Eskom Holdings Limited

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED PERSEUS-HYDRA 765kV TRANSMISSION POWER LINE

EkoInfo CC
www.ekoinfo.co.za

Scoping Report – Vegetation Component (Update)

P4209

April 2006

EXECUTIVE SUMMARY

This document represents the vegetation component of the scoping phase of the EIA process for:

1. the proposed 765 kV transmission line between Perseus sub-station near Dealesville, Free State Province and Hydra sub-station near De Aar, Northern Cape.
2. A single 765kV 12km Transmission Power Line between the Perseus and Beta (SSW of Dealesville) substations.
3. A single 33km Transmission Power Line between Perseus to a point on the existing 400 kV Beta-Hydra Power Line

The purpose of the scoping report is to determine whether there are any aspects within the vegetation, which require more detailed assessments (impact assessments).

The scoping report was based on a field trip, literature review and GIS analysis. The field trip covered the area using both vehicle and helicopter transport. The literature review made use of scientific and popular publications as well as Internet search. The emphasis of the Internet search was to find additional information on the expected Red Data flora. GIS analysis was used to model and present the available information in a spatial and visual manner.

Mainly small-scale information was available, either on national or provincial level. This information was contained either in scientific literature or GIS layers available from government and research institutions. The three-day field trip completed in August 2005, was mainly used to assess the accuracy or validity of the small-scale datasets such as the land cover and Vegmap. **It was concluded that these datasets are accurate enough for the purpose of the scoping phase**.

Of the 117 potential Red Data flora present in the area, information on their habitat preference, appearance and flowering period was only available for approximately 30%. **Based on the study area's environmental description, potential habitat for seven of the 117 potential Red Data flora species occur within the study area.** These species are mainly associated with outcrops, either of shale or dolerite, where soils occur with a sandy texture on any aspect.

ESKOM provide four alternatives based on technical considerations, the total ecological sensitivity which made use of biodiversity, transformation and potential Red Data flora and fauna habitat, indicated that **the eastern alternative is the least sensitive** and therefore the alternative of choice. **The centre alternative is the most sensitive** and therefore not the alternative of choice. **It should however be noted that the total ecological sensitivity indicated that these four alternatives does not differ significantly**. The two minor lines will also have a limited impact on the vegetation as no high to very high ecological sensitive areas occur within these areas.

In conclusion, the literature review and GIS analysis confirmed the impression formed during the field trip, that the power lines will definitely have a low impact on the vegetation and if the necessary precautions are taken, it could actually have a very low to no impact.

Precautions or mitigatory measures include

1. avoiding areas concentrated with environmental features considered to be sensitive namely, pans, outcrops, alluvial fans and drainage lines
2. controlling the spread of declared and invasive plants
3. prevent the harvesting of medicinal plants and firewood
4. implementing erosion measure in steep areas or areas located on duplex soils.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED PERSEUS-HYDRA 765kV TRANSMISSION POWER LINE

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ABBREVIATIONS

DEAT	**Department of Environmental Affairs and Tourism**
ENPAT	**Environmental Potential Atlas**
GIS	**Geographic Information System**
GPS	**Global Positioning System**
IUCN	**International Union for the Conservation of Nature and Natural Resources.**
PRECIS	**National Herbarium, Pretoria (PRE) Computerised Information System**
SANBI	**South African Biodiversity Institute**

GLOSSARY

1 INTRODUCTION

1.1 Background

Arcus Gibb approached EkoInfo CC on behalf of ESKOM to assist them with the ecological assessment of an Environmental Impact Assessment (EIA) for a proposed 765 kV transmission line from Perseus sub-station near Dealesville, Free State to Hydra sub-station near De Aar, Northern Cape. The proposed line will cover approximately 280 km and would require 80 m servitude. The ecological assessment consists of two components: a flora component and fauna component. **This document provides background information on flora in the area and the results of the total ecological sensitivity modelling based on expected biodiversity, transformation pressure and expected Red Data flora and fauna habitat.** The fauna component is discussed in a separate document.

Four alternatives are considered for the proposed transmission line and are referred to as the western, centre, eastern and existing 765 kV alternatives. These alternatives are aligned to the west of an existing 765 kV transmission line. These three alternatives are based on technical criteria or feasibility; they will be evaluated in terms of their ecological sensitivity or perceived impact on the environment.

The EIA process consists of two phases, a scoping phase and EIA phase. This document concerns the scoping phase. The aim of the scoping phase is to describe the affected area in terms of its floristic characteristics, list potential issues and evaluate the alternatives in terms of their ecological sensitivity. If any issues are considered significant, they will be studied in detail or addressed during the EIA phase of the EIA process.

1.1.1 Study Area

The study area stretches across to provinces from the Free State into the Northern Cape (Figure 1). Technical limitations determine its extent from Perseus substation near Dealsville in the Free State to Hydra substation near De Aar in the Northern Cape (Figure 2). The study area covers approximately 1 594 054.5820 ha or 15 940.5482 km^2, which is almost the size of the Kruger National Park or a country the size of Wales.

The study area transects two primary catchment areas (Figure 3), namely that of the Vaal River and of the Orange River, which it crosses. The number of quaternary catchment areas within the study area increases from the north to the south, which is the result of an increase in drainage line density.

1.2 Study Approach

Due to the nature of the study on scoping level, the following sources will be used to describe the affected area:

- Literature review
- Desktop review – Internet and GIS analysis
- Correspondence with provincial and regional specialists
- A field trip

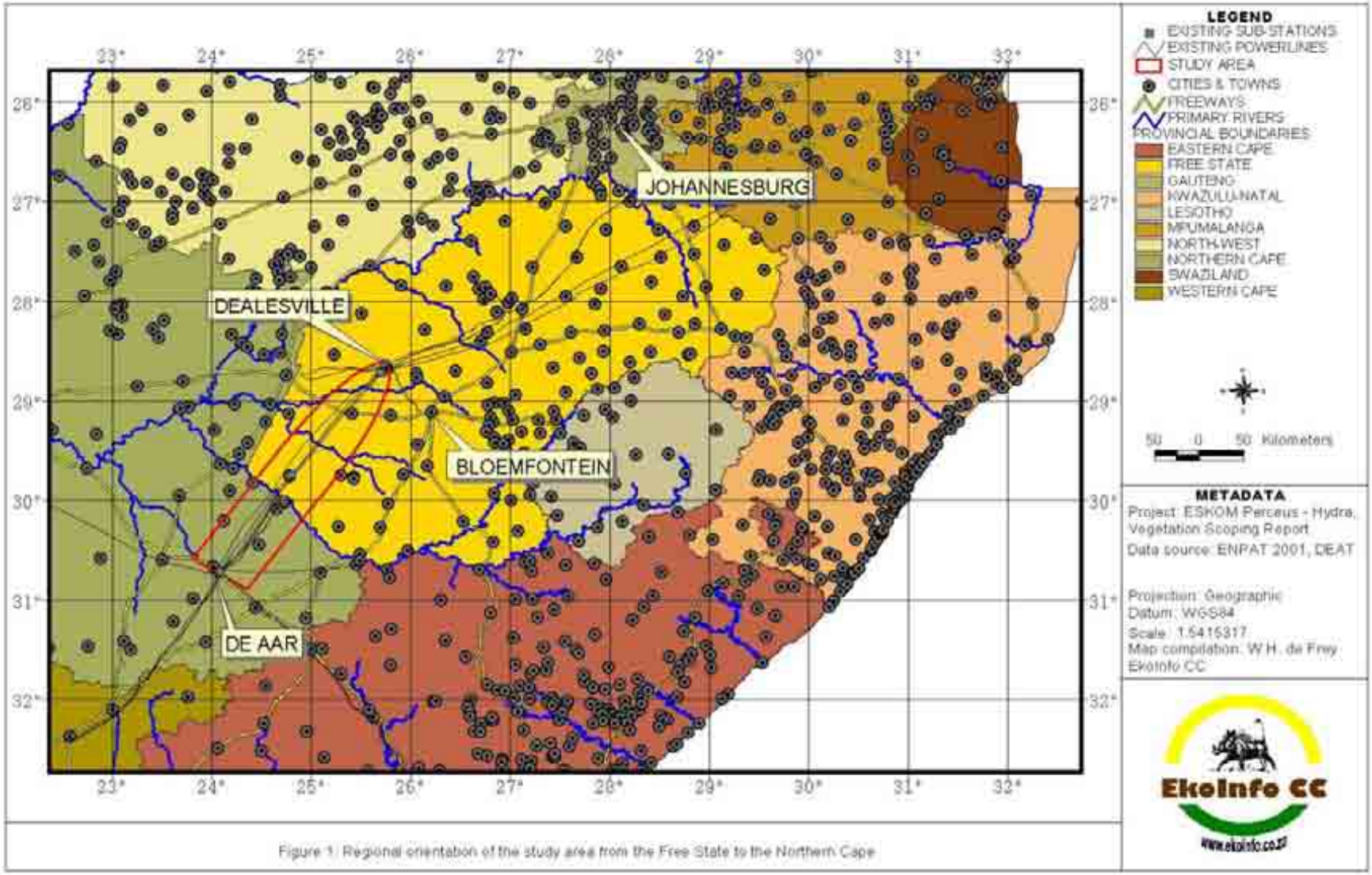

Figure 1: Regional orientation of the study area from the Free State to the Northern Cape

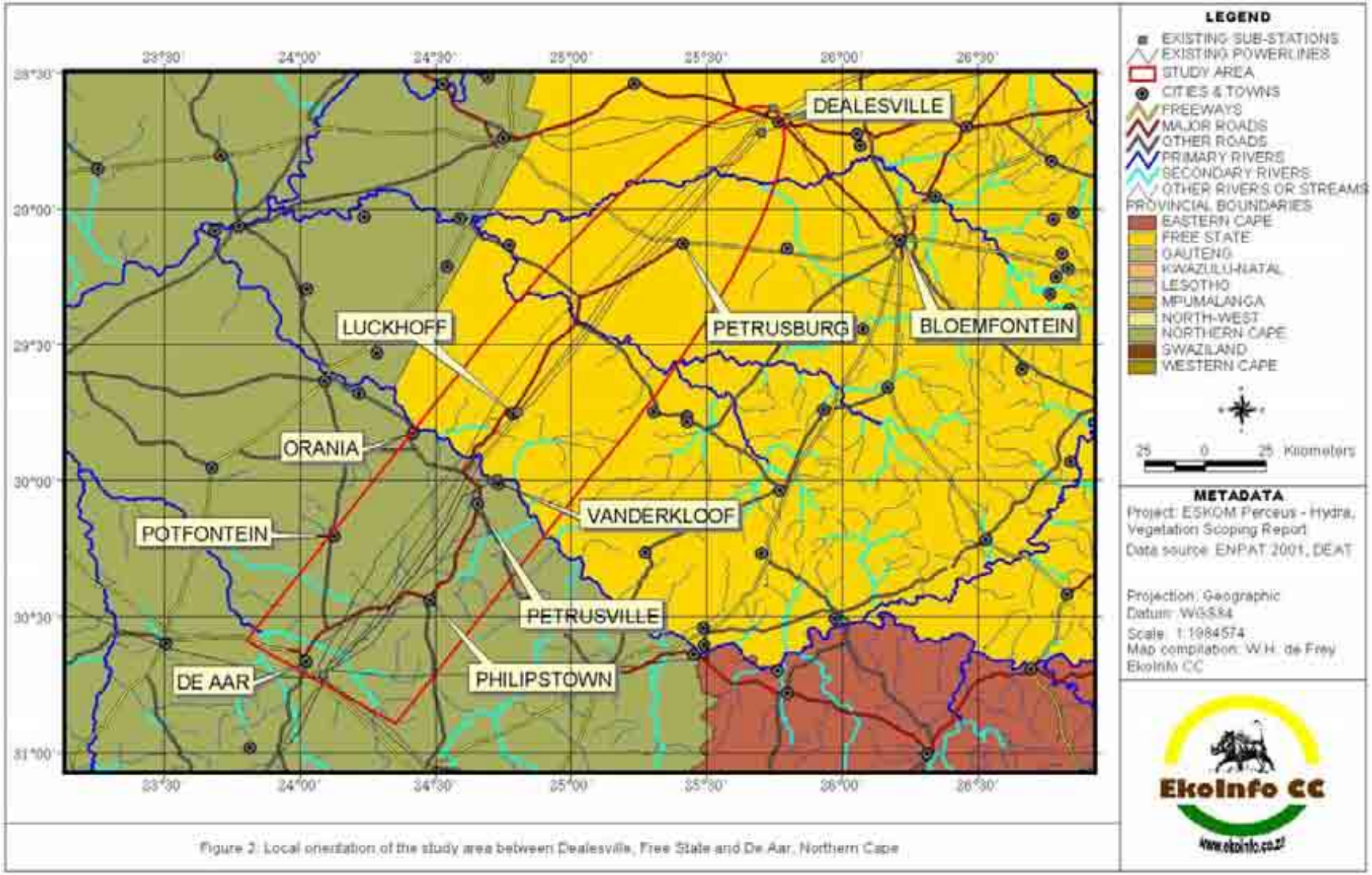

Figure 2: Local orientation of the study area between Dealesville, Free State and De Aar, Northern Cape

