bushpig	Reported	Riparian conditions
<i>P. africanus</i>	Common warthog	Sight record	Savannahs
<i>G. camelopardalis</i>	Giraffe	Sight record	Savannahs
<i>T. strepsiceros</i>	Kudu	Sight record	Savannahs
<i>T. scriptus</i>	Bushbuck	Reported	Riparian conditions
<i>S. grimmia</i>	Common duiker	Reported	Grasslands

<i>P. capreolus</i>	Grey rhebuck	Reported	Mountains
<i>R. campestris</i>	Steenbok	Reported	Grasslands
<i>A. melampus</i>	Impala	Sight record	Woodlands
<i>O. oreotragus</i>	Klipspringer	Reported	Rocky slopes

The presence of all these species are fairly easy to establish, and can be expected on a large property managed to favour conservation.

8. IMPACT ASSESSMENT

8.1 Methods

The following generic criteria drawn from published literature and general South African practise will be used to describe magnitude and significance of impacts in an objective, systematic manner.

These criteria are:

- Extent or scale of the impact (what size of the area will be affected?)
- Duration (how long will the impact last?)
- Intensity (the intensity of the impact is considered by examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself.
- Probability (how likely is it that the impact will occur?)
- Significance (how severe will the impact be?)
- Mitigatory potential and mitigation measures

Impacts should be identified for the construction and operational phases of the proposed development. Proposed mitigation measures should be practical and feasible such that they can be realistically implemented by the applicant.

The impacts are given in table form. Conventions and definitions used in these tables are described below:

Extent of impact

Site: Effect confined to the development area
Local: Effect limited to within 3-5km of the development area
Regional: Effect extends beyond the borders of the development area to influence the area as a whole.

Duration of impact

Short:	Effect last for a period up to five years
Medium:	Effect continues for a period of between five and ten years
Long:	Effect continues for a period in excess of 10 years
Permanent:	Effect lasts permanently

Intensity

Low:	Will have no or little effect on the vegetation and fauna
Medium:	Will have some effect but parts of vegetation will remain in tact
High:	Will destroy the vegetation or habitat for fauna completely

Probability of occurrence

Low:	Less than 33% chance of occurrence
Medium:	Between 33 and 66% chance of occurrence
High:	Greater than 66% chance of occurrence

Significance

Low:	Where the impact will have a relatively small effect on the environment which does not need to be accommodated
Medium:	Where the impact can have an influence on the environment that might require modification of the project
High:	Where the impact definitely has an impact on the environment and needs mitigation

Status

Positive:	Impact will be beneficial to the environment
Negative:	Impact will not be beneficial to the environment
Neutral:	No positive or negative impact

Confidence

Low:	It is uncertain whether the impact will occur
Medium:	It is likely that the impact will occur
High:	It is relatively certain that the impact will occur

8.2 Results: vegetation

Impact Table

Impact on Vegetation	Extent	Duration	Intensity	Probability	Significance	Status	Conf
A Training Camp	Site	Permanent	Low	High	Low	Negative	High
New Residential at A Training Camp	Site	Permanent	Medium	High	Low	Negative	High
Groenfontein Residential Area	Site	Permanent	Medium	High	Low	Neutral	High
D Training Camp	Site	Permanent	Low	High	Medium	Negative	High
Ammunition Safe	Site	Permanent	High	High	Low	Negative	High
B Training Camp	Site	Permanent	Low	High	Low	Negative	High
Shooting Range	Site	Permanent	High	High	Medium	Negative	High
A Training Camp	Site	Permanent	High	High	Medium	Negative	High
Landing Strip + Admin Building	Site	Permanent	High	High	Low	Negative	High
Sewer Lines	Site	Permanent	Medium	High	Low	Negative	High
Roads	Site	Permanent	Medium	High	Low	Negative	High
Plant species							
Indigenous species	Site	Permanent	High	High	Medium	Negative	High
Alien woody plant species	Site	Permanent	Low	High	High	Positive	High

8.3 Discussion

1. Existing A Training Camp (to be upgraded)

This is an already developed area and the impact on natural vegetation will be minimal. Therefore the intensity as well as the significance of the impact on vegetation are both Low. Care should however be taken to avoid that the eastwards extension of the development encroaches onto the riparia zone of the spruit.