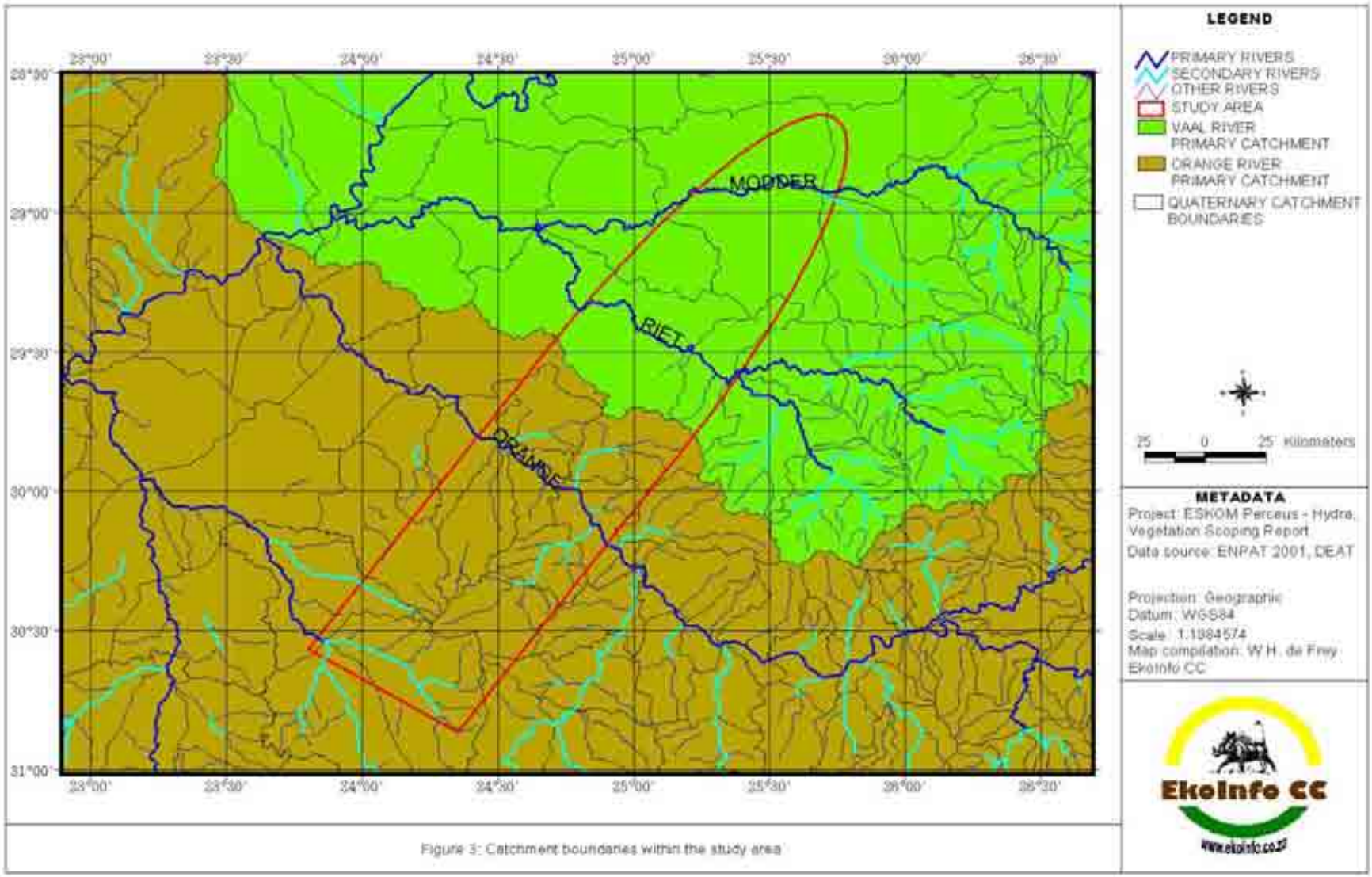

Figure 3: Catchment boundaries within the study area

1.2.1 Information sources

The literature review consists of scientific and popular publications. The Google search engine was used for the Internet review, especially to find information on potential Red Data Flora namely their habitat preference and appearance.

GIS software was used to analyse and present the data. ArcView 3.2a was used for the analysis and presentation of vector data, while Idrisi Kilimanjaro was used to model and analyse the available raster data. Mainly small-scale (1: 250 000 or smaller) data sets from National Department of Environmental Affairs and Tourism's ENPAT series, the National Land Cover programme, the Council of Geoscience, the Institute for Soil, Climate and Water and the South African Biodiversity Institute's PRECIS lists at quarter degree level.

Known provincial and regional specialists were contacted for assistance with known Red Data flora locations. The information received was incorporated in the evaluation of the proposed alternatives ecological sensitivity.

During the field trip, the study area was traversed using a vehicle and the western section of the area was flown with a helicopter to the west of the existing 765 kV transmission line. The area travelled was documented using GPS receivers, a laptop with a real time GPS interface, MS Access database and digital camera. The main aim of the field trip was to verify the accuracy of the available small-scale datasets, especially the latest land cover dataset.

1.2.2 Assumptions

None

1.2.3 Limitations

This document contains the result of a scoping level assessment, it aims to highlight potential issues and Red Data Flora habitat, and it does not claim to have assessed every hectare of the area.

No information could be retrieved from regional experts.

2 DESCRIPTION OF AFFECTED ENVIRONMENT

Vegetation communities represent the ecosystems/habitats present within the environment. They reflect the influence of the abiotic components (geology, climate, topography and soil) on them, while providing food and shelter to other organism, which together with them represent the biotic component of an ecosystem. Therefore to understand the distribution and species composition of vegetation in a specific area, factors such as geology, climate, topography and soil should be considered.

The aim of this document is to provide an overview of:

- The abiotic component – geology, climate, topography and soil
- The vegetation – regional scale
- Potential Red Data Flora habitat

2.1 The Abiotic Component

2.1.1 Geology

This section provides an overview of the geology within the study area from an ecological perspective; the engineering and heritage implications of the geology are discussed in separate specialist reports.

According to the 1: 1 000 000 scale geological map of South Africa, the four dominant lithological units within the study area are recent sedimentary deposits, dolerite, mudstone and shale (Figure 4.A), of which the shale from the Volkrust Formation within the Ecca Group of the Karoo Sequence has the largest extent (73%) (Table 1). Other lithological units occurring in the area are sand, arenite[1] and calcrete.

Due to the fine textured nature of the dominant lithological units, it is expected that fine textured soils (clayey soils) will dominate the area.

2.1.2 Climate

The study area transects two climate regions (Figure 4.B). Approximately two third of the study area in the north is located within the Northern Steppe climate region (BS (kh)w), while the southern third is located within the Southern Steppe climate region (BSkw). According to the Köppen climate code, the BS indicates Steppe climate, a semiarid climate (Figure 5.A) characterized by grasslands. It occupies an intermediate position between the desert climate (BW) and the more humid climates (Strahler & Strahler, 1987). The letters k and h indicates respectively that the mean annual temperature is either below or above 18ºC (Figure 5.B), when it is below the area is considered to be dry-cold and when it is above the area is considered to be dry-hot. The letter w indicates that the dry season occur during the winter, in other words the rainfall occurs mainly during summer and autumn. Therefore it is concluded that the area is considered to be dry-cold, with the majority of the area receiving less than 400 mm of rain a year, which confirms its arid status (Bothma, 1995)

[1] A coarse textured sandstone

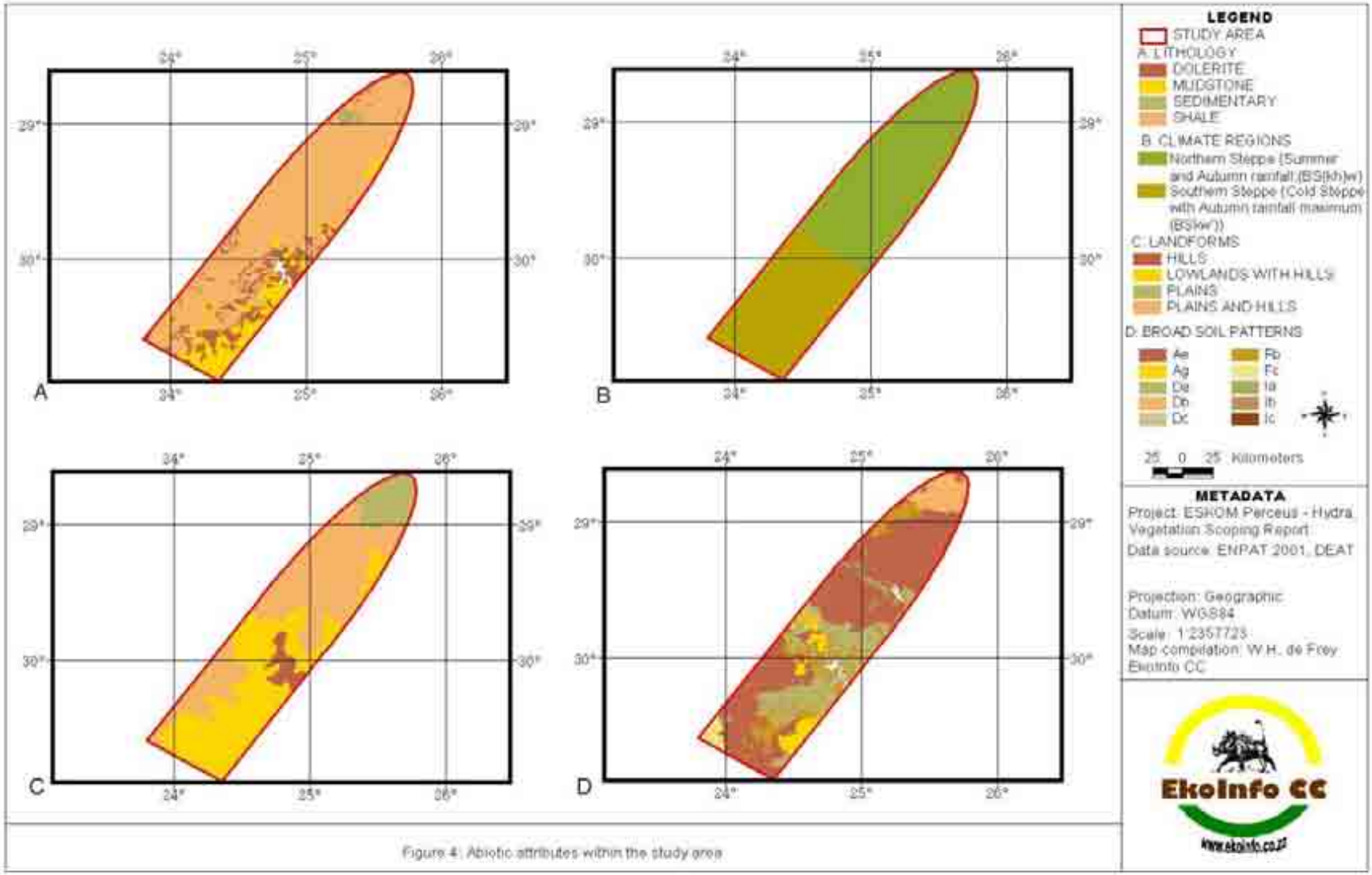

Figure 4: Abiotic attributes within the study area

Table 1: Summary of geological attributes within the study area (Data sorted according to age, from youngest deposits to eldest deposits)

Chronological Units	Primary Stratigraphic Units	Secondary Stratigraphic Units	Dominant Lithological Units	Associated Lithological Units	Hectares	% Cover
Large Water Bodies - Dams					9488.698	0.595%
Quaternary	*	*	Sedimentary	Sand, Calcrete	15557.424	0.976%
Mesozoic	*	Karoo Dolerite Suite	Dolerite		185252.466	11.622%
Phanerozoic	Karoo Sequence	Beaufort Group	Mudstone	Arenite	212369.996	13.323%
Palaeozoic	Ecca Group	Volksrust Formation	Shale		1171313.129	73.483%
TOTALS					1593982	100.000%

Table 2: Summary of topographic attributes within the study area

Terrain division	Terrain morphology	Hectares	% Cover	Pans	Hills
Plains	Plains And Pans	143073.503	9%	143073.503	
Plains and hills	Slightly irregular plains and pans	735452.982	46%	735452.98	
Lowlands with hills	Lowlands with hills	653795.010	41%		653795.010
Hills	Hills	61336.084	4%		61336.084
		1593657.579	100%	878526.485	715131.094
				55%	45%