2. New Residential Extension to Existing Housing

Most of this area is already developed with the current housing on the site. However, the extension will be to the east where there is still natural, though disturbed, vegetation. The intensity is therefore Medium, but the significance is Low, as the vegetation is disturbed with no protected or red data species present. Care should, however be taken to avoid westwards encroachment into the riparian zone of the spruit, as well as northern encroachment onto the slopes of the mountain.

3. Groenfontein Residential Area

The vegetation of this area is disturbed with no protected or red data species present. The intensity is Medium but significance of the impact is Low.

4. Existing D Training Camp (to be upgraded)

This is an already developed area and the impact on natural vegetation will be minimal. However, this area is situated on the mountain slopes and is located between two small drainage lines. Therefore the intensity is Low, but the significance is Medium. Care should be taken to avoid that the extension of the development onto the riparian zone of the spruit.

5. New Ammunition Safe at existing safe

This area has tall tree bushveld in good condition, therefore the intensity is regarded as High, but as this vegetation type is widespread and not endangered, the significance is Low.

6. Existing B Training Camp to be replaced *in situ*

The already existing camp will be demolished and replaced by a new camp. The intensity and the significance of the impact are Low.

7. New Shooting Range and Admin. Block

The Shooting Range is located at the foot of the mountain, which is an ecological more sensitive site. The intensity on the natural mountain slope vegetation is High and the significance is Medium. A slight shift towards the north to avoid development on the mountain slope will lower the significance.

8. New A Training Camp

Although this is considered a new development, there is an existing tented camp on this site. The site is partially located within a dense bush clump with a particular plant species composition, including the protected Tamboti trees. The intensity of the impact is considered as being High, due to the presence these bush clumps. The significance is at least Medium. The intensity on the surrounding “normal” bushveld is also High, but the significance Low. It is therefore suggested to place the development outside the bush clumps in the normal bushveld.

9. New Admin. Building & extension to Landing strip

This area has open, short tree bushveld, slightly disturbed. Intensity is regarded as High, but as this vegetation type is widespread and not endangered, the significance is Low.

10. Additionally a new gravity feed sewer line is planned between the exiting A Training Camp (1) and the existing Sewage works, and also between the new A Training Camp and the existing Sewage Works (2).

Due to the narrow linear nature of the sewage lines the intensity is regarded as Medium, while the significance is Low. Rehabilitation after construction will be necessary.

11. All training facilities are interconnected by farm roads.

Most of the current roads are small farm roads and some may need an upgrade. Only limited vegetation on the road edges may be affected. The narrow linear nature limits the intensity to Medium, while the significance is Low.

12. Indigenous species.

As vegetation will be destroyed at most of the sites, the intensity of the impacts on indigenous species is regarded as High. Although most of the species are widespread and not rare, some legally protected trees do occur locally, therefore the significance is Medium. Care should be taken to avoid the unnecessary cutting and removal of large trees, especially protected tree species. A permit from the dept of Agriculture and Forestry is needed to remove or even cut protected trees. No red data plant species were found.

13. Alien Woody Plant Species

From a conservation perspective, reducing the alien trees and plants will be advantageous, especially in an area with a high mammal species richness profile. However, the site is devoid of alien vegetation, other than in formal gardens. Great care must therefore be taken to prevent exotics to escape from gardens. Otherwise, indigenous plants from the area should be used in landscaping.

Mitigation measures

- No exotic invasive plant species should be planted in the areas to be developed.
- Developments, if approved, should be strictly confined to the areas planned for development.
- The riparian zones of the spruits should be avoided.
- The mountain slopes should be avoided.
- Contractors should not be allowed to roam into the natural vegetation, the construction sites should be marked clearly and fenced where feasible.
- Contractors and workers may not hunt, kill or trap any animal
- Contractors may not remove any indigenous plants, or clear vegetation other than on the approved construction sites.

8.4. Results: Mammals

- Loss of ecosystem function (e.g. reduction in water quality, soil pollution)

Nature of Impact	Extent	Duration	Probability	Intensity	Significance
Damage to ecosystem function	Nil	Nil	Nil	Nil	Nil

The planned development will not detract significantly from any of the ecosystems or habitat types defined on the site.

- Loss of faunal habitat

Nature of Impact	Extent	Duration	Probability	Intensity	Significance
Loss of faunal habitat	Nil	Nil	Nil	Nil	Nil

Loss of mammal habitat will, relatively to the overall size of the property, be insignificant on new developments and not applicable to existing facilities to be upgraded.

- Loss/displacement of threatened or protected fauna

Nature of Impact	Extent	Duration	Probability	Intensity	Significance
Loss of species	Nil	Nil	Nil	Nil	Nil

No loss or displaced of threatened or protected mammals is anticipated.

8.5 Impact Assessment Discussion

	High	Medium	Low
Extent / Spatial Scale of Impacts			X
Intensity / Severity of Impacts			X
Duration of Impacts			X
Magnitude and Significance of Impacts			X

The intended developments will be restricted and the footprint of the development sites will be insignificant measured against the total size of the approximately 9000 hectares site. In most instances development and alterations will be on sites already developed, and these therefore do not qualify for serious consideration.

Wetlands are considered as sensitive, but none of the proposed developments will affect this habitat type.

The intended development will not result in a loss of ecological sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), loss of mammal habitat, nor of loss/displacement of threatened or protected species.

There are no need for buffer zones at or near of any of the development sites.

8.6 General

NOTE: The main text below cites the enlightened mitigation measures developed by GDACE (Directorate of Nature Conservation, GDACE, 2008 and 2009) (now GDARD) and since they are universal are deemed applicable to the study site.

Developments

- An appropriate management authority that must be committed to implement the Environmental Management Plan (EMP) and Record of Decision (ROD) during the operational phase of the development should be identified and informed of his / her / their responsibilities in terms of the EMP and ROD.
- All areas designated as sensitive in a sensitivity mapping exercise should be incorporated into an open space system. Development should be located on the areas of lowest sensitivity (in this instance plantations, tilled fields and dry grasslands).
- The open space system should be managed in accordance with an Ecological Management Plan that complies with the *Minimum Requirements for Ecological Management Plans* and forms part of the EMP.

The Ecological Management Plan should:

- instead of the present practice of unplanned and regular fires, include a fire management programme to ensure persistence of grassland
- include an ongoing monitoring and eradication programme for all non-indigenous species, with specific emphasis on invasive and weedy species such as *Eucalyptus* and wattles
- include a comprehensive surface runoff and storm water management plan, indicating how all surface runoff generated as a result of the developments (during both the construction and operational phases) will be managed (e.g. artificial wetlands / storm water and flood retention ponds) prior to entering

any natural drainage system or wetland and how surface runoff will be retained outside of any demarcated buffer/flood zones and subsequently released to simulate natural hydrological conditions

- ensure the persistence of all Red and Orange List species
- include a monitoring programme for all Red and Orange List species
- facilitate/augment natural ecological processes
- provide for the habitat and life history needs of important pollinators
- minimize artificial edge effects (e.g. water runoff from developed areas & application of chemicals)
- include a comprehensive plan for limited recreational development (hiking trails, bridle trails, mountain bike routes, bird hides etc.) within the open space system.
- curb indiscriminate off-road driving
- include management recommendations for neighbouring land, especially where correct management on adjacent land is crucial for the long-term persistence of sensitive species present on the development site
- investigate and advise on appropriate legislative tools (e.g. the NEMA: Protected Areas Act 57 of 2003) for formally protecting the area (as well as adjacent land where it is crucial for the long-term persistence of sensitive species present on the development site)
- The open space system should be fenced off prior to construction commencing (including site clearing and pegging). All construction-related impacts (including service roads, temporary housing, temporary ablution, disturbance of natural habitat, storing of equipment/building materials/vehicles or any other activity) should be excluded from the open space system. Access of vehicles to the open space system should be prevented and access of people should be controlled, both during the construction and operational phases. Movement of indigenous fauna should however be allowed (i.e. no solid walls, e.g. through the erection of palisade fencing).
- When Giant Bullfrogs / Giant Bullfrog habitat will be retained in an open space system of a development situated within the urban edge, Giant Bullfrogs should be prevented from leaving the site and entering unsuitable habitat through the erection of an impermeable wall or appropriately designed fence prior to construction commencing. The wall/fence should be solid (i.e. without openings) below ground to the level of the foundations and for at least 20cm above ground.
- Information boards should be erected within the development to inform residents of the presence of Red / Orange List species, their identification, conservation status and importance, biology, habitat requirements and management requirements.
- Outside lighting should be designed to minimize impacts on fauna. All outside lighting should be directed away from sensitive areas. Fluorescent and mercury vapour lighting should be avoided and sodium vapour (yellow) lights should be used wherever possible.
- Only indigenous plant species, preferably species that are indigenous to the natural vegetation of the area, should be used for landscaping in communal areas. As far as possible, plants naturally growing on the development site, but would otherwise be destroyed during clearing for development purposes, should be incorporated into landscaped areas. Forage and host plants required by pollinators should also be planted in landscaped areas.
- In order to minimize artificially generated surface storm water runoff, total sealing of paved areas such as parking lots, driveways, pavements and walkways should be avoided. Permeable material should rather be utilized