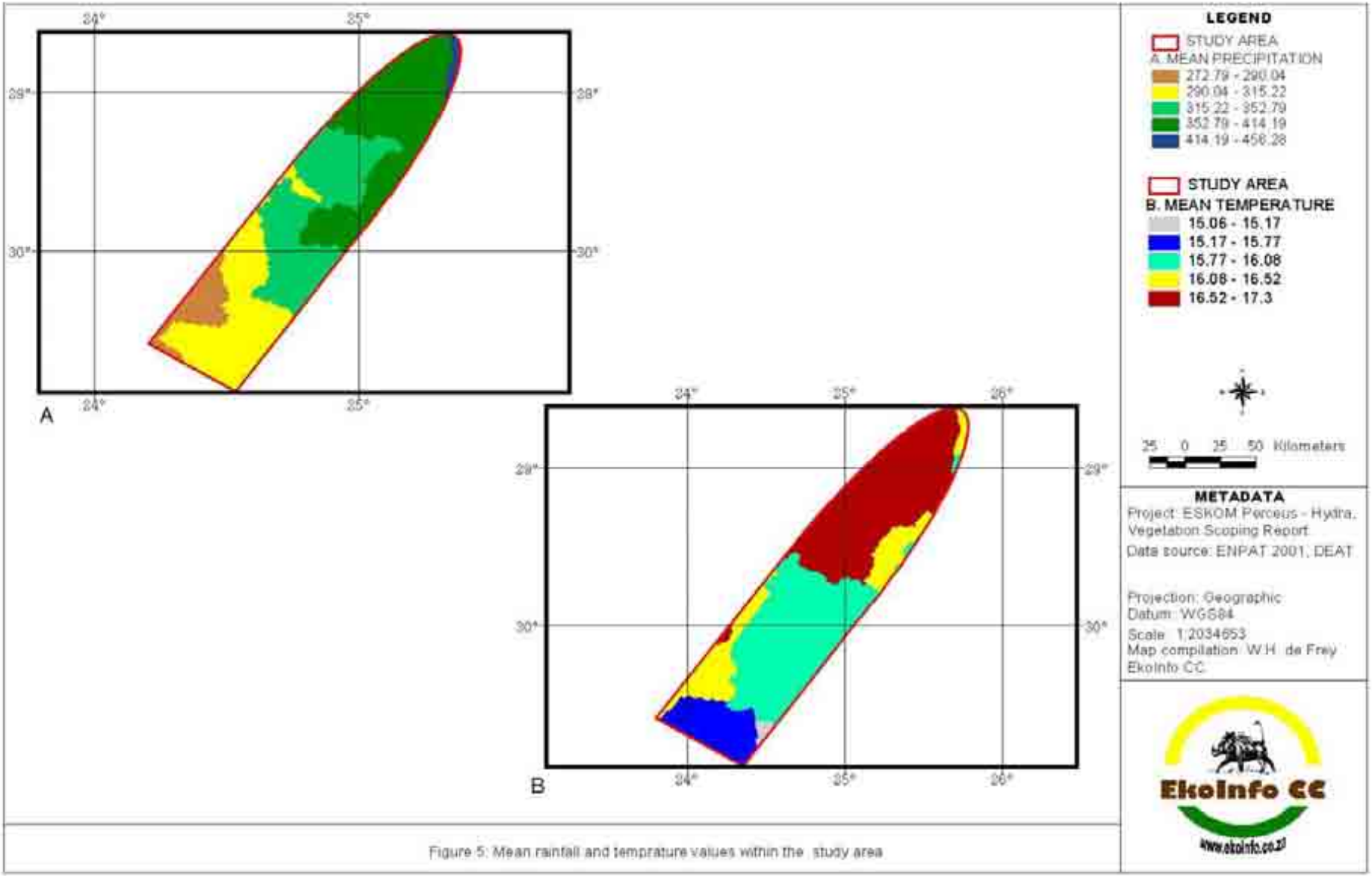

Figure 5: Mean rainfall and temprature values within the study area

It should be noted that in areas, which is classified to belong to the B major climate group, evaporation exceeds precipitation on average throughout the year. There is no water surplus hence no permanent streams originate in B climate regions.

Due to the semiarid/ dry climate within the study area, it is expected that mechanical weathering rather than chemical weathering will determine the nature of the topography.

2.1.3 Topography

The distribution of landforms determines the change in relief and therefore changes in topography. Figure 4.C indicates that the dominant landforms in the study area are plains, lowlands and hills. These are associated with the following terrain morphological units (Table 2): plains and pans, slightly irregular plains and pans, lowlands with hills and hills.

The plains and hills are the result in the difference in resistance to weathering of the underlying lithological units. In arid climates, sedimentary rocks (shale, sandstone) tends to be less resistant to mechanical weathering than igneous rocks (dolerites) which are more prone to chemical weathering in humid climates. Therefore in arid areas, plains are the result of the weathering of the sedimentary rocks and ridges or hills consist of igneous rocks (Figure 6). Pans developed on the large plains between residing remnants of large mountains, which in the study area most probably consisted of large dolerite sills which eroded along existing fault lines (Figure 7).

Alluvial fans (Figure 8) occur throughout the study area in association with steep environments (mountains, ridges, hills, escarpments). They are the result of the movement of sediment in these steep environments within channels (canyons/ gorges/ ravines, drainage lines) during sporadic episodes of significant rain (flooding) and occur were the current of water and sediment (suspended material) exits on a flat area (plains, pans). They therefore vary significantly in scale and extent.

The altitude decreases from the east towards the west (Figure 9). Primary (Orange river) and secondary (Riet river) drainage lines flowing towards the northwest drains the landscape in a southwesterly to northeasterly direction. With the increase in altitude towards the south of the study area, there is an increase in drainage lines, which are mainly non-perennial.

It should be noted that these geological process are currently taking place within the study area and that different stages of landscape development occur within the study area only separated over space. This intricate landscape with its mosaic of landforms in conjunction with the geology and climate set the platform for soil development in the area.

2.1.4 Soil

Ten broad soil patterns occur within the study area (Figure 4.D). They are Ae, Ag, Da, Db, Dc, Fb, Fc, Ia, Ib and Ic, of which Ae soil pattern covers more than 50% of the study area (Table 3). Deep, sandy soil covers approximately 60% of the study area.

Areas with percentage rock cover of more than 50% are limited (Figure 10.A), soils of more than 300 mm deep cover large areas (Figure 10.B) while percentage clay in the A – horizon does not exceed 30% (Figure 10.C). It is expected that the vegetation will reflect these difference in the soil.

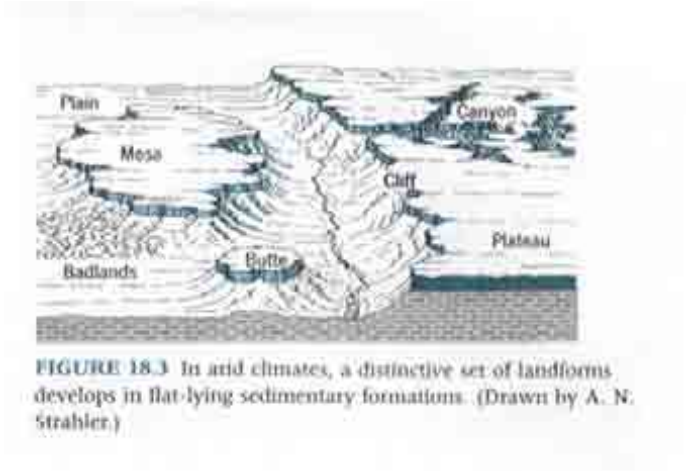

FIGURE 18.3 In arid climates, a distinctive set of landforms develops in flat-lying sedimentary formations. (Drawn by A. N. Strahler.)

Figure 6: Landforms of arid environments present within the study area (mainly in a sedimentary rock dominated environment)

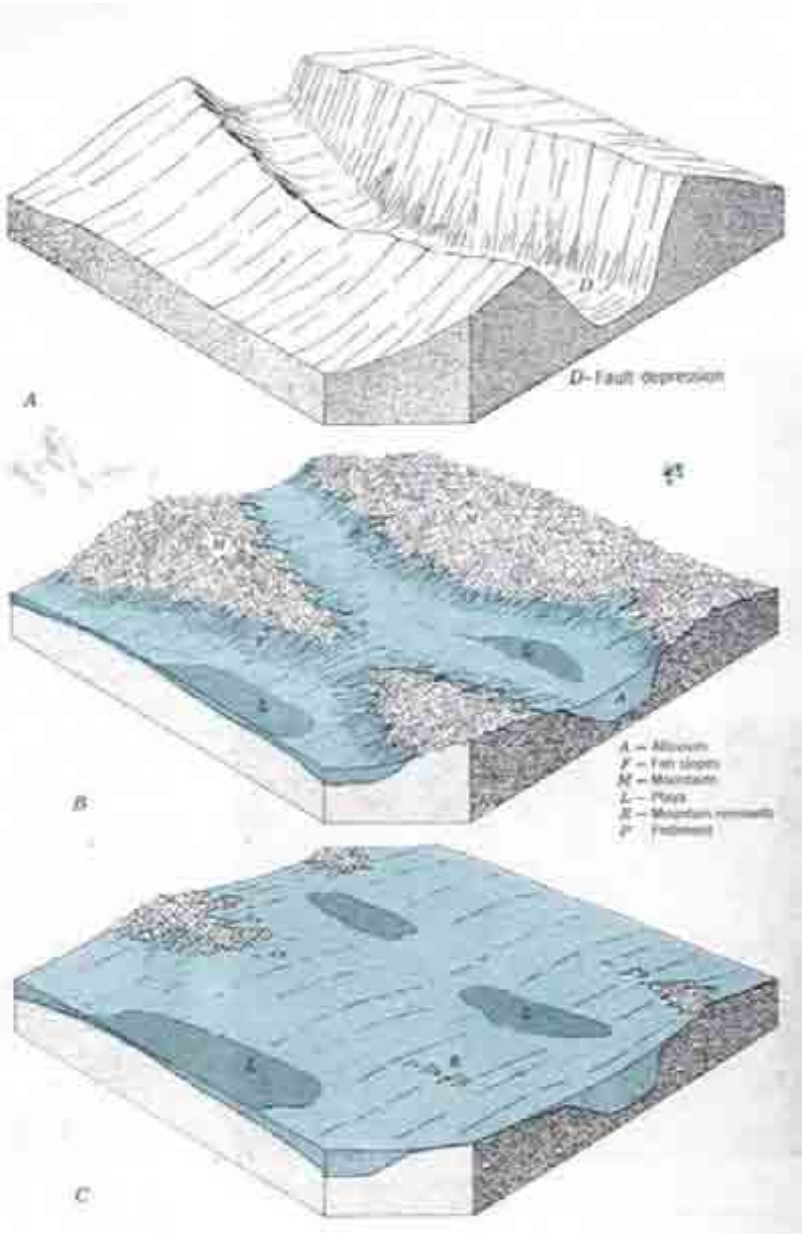

FIGURE 17.10 Stages in the denudation of mountain blocks in a desert environment. (Drawn by A. N. Strahler.)

Figure 7: Landforms of arid environments present within the study area (mainly in an igneous rock dominated environment)

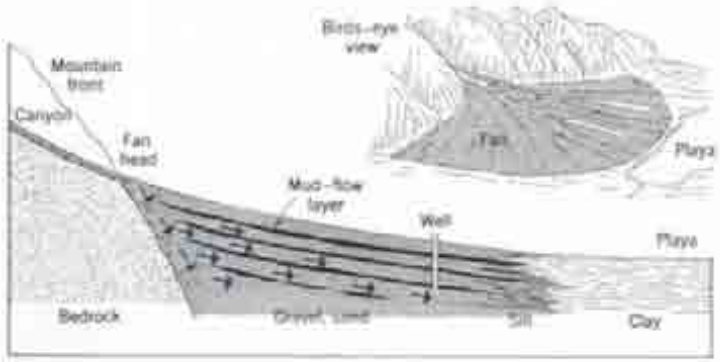

FIGURE 17.9 An idealized cross section of an alluvial fan showing mudflow layers (aquicludes) interbedded with sand layers (aquifers). (Redrawn from A. N. Strahler, *Planet Earth: Its Physical Systems Through Geologic Time*, Harper & Row, Publishers, Figure E.32. Copyright © 1972 by Arthur N. Strahler.)

Figure 8: Alluvial fans occur throughout the study area in association with steep environments (mountains, ridges, hills, escarpments)

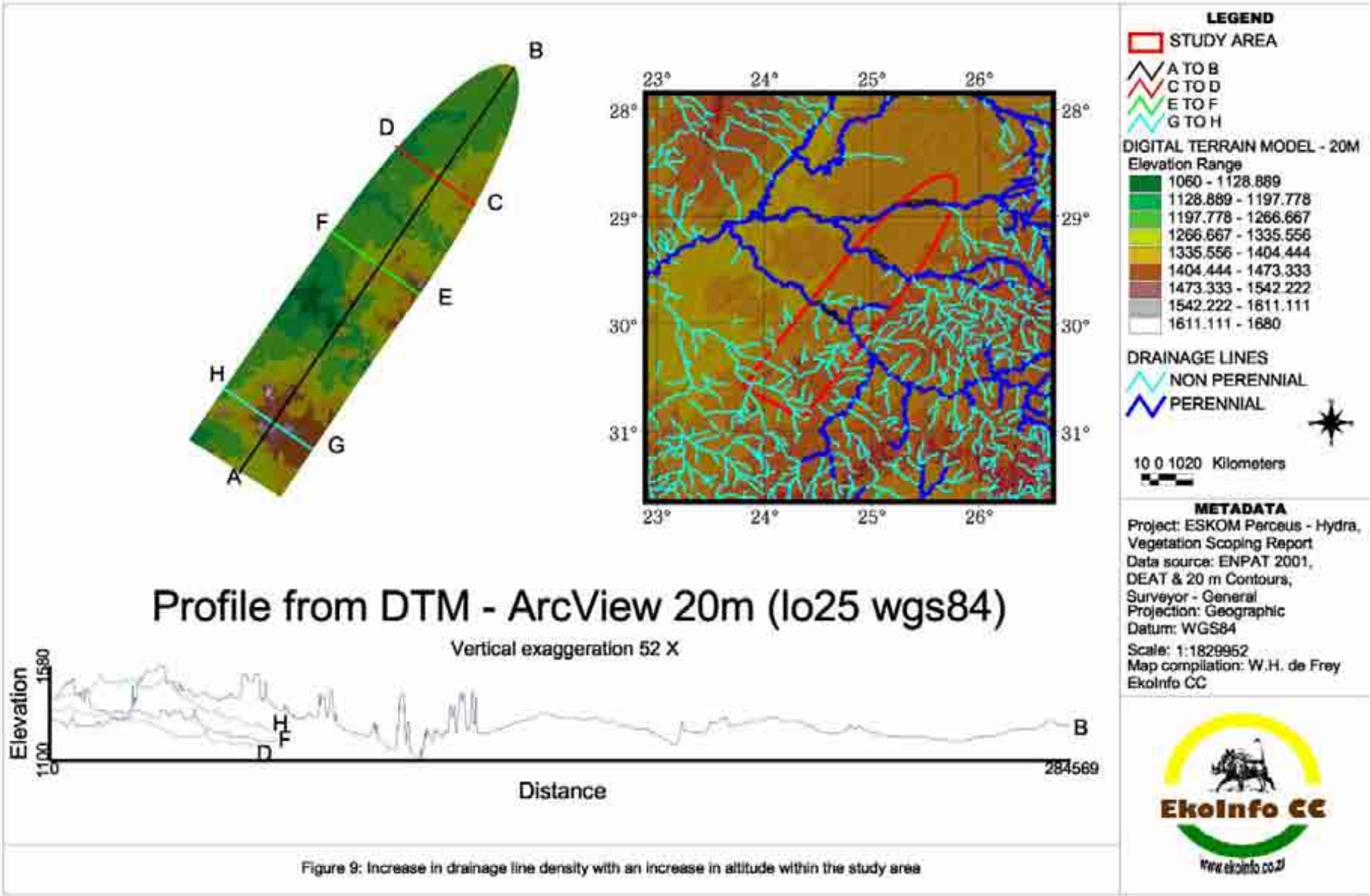

Figure 9: Increase in drainage line density with an increase in altitude within the study area

Table 3: Overview of the broad soil patterns and their attributes

Broad soil patterns	Hectares	% Cover	Drainage line	Structured soils/ Duplex soils	Red apedal soils	High lime content	Rocky areas	Shallow soils < 600 mm	Deep soils > 600 mm
Ae	854493.688	53.605%			854493.688				854493.688
Ag	74313.070	4.662%			74313.070			74313.070	
Da	280494.669	17.596%		280495				280494.669	
Db	98593.456	6.185%		98593					98593.456
Dc	778.267	0.049%		778					778.267
Fb	158888.905	9.968%				158888.905		158888.905	
Fc	26815.458	1.682%				26815.458		26815.458	
Ia	12768.971	0.801%	12768.971						12768.971
Ib	74399.011	4.667%					74399.011	74399.011	
Ic	66.117	0.004%					66.117	66.117	
Waterbodies	12445.948	0.781%							
	1594057.560		12768.971	379866.392	928806.758	185704.363	74465.128	614977.230	966634.382
			1%	24%	58%	12%	5%	39%	61%

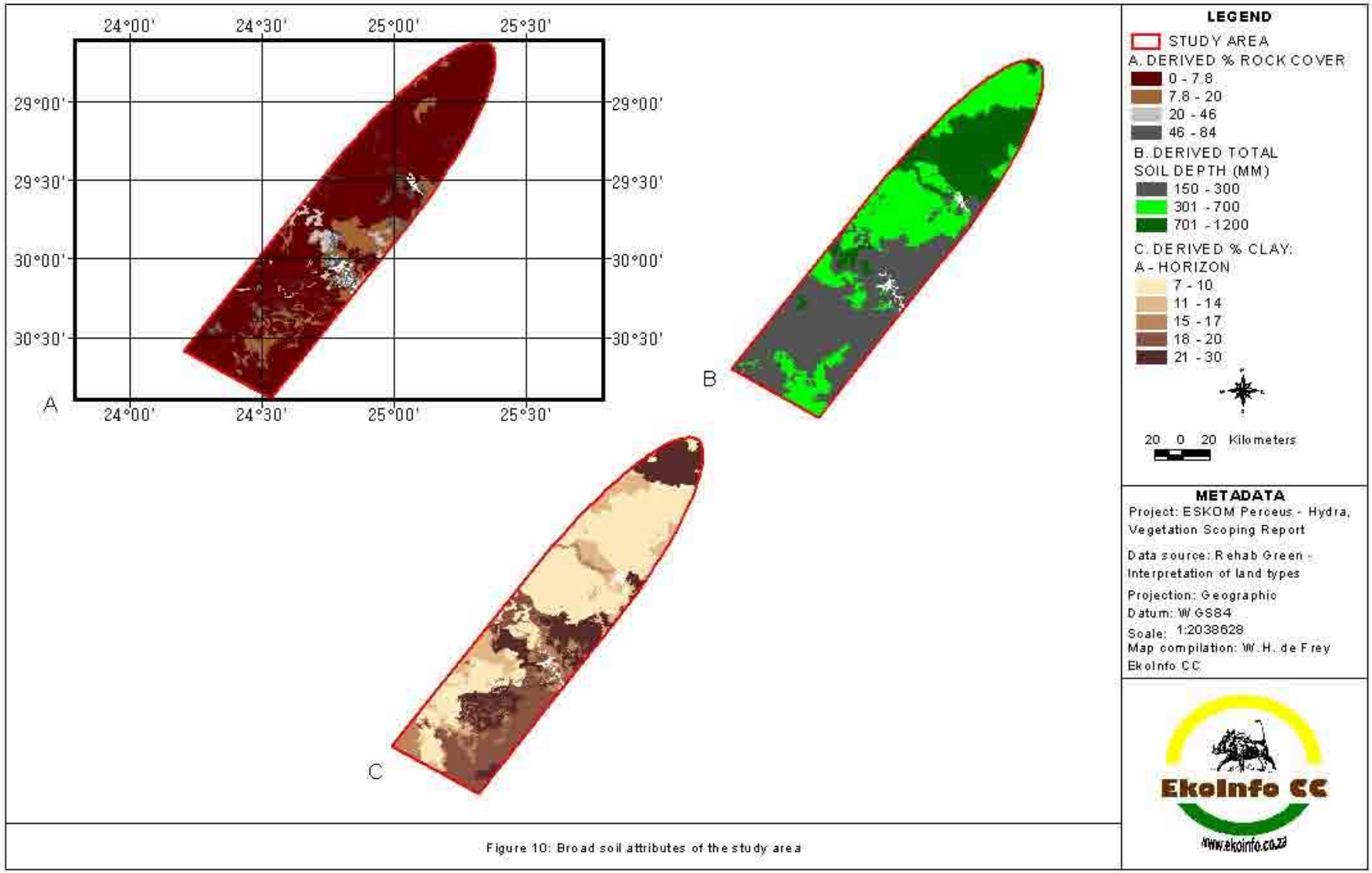

Figure 10: Broad soil attributes of the study area

2.2 Regional Vegetation

On a regional scale, vegetation is classified into biomes and vegetation units. In South Africa three sources of regional vegetation is recognised: Acocks, Low and Rebelo and Vegmap

2.2.1 Biomes

Three biomes occur within the study area (Figure 11.A), namely Savanna, Grassland and Nama Karoo, of which the Nama Karoo has the largest extent at approximately 97% (Table 4).

The Nama Karoo Biome occurs on the central plateau of the western half of South Africa, at altitudes between 500 and 2 000 m, with most of the biome falling between 1 000 and 1 400 m. It is the second-largest biome in the region. Rainfall primarily determines its distribution (Low & Rebelo, 1996).

The dominant vegetation is a grassy, dwarf shrubland. The amount and nature of the fuel load is insufficient to carry fires and fires are rare within the biome (Low & Rebelo, 1996). A wide variety of life forms co-exists in the Nama Karoo. Small trees occur along drainage line and on rocky hillsides. Plains are dominated by low shrubs (generally less than 1m in height) intermixed with grasses, succulents, geophytes and annual forbs. The grassiness of the vegetation varies over time, increasing in periods of above average summer rainfall and decreasing in periods when summers are drier than winters (Le Roux, 2002).

The Pricly Pear *Opuntia aurantiaca* and Mesquite *Prosopis glandulosa* are the major alien invader species. Urbanization and agriculture are minimal, and irrigation is confined to the Orange River valley and some pans (Low & Rebelo, 1996).

Less than one percent of the Nama Karoo biome is conserved, with the exception of the Oranger River Nama Karoo (1.47 %) and eastern mixed Nama Karoo (1.08 %). The highest densities of threatened plant species have been recorded in the Steytlerville, Greater Karoo and Noorsveld regions, but scientific plant specimens have generally been poorly collected throughout the biome as a whole. **Threatened and sensitive habitats include riverine areas, pans and drainage systems, as well as localised red sand dunes and succulent plant habitats (eg. specific calcrete, dorbank and quartz patches)** (Knobel, 1999).

2.2.2 Acocks

In terms of Acocks' veld type classification of South Africa (Acocks, 1988) (Figure 11.B), the study area transects four major veld type regions and eight veld types (Table 5). According to Acocks' a **veld type present a unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities**.

The majority of the study area is associated with the False Karoo major veld type region (86%), of which the False Upper Karoo veld type represents 77% of the study area.

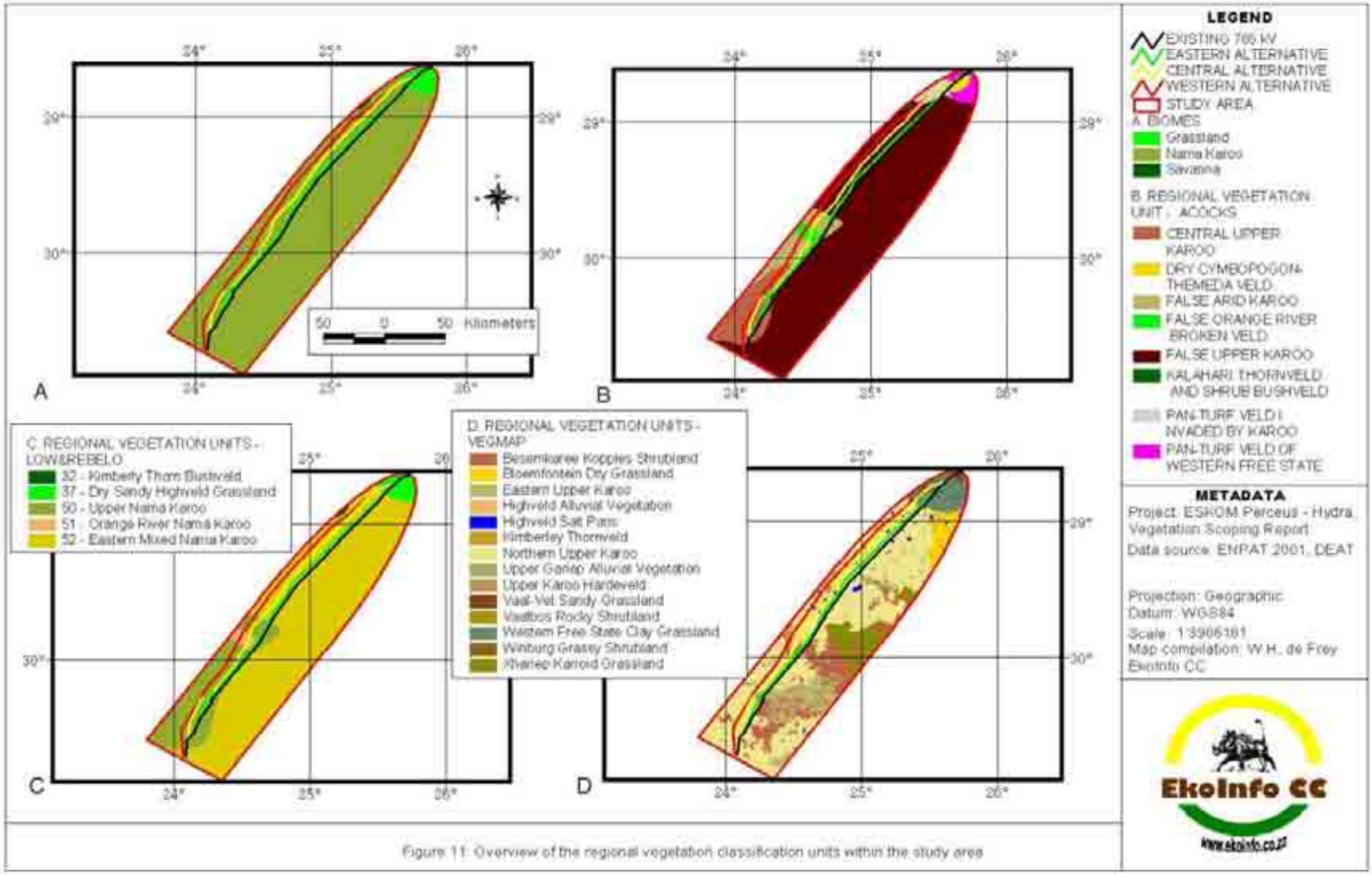

Figure 11: Overview of the regional vegetation classification units within the study area