- for these purposes.
- The crossing of natural drainage systems should be minimized and only constructed at the shortest possible route, perpendicular to the natural drainage system. Where possible, bridge crossings should span the entire stretch of the buffer zone (see *Sensitivity Mapping Rules for Biodiversity Assessments* for buffer zone requirements).

Roads / Pipelines / Power lines

- The appropriate agency should implement an ongoing monitoring and eradication program for all invasive and weedy plant species growing within the servitude.
- Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a specialist registered in terms of the Natural Scientific Professions Act (No. 27 of 2003) in the field of Ecological Science.
- Any post-development re-vegetation or landscaping exercise should use species indigenous to the veld types overlying the site. Plant species locally indigenous to the area are preferred. As far as possible, indigenous plants naturally growing along the routes, but would otherwise be destroyed during construction, should be used for re-vegetation / landscaping purposes.
- Where a road / pipeline / power line is to traverse a wetland, measures are required to ensure that the road / pipeline / power line has minimal effect on the flow of water through the wetland, e.g. by using a high level clear span bridge or box culverts rather than pipes.
- Prior to construction, fences should be erected in such a manner to prevent access and damage to any sensitive areas identified in a sensitivity mapping exercise.
- Sealing of surfaces under a bridge or gabion construction should be avoided.
- Disturbance to any wetlands during construction should be minimized. A plan for the immediate rehabilitation of damage caused to wetlands should be compiled by a specialist registered in accordance with the Natural Scientific Professions Act (No. 27 of 2003) in the field of Ecological Science. This rehabilitation plan should form part of the EMP and a record book should be maintained on site to monitor and report on the implementation of the plan.
- Engineering measures are recommended to lower the risk of spillages into any wetlands located within 200m of the road / pipeline.
- Appropriate road design and traffic control measures are recommended to reduce air pollution and animal mortality.
- All storm water structures should be designed so as to block amphibian and reptile access to road surfaces.
- A comprehensive surface runoff and storm water management plan should be compiled, indicating how all surface runoff generated as a result of the road development (during both the construction and operational phases) will be managed (e.g. artificial wetlands / storm water and flood retention ponds) prior to entering any natural drainage system or wetland and how surface runoff will be retained outside of any demarcated buffer / flood zones and subsequently released to simulate natural hydrological conditions. This plan should form part of the EMP.
- Where roads traverse streams / rivers, an underpass should provide for the movement of aquatic as well as terrestrial species through the inclusion of appropriate buffer zones within the underpass (a 100m buffer zone from the edge of the riparian zone recommended for rivers outside the urban edge).
- Suitable terrestrial underpasses should be provided to facilitate safe movement of animals, specifically where roads traverse provincially important species / climate change corridors or ridges or habitat suitable for any Red

List amphibian / reptile / mammal species. The number and spacing of underpasses will need to be determined by a specialist registered in accordance with the Natural Scientific Professions Act (No. 27 of 2003) in the fields of Ecological / Zoological Science. All underpasses should be dressed with a layer of sand (minimum 10cm), should be a minimum of 1.5m high and 1.0m wide so as to facilitate maintenance access and should be provided with small grates in the road surface to allow light penetration into the underpass. Underpasses should be accessible to maintenance staff and should be cleared of accumulated material at least at the start of each rainy season.