Table 4: Summary of the biomes and regional vegetation units according to Low and Rebelo within the study area

			Biomes		
Regional vegetation units - Low and Rebelo (1996)	**Hectares**	**% Cover**	**Savanna**	**Grassland**	**Nama Karoo**
32 - Kimberly Thorn Bushveld	4499.259	0.3%	4499.259		
37 - Dry Sandy Highveld Grassland	49662.791	3.1%		49662.791	
51 - Orange River Nama Karoo	20439.087	1.3%			20439.087
52 - Eastern Mixed Nama Karoo	1211080.554	76.2%			1211080.554
50 - Upper Nama Karoo	308105.679	19.4%			308105.679
	1589288.111	100.0%	4499.259	49662.791	1539625.320
			0.3%	3.1%	96.9%

Table 5: Summary of Acock's major veld type regions and veld types within the study area

			Major Veld Type Regions			
Veld types – Acocks 1953 (1988)	**Hectares**	**% Cover**	**Tropical bush and Savanna Types**	**Karoo and Karroid types**	**False Karroo**	**Pure Grassveld Types**
Central Upper Karoo	171630.2120	11%		171630.2120		
Dry Cymbopogon-Themeda Veld	17385.0570	1%				17385.0570
False Arid Karoo	97538.6530	6%			97538.6530	
False Orange River Broken Veld	18503.3870	1%			18503.3870	
False Upper Karoo	1225787.2090	77%			1225787.2090	
Kalahari Thornveld And Shrub Bushveld	3362.7200	0%	3362.7200			
Pan-Turf Veld Invaded By Karoo	29664.8850	2%			29664.8850	
Pan-Turf Veld Of Western Free State	30368.8780	2%				30368.8780
	1594241.0010	100%	3362.72	171630.212	1371494.134	47753.935
			0.2%	10.8%	86.0%	3.0%

Acocks' describe this veld type as a national disaster because it represent degraded grassland. In principle the grassland had been replaced by eroded Karoo, which can only establish significantly once all of the topsoil had been removed.

2.2.3 Low and Rebelo

Five regional vegetation types (Figure 11.C) occur within the study area, of which Eastern Mixed Nama Karoo dominates at 76% (Table 4) associated with the Nama Karoo Biome. Vegetation types were compiled according to the following criteria: "Each Vegetation Type had to be a coherent array of communities which shared common species (or abundances of species), possessed a similar vegetation structure (vertical profile), and shared the same set of ecological processes. **They would thus have similar uses, management programmes and conservation requirements**".

The Eastern Mixed Namam Karoo is described as follows (Low & Rebelo, 1996):

"52. EASTERN MIXED NAMA KAROO

Synonyms:
False Upper Karoo (A36), False Karroid Broken Veld (A37).

Statistics:
77 784 km²; area transformed unknown; **1.08% conserved**.

Locality & Physical Geography:
Eastern Mixed Nama Karoo reflects an extensive ecotone between the Nama Karoo Biome in the west and the Grassland Biome to the east. Altitude varies from about 1 400 m for areas north of the escarpment to around 700 m for sites below the escarpment. This is the typical Karoo landscape of mesas and buttes.

Climate:
Rainfall is between 300 and 500 mm per year, occurring mostly in late summer and autumn.

Geology & Soil:
Beaufort Group sandstones and shales dominate the landscape, with the flat-topped landscape shaped by many dolerite dykes and sills.

Vegetation:
A complex mix of grass- and shrub-dominated vegetation types, which are subject to dynamic changes in species composition dependent on seasonal rainfall events, occurs within this vegetation type. Common shrubs include Bitterkaroo *Pentzia incana*, Kapokbush *Eriocephalus ericoides*, Thornkapok *E. spinescens* and *Hermannia* spp., while grasses, such as *Aristida* spp., *Eragrostis* spp. and Redgrass *Themeda triandra*, may dominate the landscape after good summer rains, especially in the north-east. **Trees are not abundant**, except along the dry river beds where Sweet Thorn *Acacia karroo* is a common element. **This type has the highest cover of herbs of all the Nama Karoo types, as well as numerous geophytes**.

Key Environmental Parameters:
The north-east region of Eastern Mixed Nama Karoo is the only Karoo type in which fire is important in shaping the communities. This type has

the highest rainfall of all the Karoo types and is thus ecotonal to grassland. As a result, it is relatively sensitive to grazing pressure and, depending on stocking density and rainfall conditions, may resemble either grassland or Karoo.

Conservation Status:
Poorly conserved - most of the conservation areas are immediately around the major dams. Acocks considered this the most degraded of all the vegetation types in South Africa. This is where all the classical research on desertification and Karoo encroachment has been undertaken. Although there is much support for Acocks's theory on Karoo encroachment due to overgrazing, some scientists maintain that this "invasion" is determined by rainfall events and that drought periods result in an increase in Karoo elements. This process is reversed during wet cycles in which the grasses again dominate. **However, overgrazing does encourage Karoo encroachment and it is important that stocking densities should be maintained at the carrying capacity of the vegetation as determined by its rainfall at the time.**

Key Reference:
Acocks (1988).

Author:
Timm Hoffman. "

2.2.4 Vegmap

Vegmap represents the latest classification of South Africa's vegetation (Figure 11.D). It is clearly based on more detail than the previous classifications, with 14 different vegetation units occurring within the study area (Table 6). Of the 14 vegetation units Northern Upper Karoo (Figure 12) covers 58% of the study area. Although used in the compilation of the South African National Spatial Biodiversity Assessment 2004[2] no detailed description of the vegetation units are currently available, until published.

None of the vegetation units occurring within the study area is listed as critical endangered in terms of the South African National Spatial Biodiversity Assessment (Rouget, Reyers, Jonas, Desmet, Driver, Maze, Egoh, B. & Cowling, 2004).

2.2.5 Land Cover

Based on the 2001 National Land Cover Assessment (Figure 13) for the study area, approximately 94% of the study area is considered to be natural (Table 7). Shrubland cover approximately 53% of the study area (Table 7). Transformation within the study area is mainly attributed to cultivation.

[2] www.sanbi.org

Table 6: Summary of Vegmap vegetation units within the study area

					Biomes			Physionomic significance	
Regional vegetation unit - Vegmap (2004)	**No of stands**	**Hectares**	**Average stand size**	**% Cover**	**Savanna**	**Grassland**	**Nama Karoo**	**Woody species conspicuous**	**Herbaceous species conspicuous**
Kimberley Thornveld	15	16317.5640	1087.8376	1.02%	16317.5640			16317.5640	
Xhariep Karroid Grassland	12	107261.7790	8938.4816	6.73%		107261.7790			107261.7790
Western Free State Clay Grassland	1	92968.2750	92968.2750	5.83%		92968.2750			92968.2750
Bloemfontein Dry Grassland	1	59358.2430	59358.2430	3.72%		59358.2430			59358.2430
Vaal-Vet Sandy Grassland	2	8829.3460	4414.6730	0.55%		8829.3460			8829.3460
Northern Upper Karoo	10	931411.3900	93141.1390	58.43%			931411.3900	931411.3900	
Besemkaree Koppies Shrubland	75	213540.6790	2847.2091	13.40%			213540.6790	213540.6790	
Eastern Upper Karoo	17	117285.6840	6899.1579	7.36%			117285.6840	117285.6840	
Highveld Salt Pans	166	20995.6960	126.4801	1.32%			20995.6960	20995.6960	
Upper Gariep Alluvial Vegetation	5	14378.2720	2875.6544	0.90%			14378.2720	14378.2720	
Vaalbos Rocky Shrubland	19	8490.1690	446.8510	0.53%			8490.1690	8490.1690	
Winburg Grassy Shrubland	9	1703.1480	189.2387	0.11%			1703.1480	1703.1480	
Highveld Alluvial Vegetation	1	782.4120	782.4120	0.05%			782.4120	782.4120	
Upper Karoo Hardeveld	2	660.7750	330.3875	0.04%			660.7750	660.7750	
		1593983.4320		**100.00%**	**16317.564**	**268417.643**	**1309248.23**	**1325565.7890**	**268417.6430**
					1%	**17%**	**82%**	**83%**	**17%**

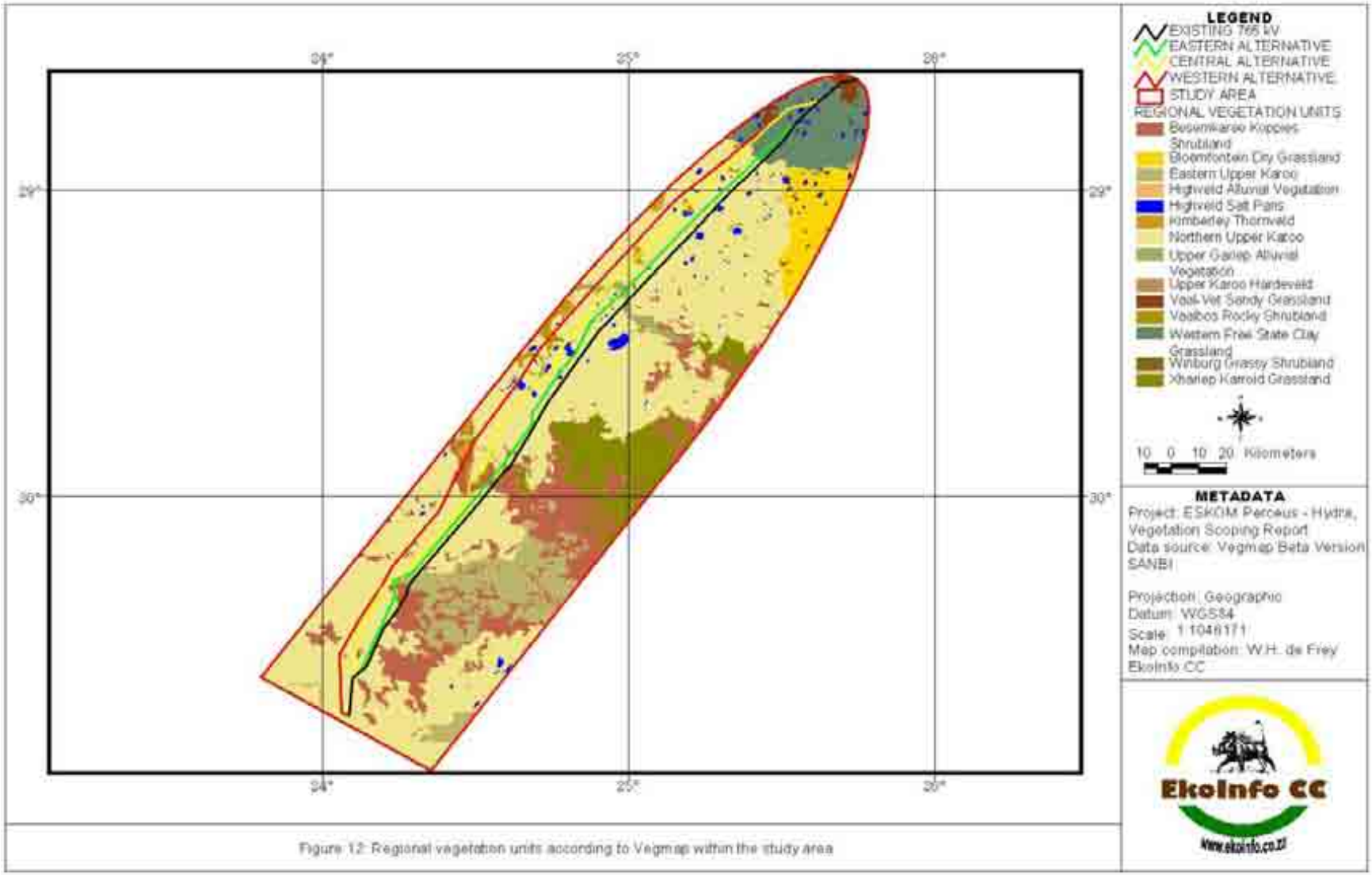

Figure 12: Regional vegetation units according to Vegmap within the study area

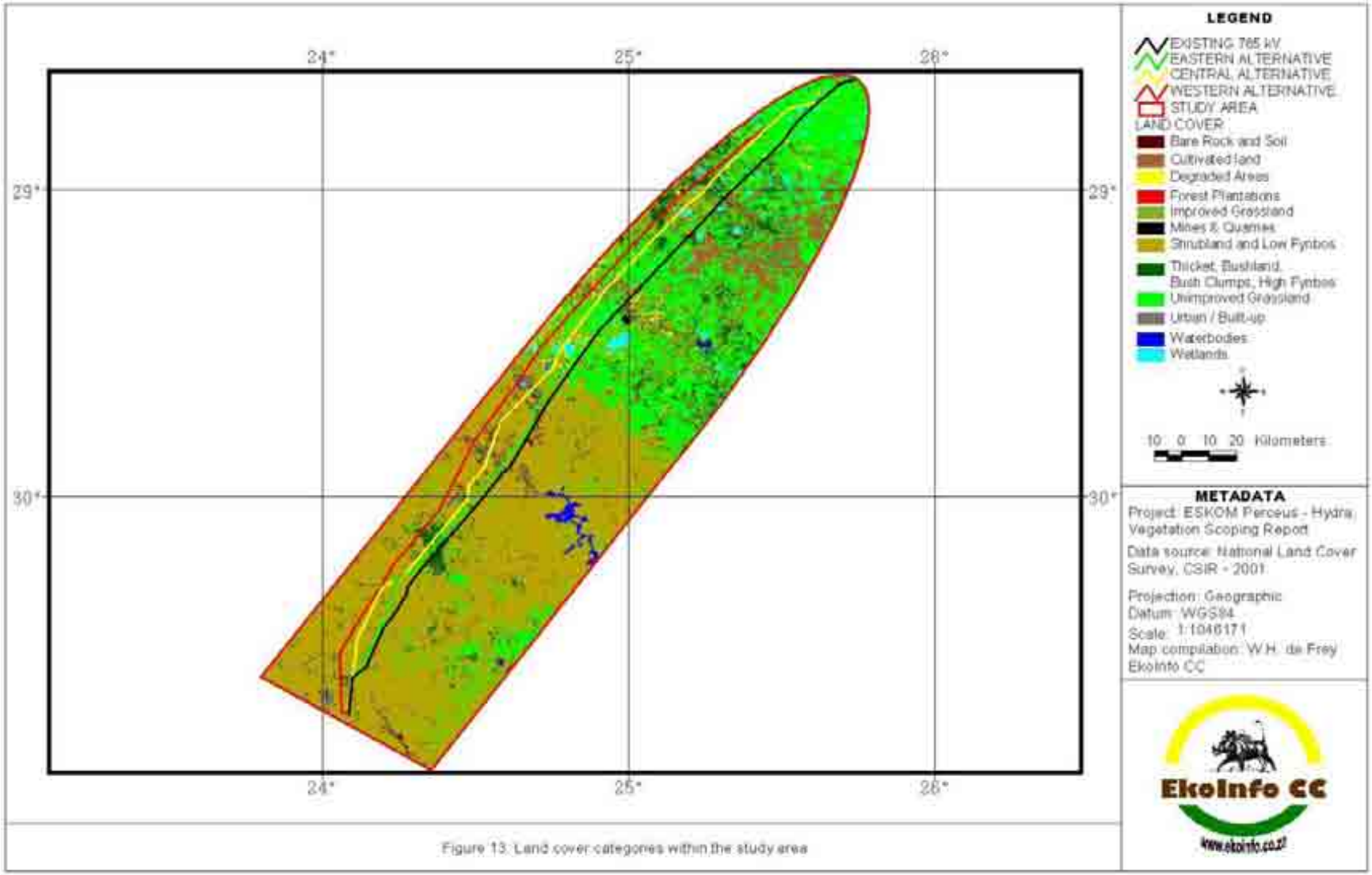

Figure 13: Land cover categories within the study area

Table 7: Summary of land cover categories within the study area (National Survey, CSIR – 2001)

			Natural		Transformed	
Land Cover Categories	**Hectares**	**% Cover**	**Pristine**	**Degraded**	**Construction**	**Cultivation**
Bare Rock and Soil (erosion : dongas / gullies)	1010.217	0.06%		1010.217		
Bare Rock and Soil (erosion : sheet)	15606.106	0.98%		15606.11		
Bare Rock and Soil (natural)	804.032	0.05%	804.032			
Cultivated, temporary, commercial, dryland	59769.476	3.75%				59769.48
Cultivated, temporary, commercial, irrigated	29736.027	1.87%				29736.03
Cultivated, temporary, subsistence, dryland	1633.85	0.10%				1633.85
Cultivated, temporary, subsistence, irrigated	867.606	0.05%				867.606
Degraded Shrubland and Low Fynbos	6254.157	0.39%		6254.157		
Degraded Unimproved (natural) Grassland	26104.545	1.64%		26104.55		
Forest Plantations (Eucalyptus spp)	545.025	0.03%				545.025
Improved Grassland	59.987	0.00%				59.987
Mines & Quarries (mine tailings, waste dumps)	446.127	0.03%			446.127	
Mines & Quarries (surface-based mining)	339.943	0.02%			339.943	
Mines & Quarries (underground / subsurface mining)	25.2	0.00%			25.2	
Shrubland and Low Fynbos	857337.994	53.79%	857338			
Thicket, Bushland, Bush Clumps, High Fynbos	133372.91	8.37%	133372.9			
Unimproved (natural) Grassland	418912.227	26.28%	418912.2			
Urban / Built-up (residential)	130.174	0.01%			130.174	
Urban / Built-up (residential, formal suburbs)	737.556	0.05%			737.556	
Urban / Built-up (residential, formal township)	83.899	0.01%			83.899	
Urban / Built-up (residential, informal squatter camp)	101.341	0.01%			101.341	
Urban / Built-up (residential, informal township)	412.467	0.03%			412.467	
Urban / Built-up (smallholdings, shrubland)	480.263	0.03%			480.263	
Urban / Built-up, (commercial, education, health, IT)	24.479	0.00%			24.479	
Urban / Built-up, (commercial, mercantile)	52.06	0.00%			52.06	
Urban / Built-up, (industrial / transport : heavy)	475.337	0.03%			475.337	
Urban / Built-up, (industrial / transport : light)	575.752	0.04%			575.752	
Waterbodies	11851.222	0.74%	11851.22			
Wetlands	26248.708	1.65%	26248.71			
	1593998.687	**100.00%**	**1448527**	**48975.03**	**3884.598**	**92611.97**
			90.9%	**3.1%**	**0.2%**	**5.8%**
			94%		**6%**	

2.3 Potential Red Data Flora species

The South African National Biodiversity Institute's Interim Red Data Flora list indicates 97 species for the Free State Province and 685 species for the Northern Cape. Of the 685 species for the Northern Cape, 99 species are considered threatened. Nine (9) of the species from the Free State Province are considered threatened.

A combined list of the threatened species from both provinces indicates that 117 species are considered threatened, of which three species occur in both provinces (Appendix A).

The 117 threatened species are representative of 18 plant families (Table 8) of which the following families represent 50% of the species in the list:

- Mesembryanthemaceae
- Asteraceae
- Amaryllidaceae

Fifty-five (55) or 46% of the 117 threatened species are vulnerable, while three species (3%) are considered endangered and three (3%) species are considered critical endangered (Table 9).

The majority (68% or 79 species) of the threatened species is herbaceous (Table 10), of which 32% (38) are geophytes and 26% (31) are succulents. Hundred-and-three (103) species or 88% of the threatened species are considered to be endemic (Table 11).

Limited information is available for the 117 threatened species in terms of their habitat preference, what are their physical appearances and when are they supposed to flower (Table 12).

A plot of the quarter degree grids in which the 117 threatened species had been recorded, indicates that the majority of the species where recorded outside the study area (Figure 14). In consideration of the precautionary principle as applied within the National Environmental Management Act No 107 of 1998, all quarter degree units which transects both the study area and Vegmap units which occur within the study area was selected. Based on this approach, seven species (Table 13) are expected to occur within the study area, of these seven species, one is considered to be endangered, one vulnerable and five had not been evaluated using the latest IUCN criteria. Six of seven species are considered endemic and one is considered rare.

An overview of the seven species habitat preference based on PRECIS data, indicated that the species can occur on shale and dolerite, prefer more sandy textured soils in association with rocky areas on almost any aspect in either grassland or woodland (Table 14). Therefore this information was used to model those areas within the study area, which is the most likely for them to occur in (Figure 15.A). Areas, where all five criteria were present were given 100% probability and those with only one criteria 20% probability, areas with no corresponding criteria or transformed areas (agricultural areas, forest plantations, water bodies) where given a zero (0) probability. **The results indicated only limited areas with 100 % probability of any of the seven species occurring within it, while the majority of the study area was in the 60% probability range of having at least three of the criteria suitable for any of the seven species to occur within it.**

Table 8: List of families associated with the potential Red Data Flora species within the study area

Family	Frequency	% Frequency	Cumulative % Frequency
Mesembryanthemaceae	24	21%	21%
Asteraceae	19	16%	37%
Amaryllidaceae	15	13%	50%
Asphodelaceae	12	10%	60%
Iridaceae	12	10%	70%
Apocynaceae	9	8%	78%
Fabaceae	5	4%	82%
Crassulaceae	3	3%	85%
Hyacinthaceae	3	3%	87%
Euphorbiaceae	3	3%	90%
Hypoxidaceae	2	2%	91%
Orchidaceae	2	2%	93%
Poaceae	2	2%	95%
Scrophulariaceae	2	2%	97%
Zamiaceae	1	1%	97%
Cyperaceae	1	1%	98%
Cucurbitaceae	1	1%	99%
Portulacaceae	1	1%	100%
	117	100%	

Table 9: Number of species considered to be Not Evaluated, Data deficient, Vulnerable, Endangered and Critical Endangered amongst the 117 threatened Red Flora species within the study area

IUCN Red Data Criteria Ver 3 - Victor 2002	Frequency	% Frequency	Not Evaluated	Data deficient	Vulnerable	Endangered	Critical Endangered
CR A1acdB1B2abceC2bD1	1	0.85%					1
CR A2ace	1	0.85%					1
CR B1+2abce C2b	1	0.85%					1
DD	2	1.71%		2			
EN A2c	1	0.85%				1	
EN B1B2abce	1	0.85%				1	
EN B1B2e	1	0.85%				1	
NE	54	46.15%	54				
VU A1ce	1	0.85%			1		
VU B1+2b,c	1	0.85%			1		
VU B1B2abc	1	0.85%			1		
VU B1B2abcd	1	0.85%			1		
VU B1B2c	1	0.85%			1		
VU B1B2e	3	2.56%			3		
VU D2	47	40.17%			47		
	117	**100.00%**	**54**	**2**	**55**	**3**	**3**
			46%	**2%**	**47%**	**3%**	**3%**

Table 10: Distribution of the growth forms amongst 117 threatened species

			Herbaceous species				Woody species		
Growth form	**Frequency**	**% Frequency**	**Forbs**	**Succulent**	**Geophytes**	**Grasses**	**Dwarf shrubs**	**Shrubs**	**Trees**
Dwarf shrub	1	1%					1		
Dwarf shrub herb,	2	2%					2		
Dwarf shrub	9	8%					9		
Dwarf shrub, geophyte, succulent	1	1%					1		
Dwarf shrub, succulent,	4	3%					4		
Geophyte	21	18%			21				
Geophyte, succulent,	1	1%			1				
Graminoid	2	2%				2			
Herb climber,	1	1%	1						
Herb succulent,	1	1%	1						
Herb	4	3%	4						
Herb, cyperoid, mesophyte	1	1%	1						
Herb, geophyte,	14	12%			14				
Herb, geophyte, succulent	2	2%			2				
Herb, prostate,	1	1%	1						
Resprouting subshrub	1	1%					1		
Shrub dwarf shrub,	1	1%					1		
Shrub	11	9%						11	
Shrub, geophyte, succulent	1	1%						1	
Shrub, succulent,	1	1%						1	
Shrublet	1	1%						1	
Shrubs	1	1%						1	
Shrubs/Tree	1	1%						1	
Succulent climber	1	1%		1					
Succulent	30	26%		30					
Tree	2	2%							2
Tree, shrub,	1	1%							1
	117	**100%**	**8**	**31**	**38**	**2**	**19**	**16**	**3**
			7%	**26%**	**32%**	**2%**	**16%**	**14%**	**3%**

Table 11: Percentage endemic species among the 117 threatened species

SA Endemic	Frequency	% Frequency
Wide spread	14	12%
Endemic	103	88%
	117	100%

Table 12: Overview of the available information for the 117 threatened species

Habitat Description	Frequency	% Frequency
No	80	68%
Yes	37	32%
	117	
Picture available	Frequency	% Frequency
No	82	70%
Yes	35	30%
	117	100%
Flowering Data	Frequency	% Frequency
No	91	78%
Yes	26	22%
	117	100%