- Where roads are routed past expected or confirmed Giant Bullfrog breeding areas, road signs warning motorists to slow down on account of Giant Bullfrogs should be erected (in accordance with applicable legislation).
- Where roads traverse natural corridors such as streams and ridges, traffic control measures are recommended (e.g. 60km/h speed limits, speed traps, rumble strips and speed bumps).
- Where roads are associated with power lines and telephone lines (these provide an attraction for species that hunt from perches), road margins should be mowed and/or burned regularly to prevent the accumulation of grass cover that could provide refuge for small mammals.

The following recommended mitigatory measures only apply to power lines / telephone lines / communication masts / cell phone towers:

- Where communication masts / cell phone towers / overhead lines (power lines or telephone lines) are to be constructed within / adjacent to urban open space systems or within rural areas, the Eskom-EWT strategic partnership should advise on appropriate mitigatory measures.
- The design (including mitigation measures) and location of any proposed power lines (whether new alignments or refurbishment / upgrading of existing lines) should be endorsed by the bird conservation experts of the Eskom-EWT strategic partnership.
- Anti-collision devices such as bird flappers should be installed where power lines cross corridors, rivers or ridges.

Reference: Directorate of Nature Conservation, GDACE. 2008 and revised on February 2009. GDACE Requirements for Biodiversity Assessments, Version 2. Gauteng Provincial Government.

9. LIMITATIONS, ASSUMPTIONS AND GAPS IN INFORMATION

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Eco-Agent CC can thus not

accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

10. RECOMMENDED MITIGATION MEASURES

It is suggested that

- Building rubble is removed from the property
- That the trench for the new gravity feed sewage line is filled, with topsoil replaced.
- That planting of alien plants for landscaping is avoided in favour of endemics.
- Existing and new roads could be the cause for erosion, and it thus suggested that appropriate precautions are taken.

11. ACKNOWLEDGEMENTS

A special word of appreciation is extended to Warrant Officer Hennie Kruger for valuable information and orientation during our visit.

12. LITERATURE SOURCES

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APPENDIX A: ABRIDGED CURRICULUM VITAE: GEORGE JOHANNES BREDENKAMP

Born: 10 February 1946 in Johannesburg, South Africa.

Citizenship: South African

Marital status: Married, 1 son, 2 daughters

Present work address

Extra-ordinary Professor

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Qualifications:

1963 Matriculation Certificate, Kemptonpark High School

1967 B.Sc. University of Pretoria, Botany and Zoology as majors,

1968 B.Sc. Hons. (cum laude) University of Pretoria, Botany.

1969 T.H.E.D. (cum laude) Pretoria Teachers Training College.

1975 M.Sc. University of Pretoria, Plant Ecology .

1982 D.Sc. (Ph.D.) University of Pretoria, Plant Ecology.

Theses: (M.Sc. and D.Sc.) on plant community ecology and wildlife management in nature reserves in South African grassland and savanna.

Professional titles:

- MSAIE&ES South African Institute of Ecologists and Environmental Scientists
 - 1989-1990 Council member
- MGSSA Grassland Society of Southern Africa
 - 1986 Elected as Sub-editor for the Journal
 - 1986-1989 Serve on the Editorial Board of the Journal
 - 1990 Organising Committee: International Conference: Meeting Rangeland challenges in Southern Africa
 - 1993 Elected as professional member
- Pr.Sci.Nat. South African Council for Natural Scientific Professions **Reg No 400086/83**
 - 1993-1997 **Chairman** of the Professional Advisory Committee: Botanical Sciences
 - 1993-1997: **Council** Member
 - 1992-1994: Publicity Committee
 - 1994-1997: Professional Registration Committee

Professional career:

- Teacher in Biology 1970-1973 in Transvaal Schools
- Lecturer and senior lecturer in Botany 1974-1983 at University of the North
- Associate professor in Plant Ecology 1984-1988 at Potchefstroom University for CHE
- Professor in Plant Ecology 1988-2008 at University of Pretoria.
- Founder and owner of the Professional Ecological Consultancy firms Ecotrust Environmental Services CC and Eco-Agent CC, 1988-present.

Academic career:

- Students:
 - Completed post graduate students: M.Sc. 53; Ph.D. 14.
 - Presently enrolled post-graduate students: M.Sc. 4; Ph.D. 1.
- Author of:
 - 175 scientific papers in refereed journals
 - >150 papers at national and international congresses

- >300 scientific (unpublished) reports on environment and natural resources

- 17 popular scientific papers.

- 39 contributions in books

- Editorial Committee of

- South African Journal of Botany,

- Journal Grassland Society of Southern Africa,

- Bulletin of the South African Institute of Ecologists.

- Journal of Applied Vegetation Science.(Sweden)

- Phytocoenologia (Germany)

- FRD evaluation category: C1 (=leader in South Africa in the field of Vegetation Science/Plant Ecology)

Membership:

- International Association of Vegetation Science.

- International Society for Ecology (Intecol)

- Association for the Taxonomic study of the Flora of Tropical Africa (AETFAT).

- South African Association of Botanists (SAAB)

- 1988-1993 Elected to the **Council** of SAAB.

- 1989-1990 Elected as **Chairman** of the Northern Transvaal Branch

- 1990 Elected to the Executive Council as **Vice-President**

- 1990- Sub-editor Editorial Board of the Journal

- 1991-1992 Elected as **President** (2-year period)

- 1993 **Vice-President** and Outgoing President

- Wildlife Management Society of Southern Africa

- Suid-Afrikaanse Akademie vir Wetenskap en Kuns

- (=South African Academy for Science and Art).

- Wildlife Society of Southern Africa

- 1975 - 1988: Member

- 1975 - 1983: Committee member, Pietersburg Centre

- 1981 - 1982: **Chairman**, Pietersburg Centre

- Dendrological Society of Southern Africa

- 1984 - present: Member

1984 - 1988: Committee member, Western Transvaal Branch

1986 - 1988: **Chairman**, Western Transvaal Branch

1987 - 1989: Member, Central Committee (National level)

1990 - 2000: Examination Committee

- Succulent Society of South Africa

1987 - present: Member

- Botanical Society of South Africa

2000 – present: Member

2001- 2008: Chairman, Pretoria Branch

2009-present Committee member Pretoria Branch

2002 – present: Chairman, Northern Region Conservation Committee

2002- 2007: Member of Council

Special committees:

- Member or past member of 10 special committees re ecology, botany, rangeland science in South Africa.

- Member of the International Code for Syntaxonomical Nomenclature 1993-1996.

Merit awards and research grants:

1968 Post graduate merit bursary, CSIR, Pretoria.

1977-1979 Research Grant, Committee re Research Development, Dept. of Co-operation and Development, Pretoria.

1984-1989 Research Grant, Foundation for Research Development, CSIR, Pretoria.

1986-1987 Research Grant, Dept. of Agriculture and Water Supply, Potchefstroom.

1990-1997 Research Grant, Dept. of Environmental Affairs & Tourism, Pretoria.

1991-present Research Grant, National Research Foundation , Pretoria.

1991-1993 Research Grant, Water Research Commission.

1999-2003 Research Grant, Water Research Commission.

2006 South African Association of Botanists Silver Medal for outstanding contributions to South African Botany

Abroad:

1986 Travel Grant, Potchefstroom University for Christian Higher Education, Potchefstroom

Visits to Israel, Italy, Germany, United Kingdom, Portugal.

1987 Travel Grant, Potchefstroom University for Christian Higher Education, Potchefstroom.

Visits to Germany, Switzerland, Austria, The Netherlands, United Kingdom.

1990 Travel Grant, FRD.

Visit to Japan, Taiwan, Hong-Kong.

1991 Travel Grant, FRD.

Visits to Italy, Germany, Switzerland, Austria, France, The Netherlands, United Kingdom.

1993 Travel Grant, University of Pretoria.

Visits to the USA, Costa Rica, Czech Republic, Austria.