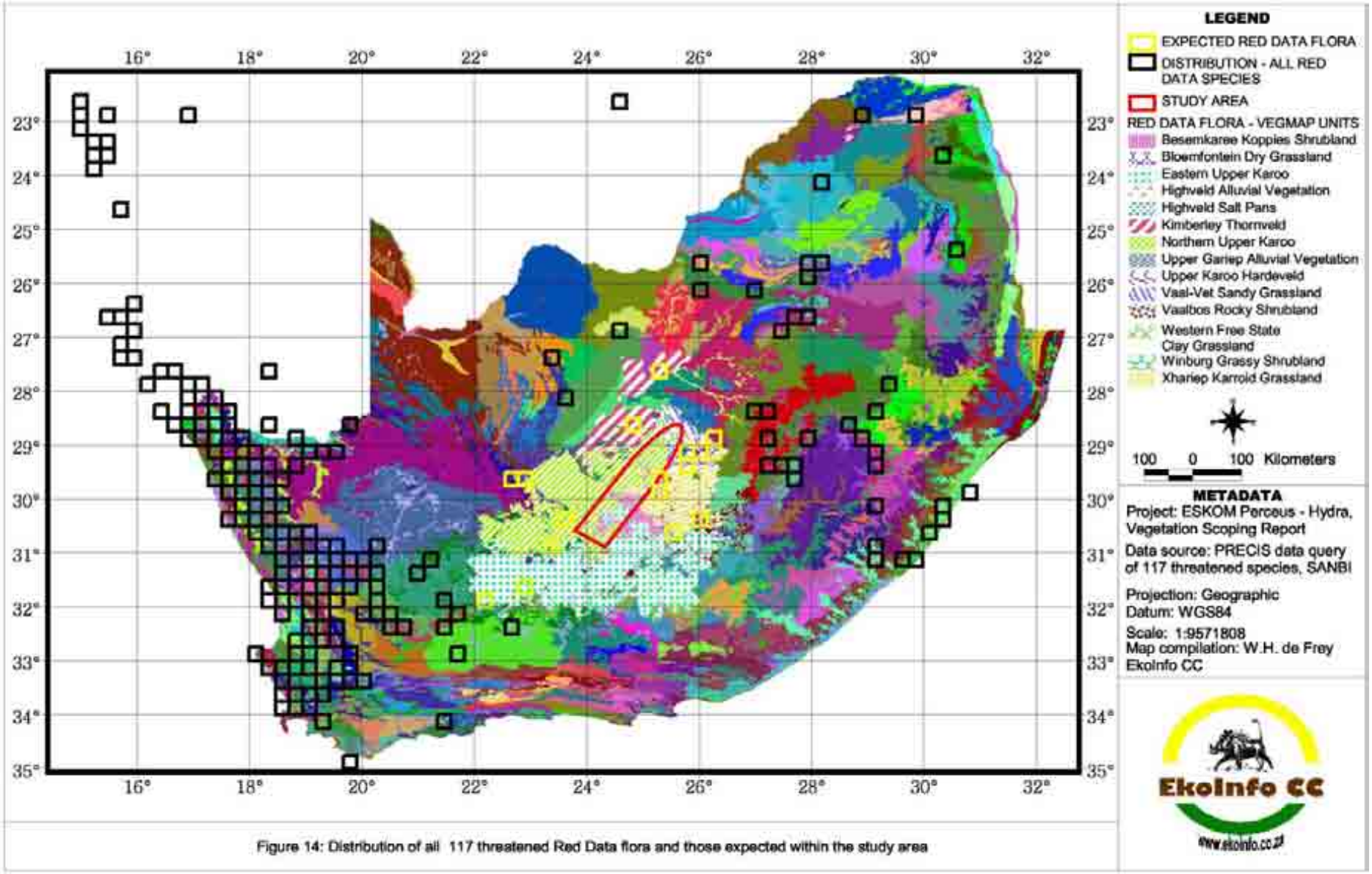

Figure 14: Distribution of all 117 threatened Red Data flora and those expected within the study area

Table 13: List of seven expected Red Data flora to occur within the study area

Botanical name	Family	Hilton-Taylor 1996	Victor 2002	Summary	SA ENDEMIC	Rarity
Aloe chlorantha Lavranos	Asphodelaceae	E	EN B1B2e	Threatened	Endemic	Rare
Anacampseros filamentosa (Haw.) Sims subsp. filamentosa	Portulacaceae	R/V	NE	Threatened	Endemic	
Brachystelma dimorphum R.A.Dyer subsp. gratum R.A.Dyer	Asclepiadaceae	I	VU D2	Threatened	Endemic	
Cynanchum virens D.Dietr.	Asclepiadaceae	V	NE	Threatened		
Euphorbia albertensis N.E.Br.	Euphorbiaceae	R/V	NE	Threatened	Endemic	
Euphorbia cylindrica A.C.White, R.A.Dyer & B.Sloane	Euphorbiaceae	V	NE	Threatened	Endemic	
Neohenricia sibbettii (L.Bolus) L.Bolus	Mesembryanthemaceae	V	NE	Threatened	Endemic	

Table 14: Overview of the seven expected Red Data species vegetation characteristics and habitat preferences

Botanical name	Growth form	Plant height (m)	Altitude (m)	Flower period	Habitat	Habitat Description	Geology	Substrate	Aspect	Soil	Vegetation
Aloe chlorantha Lavranos	Dwarf shrub, herb,	0.5-1m	1250-1450m	October	Dry rocky northern slopes in small area near Frasersburg	Yes		stony soil/rocky			
Anacampseros filamentosa (Haw.) Sims subsp. filamentosa	Herb, ,	0.03-0.07m	350-1600m	Oct - Jan	Granite outcrops	Yes		stony soil/rocky			
							dolerite	stony soil/rocky	E	loam	nama karoo
							shale	stony soil/rocky	W	sand	succulent karoo
Brachystelma dimorphum R.A.Dyer subsp. gratum R.A.Dyer	Geophyte, ,	10-50mm	1200-1400m			No					
Cynanchum virens D.Dietr.	Herb, climber,	0.5-2m	1200-2000m	Nov - Feb	Thickets, near rivers, forest margins	Yes					closed shrubland
											open woodland
								soil		sand	grassland
Euphorbia albertensis N.E.Br.	Dwarf shrub, succulent,	0.05-0.1m	1450-1550m			No					karroo
Euphorbia cylindrica A.C.White, R.A.Dyer & B.Sloane	Shrub, succulent,	0.2-0.5m	1325-1675m			No					
Neohenricia sibbettii (L.Bolus) L.Bolus	Succulent, ,	Up to 0.01m	1120-1380m		Shallow pans of grit over rock	Yes					

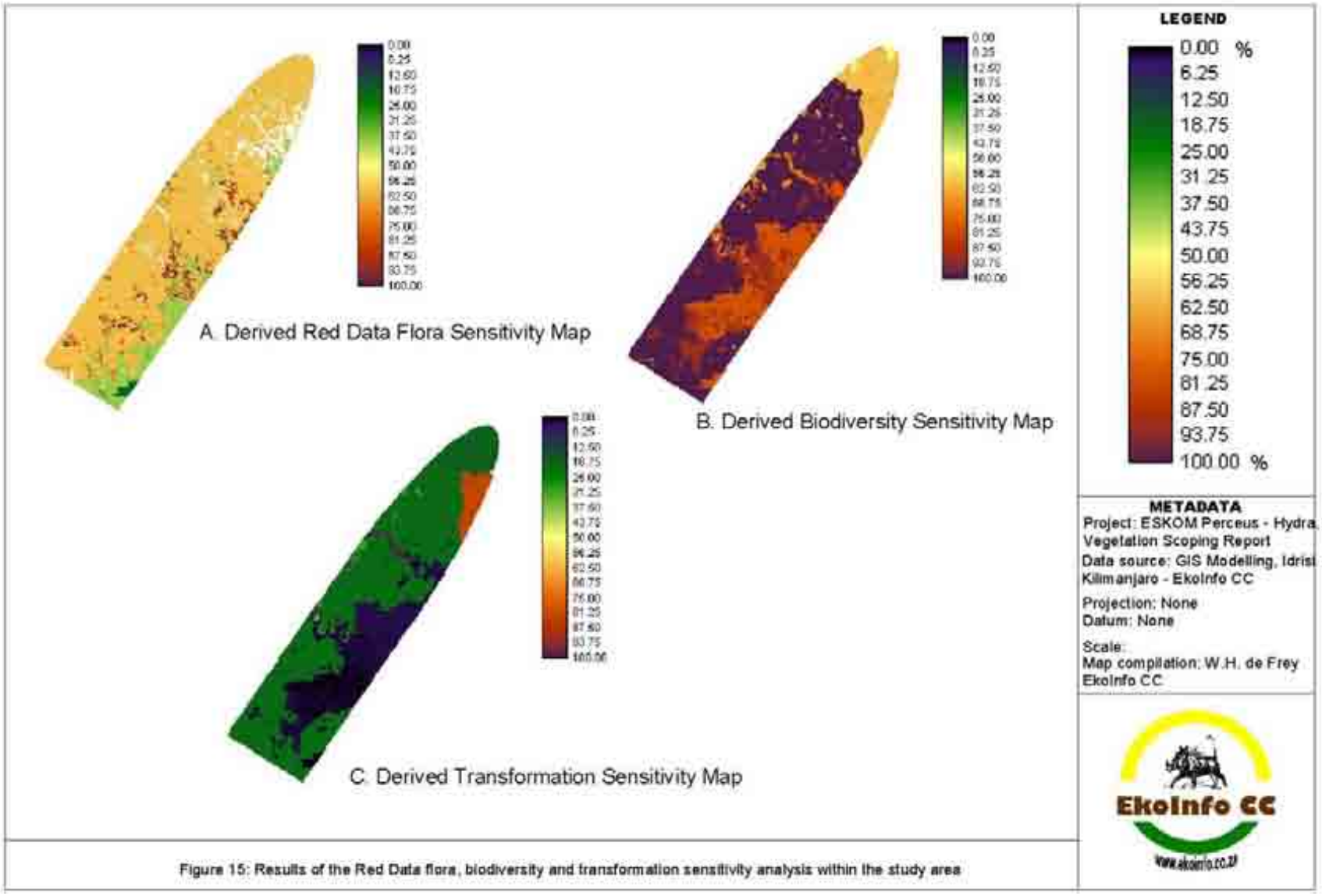

Figure 15: Results of the Red Data flora, biodiversity and transformation sensitivity analysis within the study area

2.4 Total Ecological Sensitivity

Three parameters were used in conjunction with the Red Data flora sensitivity results to determine the total ecological sensitivity within the study area, they were:

- Biodiversity
- Transformation
- Red Data fauna sensitivity

2.4.1 Biodiversity

The Biodiversity Bill No 30 of 2003 requires the responsible management of South Africa's biodiversity, therefore it was considered important to determine which of the Vegmap units within the study area is likely to have the highest percentage of biodiversity based on:

- No of lithological units per Vegmap unit
- No of broad soil patterns per Vegmap unit
- No of slope classes (5 degree intervals) per Vegmap unit
- No of aspects associated with the major bearings (None, North, East, South, West) per Vegmap unit
- No of pristine land cover units per Vegmap unit
- No of wetland types (Waterbodies, Wetlands) per Vegmap unit
- No of degraded land cover units per Vegmap unit.

Based on the adjusted results of the analysis (Table 15), it was derived that the Northern Upper Karoo has the potential for the highest diversity (100%) and the Highveld Alluvial Vegetation the lowest at 36% (Figure 15.B).

In terms of species richness, a total of 1153 species was recorded across 42-quarter degree grids, which transect the study area. These 1153 species are representative of 110 plant families (Appendix B), of which the following eight families contains 50% of the species: Asteraceae, Poaceae, Mesembryanthemaceae, Fabaceae, Scrophulariaceae, Hyacinthaceae, Chenopodiaceae and Apocynaceae. Of the 1153 species, the following 17 species are used for medicinal purposes: *Acacia karroo* Hayne, *Artemisia afra* Jacq. ex Willd, *Boophane disticha* (L.f.) Herb., *Dicoma capensis* Less., *Elephantorrhiza elephantina* (Burch.) Skeels, *Melianthus comosus* Vahl, *Pittosporum viridiflorum* Sims, *Rapanea melanophloeos* (L.) Mez, *Rumex lanceolatus* Thunb., *Scabiosa columbaria* L., *Sutherlandia frutescens* (L.) R.Br., *Tarchonanthus camphoratus* L., *Thesium hystrix* A.W.Hill, *Tulbaghia violacea* Harv. *Vernonia oligocephala* (DC.) Sch.Bip. ex Walp., *Withania somnifera* (L.) Dunal and *Xysmalobium undulatum* (L.) Aiton f.

The following 13 species recorded within the study area are declared weeds and invaders and should be treated and managed accordingly*: Argemone ochroleuca* Sweet subsp. *ochroleuca*, *Atriplex lindleyi* Moq. subsp. *inflata* (F.Muell.) Paul G.Wilson, *Atriplex nummularia* Lindl. subsp. *nummularia*, *Cestrum laevigatum* Schltdl., *Convolvulus arvensis* L., *Cuscuta campestris* Yunck., *Datura ferox* L., *Melia azedarach* L., *Nicotiana glauca* Graham, *Pennisetum villosum* R.Br. ex Fresen. , *Solanum elaeagnifolium* Cav., *Xanthium spinosum* L. and *Xanthium strumarium* L.