1994 Travel Grant FRD.

Visits to Switzerland, The Netherlands, Germany, Czech Republic.

1995 Travel Grant FRD, University of Pretoria

Visits to the USA

1996 Travel Grant, University of Pretoria

Visit to the UK.

1997 Travel Grant University of Pretoria, Visit Czech Republic, Bulgaria

1998 Travel Grant, University of Pretoria, Visit Czech Republic, Italy, Sweden

1999 Travel Grant, University of Pretoria, Visit Hungary, Spain, USA

2000 Travel Grant, University of Pretoria, Visit Poland, Italy, Greece.

2001 Travel Grant, NRF, Visit Brazil

2006 German Grant Invited lecture in Rinteln, Germany

Consultant

Founder and owner of Ecotrust Environmental Services CC and Eco-Agent CC

Since 1988 >300 reports as consultant on environmental matters, including:

- Game Farm and Nature Reserve planning,

- Environmental Impact Assessments,
- Environmental Management Programme Reports,
- Vegetation Surveys,
- Wildlife Management,
- Veld Condition and Grazing Capacity Assessments,
- Red data analysis (plants and animals).

APPENDIDIX B: RESUMè - RAUTENBACH, Ignatius Lourens

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Gender Male

Date of birth 1 December 1942

Nationality South African

Home languages Afrikaans, fluent in English

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Former position Retired Director: Planning, Northern Flagship Institute

Present position Consultant – Specialist Environmental Assessments, **Project management** Research –EIAs, writing, woodworking, photo-recording

Qualifications **B.Sc.** (UP), **T.H.E.D** (Pta TTC), **M.Sc.** (UP), **Ph.D.**(Un. Natal)

Honours Fellow of the Photographic Society of South Africa
Master photographer at club level
Professional Natural Scientist (Zoology) – S.A Council for Natural Scientific Professions, Registration # 400300/05

Notable Research Contribution In-depth survey of the Mammals of the Transvaal

Notable Literary Contribution Rautenbach, Naas & Annalene Rautenbach. 2008. *Photography for Focused Beginners*. 302pp with 250 images. Green Door Studio, Pretoria.

Formal Courses Computer Literacy, Project Management, Contract Design, Senior Management

Employment history

May 2001 - Present Self-employed, collaborator with du Plessis & Associates [display design and construction], Galago Ventures [environmental impact assessment], technical writing, and photography

April 1999 - August 2001 Director: Planning, Northern Flagship Institution

Jan 1991 - April 1999 Executive Director, Transvaal Museum

July 1967 - Dec 1990 Curator (in charge) of the Division of Mammalogy, Transvaal Museum. Promoted to Specialist Scientist rank as of June 1985

March - June 1967 Research student at the Mammal Research Institute of the Zoology Department, University of Pretoria

July 1966, Nov 1966 - Febr 1967 Member of the Smithsonian Institution's field teams as part of the 'African Mammal Project'

1966: Part-time research assistant to Prof. J. Meester, University of Pretoria

1962 - 1965 Temporary assistant during University holidays in the Nematology laboratories, Agricultural Technical Services

1992 - 2001 Founder member and non-executive director of the Board of Trustees of the Museum Park Section 21 Company

1993 - 2001 Founder member and Trustee of the privatised Museums Pension Fund

1997 - 2001 Non-executive director of the Tswaing Section 21 Company

Professional Achievement **Managed** a research institute of 125 members of staff. Solicited numerous grants totalling ≥ R1 000 000. Initiated and overseen building programmes of R30 million at Transvaal Museum. Conceptualised and managed 12 display programmes.

Research: Author and co-author of 85 scientific publications re mammalogy in peer reviewed subject journals, 18 Popular articles, 10 Books, and >400 contractual EIA research reports. Extensive field work and laboratory experience in Africa, Europe, USA, Alaska, Brazil and Mexico. B-rated by FRD as scientist of international status

Public Recognition: Public speaking *inter alia* Enrichment Lecturer on board the 6* SS Silver Wind, radio talks, TV appearances

Hobbies Technical writing, photography, field logistics, biological observations, wood working, cooking, designs