Table 15: Overview of the diversity levels per category with the Vegmap units occurring within the study area

Vegmap unit	No of lithological units	No of broad soil patterns	No of slope classes	No of major aspects	No of pristine land cover units	No of wetland types	No of degraded land cover units	TOTAL	%
Vaal-Vet Sandy Grassland	2	2	2	4	3	1	1.5	15.5	5.2%
Xhariep Karroid Grassland	3	5	5	4	4	2	2	25	8.4%
Highveld Salt Pans	4	5	1	5	3	2	2	22	7.4%
Bloemfontein Dry Grassland	3	3	3	5	3	1	1.5	19.5	6.5%
Western Free State Clay Grassland	2	4	2	5	3	1	2	19	6.4%
Northern Upper Karoo	4	10	5	5	4	2	2	32	10.7%
Besemkaree Koppies Shrubland	4	8	5	4	4	2	2	29	9.7%
Eastern Upper Karoo	4	6	5	5	3	2	0.5	25.5	8.5%
Winburg Grassy Shrubland	2	2	3	4	3	0	1	15	5.0%
Upper Karoo Hardeveld	2	4	4	4	2	0	0	16	5.4%
Vaalbos Rocky Shrubland	3	6	4	4	4	2	2	25	8.4%
Highveld Alluvial Vegetation	1	1	1	4	3	0	1.5	11.5	3.8%
Upper Gariep Alluvial Vegetation	2	6	4	4	3	2	2	23	7.7%
Kimberley Thornveld	2	5	3	4	3	2	2	21	7.0%
								299	100.0%

Table 16: The criteria used to calculate the percentage transformed areas per Vegmap unit

Vegmap units	Pristine Area	Wetland Area	W+P Area	Total Area	% Untransformed/ Degraded	%Transformation
Vaal-Vet Sandy Grassland	7836.669502	29.9949075	7866.66441	8833.500262	89.05%	10.95%
Xhariep Karroid Grassland	103618.4078	1939.670686	105558.079	107279.7862	98.40%	1.60%
Highveld Salt Pans	2635.55254	16896.1314	19531.6839	21007.43339	92.98%	7.02%
Bloemfontein Dry Grassland	34611.12378	748.8728575	35359.9966	59353.92298	59.57%	40.43%
Western Free State Clay Grassland	82807.94099	1444.754712	84252.6957	92971.21549	90.62%	9.38%
Northern Upper Karoo	827749.4659	7309.75896	835059.225	931499.8514	89.65%	10.35%
Besemkaree Koppies Shrubland	202812.5668	8611.537946	211424.105	213552.7433	99.00%	1.00%
Eastern Upper Karoo	116593.205	213.9636736	116807.169	117264.0911	99.61%	0.39%
Winburg Grassy Shrubland	1660.718046	0	1660.71805	1704.710577	97.42%	2.58%
Upper Karoo Hardeveld	612.8959435	0	612.895944	655.8886442	93.45%	6.55%
Vaalbos Rocky Shrubland	7894.659657	6.9988118	7901.65847	8509.555261	92.86%	7.14%
Highveld Alluvial Vegetation	563.9042613	0	563.904261	776.8681045	72.59%	27.41%
Upper Gariep Alluvial Vegetation	6393.914451	903.8465463	7297.761	14354.5629	50.84%	49.16%
Kimberley Thornveld	13613.68869	40.9930403	13654.6817	16294.23359	83.80%	16.20%

2.4.2 Transformation

Due to the fact that the power line involves infrastructure and infrastructure requires construction, which results in transformation, it was considered important to highlight which of the Vegmap units are the most sensitive in terms of transformation. In otherwords, which of the Vegmap units are the most transformed and therefore should be protected from additional transformation pressures. Percentage transformation was determined by calculating the percentage pristine and wetland areas within each Vegmap unit and subtracting it from 100% to determine the percentage transformation pressure (Table 16). Based on the results of the calculations it was determined that the Upper Gariep Alluvial Vegetation experienced the highest (100%) transformation pressure and the Eastern Upper Karoo the lowest (1%) or the least transformation pressure (Figure 15.C).

2.4.3 Red Data Fauna sensitivity

The Red Data fauna sensitivity was determined using a similar approach to that of the Red Data flora sensitivity analysis based on habitat preference of the expected species. For a more comprehensive explanation of the approached used, please refer to the relevant fauna report (Kamffer, 2005).

The four separate layers were combined and divided by four to display percentage total ecological sensitivity. The resulting image was reclassified using five classes (Figure 16):

0 – 20%: Very low ecological sensitivity
20 – 40%: Low ecological sensitivity
40 – 60%: Moderate ecological sensitivity
60 – 80%: High ecological sensitivity
80 – 100%: Very high ecological sensitivity

Very high ecological sensitive areas cover less than 1% of the study area (Table 17), while moderate to high ecological sensitive areas cover approximately 60% of the study area.

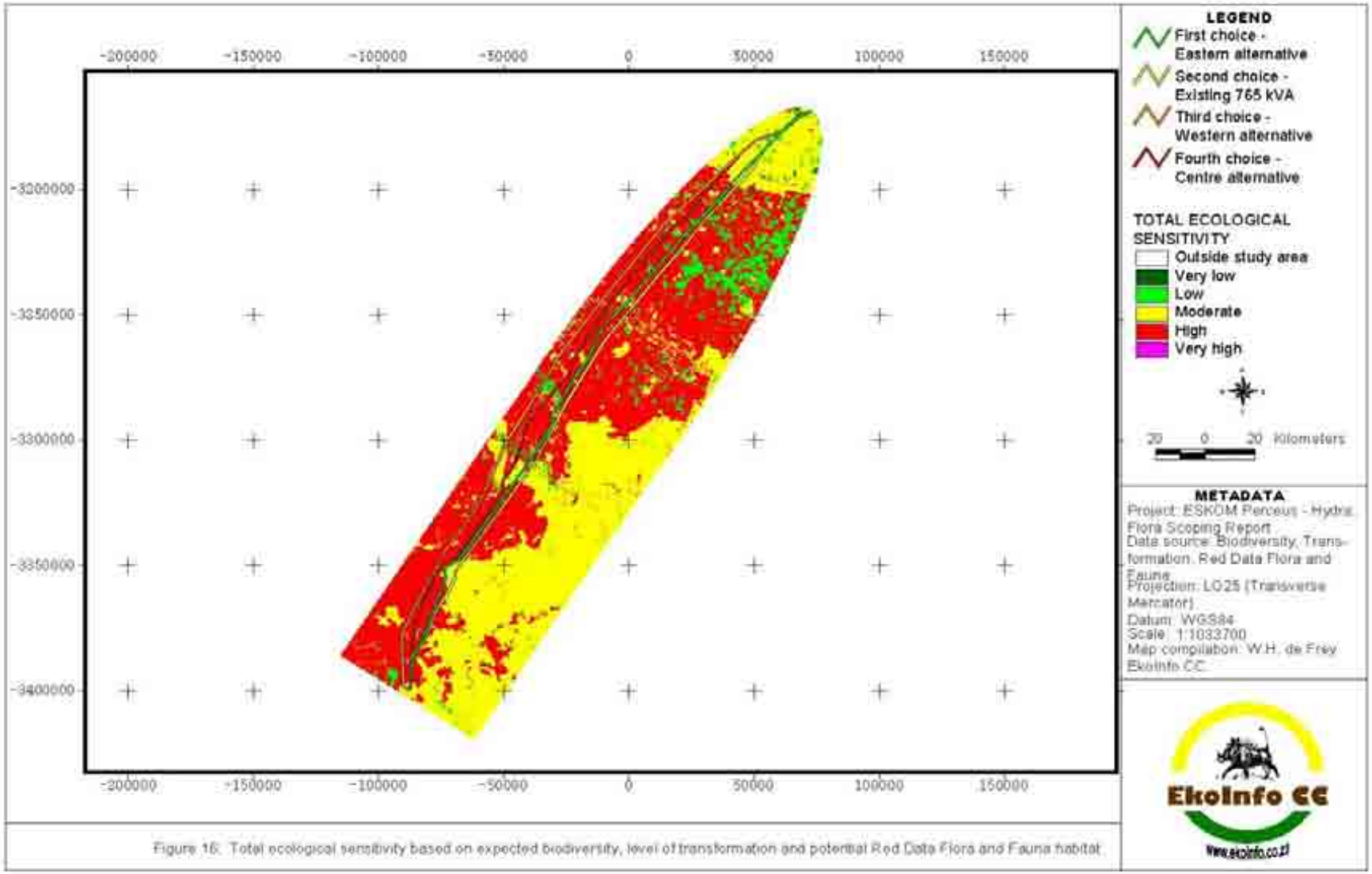

Figure 16: Total ecological sensitivity based on expected biodiversity, level of transformation and potential Red Data Flora and Fauna habitat

Table 17: Percentage extent of total ecological sensitivity classes within the study area

Percentage Total Ecological Sensitivity Intervals	Category	Hectares	% Cover
0 - 20	Very low	3578.392	0.22%
20 - 40	Low	103400.4	6.49%
40 - 60	Moderate	664979.1	41.72%
60 - 80	High	822008.4	51.57%
80 - 100	Very high	91.98438	0.01%
		1594058	

3 IDENTIFICATION OF RISK SOURCES

National Department of Environmental Affairs and Tourism's Integrated Environmental Management Series, document of Ecological Risk Assessment states that:
"Risk in the context of ecological risk assessment and management is defined by the following necessary components:

Subject:

A hazard or stressor that initiates risk, including an exposure pathway ("Affected by what")

Object:

The target (receptor) upon which the stressor or hazard is expected to have an effect ("The effect on what")

Effect:

The type, magnitude and characteristics of the effect being assessed (the response of the receptor given a specific stressor)

Expression of likelihood:

Probability of effect or other expression of expectation appropriate to the assessment"

Based on these criteria the following components of ecological risk assessment associated with the proposed 765Kv power line were identified:

1. Infrastructure associated with the construction of the power line namely
    a. Access roads
    b. Construction camps
    c. Footprint of towers
2. The following components of the flora are considered to be receptors:
    a. The natural vegetation as a whole
    b. Medicinal plants
    c. Red Data flora habitat

Table 18 provides an overview of the stressors, receptors, the expected effect and the expression of likelihood. The expression of likelihood is based on extent of the receptors and historic records of the distribution of relevant species based on quarter degree grids from the PRECIS database.

Although expression of likelihood was kept the same for all three stressors having an influence on the receptors, as the footprint of the stressor decreases the likelihood that the stressor will have an affect will also increases

1. A road of for example of 1 000m length with a 25 m servitude would affect 25 000m²
2. A construction camp would affect approximately 5 000m²
3. The foundation of a single pylon would affect approximately 20m²

Table 18: Summary of ecological risk assessment components with regards to the proposed 765Kv power line

Stressor	Receptor	Effect	Expression of likelihood
a. Access roads	a. The natural vegetation as a whole	Loss of vegetation within the road servitude whether temporary or permanent	The probability of any access road resulting in loss of vegetation is 96% because 96% of the study area is untransformed
	b. Medicinal plants	Destruction of medicinal plants during the preparation of the access roads	The probability of the any access road affecting medicinal plants is 50% as specimens were recorded in 22 of the 42 quarter degree grids which the study area transects
	c. Red Data flora habitat	Destruction of Red Data flora populations associated with potential Red Data flora habitats	The probability of the any access road affecting Red Data plants is 5% as specimens were recorded in 2 of the 42 quarter degree grids which the study area transects
b. Construction camps	a. The natural vegetation as a whole	Loss of vegetation within construction site extent, if located within natural areas or harvesting of firewood from surrounding areas	The probability of any construction camp resulting in loss of vegetation is 96% because 96% of the study area is untransformed
	b. Medicinal plants	Harvesting of medicinal plants to service construction workers at construction sites	The probability of the any construction camp affecting medicinal plants is 50% as specimens were recorded in 22 of the 42 quarter degree grids which the study area transects
	c. Red Data flora habitat	Destruction of Red Data flora populations associated with potential Red Data flora habitats within the construction site extent	The probability of the any construction camp affecting Red Data plants is 5% as specimens were recorded in 2 of the 42 quarter degree grids which the study area transects
c. Footprint of towers	a. The natural vegetation as a whole	Loss of vegetation were the foundations for the pylons will be constructed	The probability of the pylon foundations resulting in loss of vegetation is 96% because 96% of the study area is untransformed
	b. Medicinal plants	Loss of medicinal plants were the foundations for the pylons will be constructed	The probability of the pylon foundations affecting medicinal plants is 50% as specimens were recorded in 22 of the 42 quarter degree grids which the study area transects
	c. Red Data flora habitat	Destruction of Red Data flora populations associated with potential Red Data flora habitats within the pylon foundations area	The probability of the pylon foundations affecting Red Data plants is 5% as specimens were recorded in 2 of the 42 quarter degree grids which the study area transects

4 ENVIRONMENTAL ASSESSMENT

4.1 Major 765 kV lines between Perseus (Dealesville) and Hydra (De Aar)

The results of the total ecological sensitivity assessment (Figure 16) will be used as a basis for the discussion and comparison of each alternative (Table 19).

4.1.1 Western alternative

This is the second most sensitive alternative and therefore the third option in terms of being the preferred alternative (Table 19). Based on its current alignment its servitude will affect all five total ecological sensitivity categories within the study area but the highest percentage of the very low total ecological sensitivity category. It influences the same percentage of the very high total ecological sensitivity category than the proposed centre alternative.

This alternative's average derived total ecological sensitivity is 73.4%. Average derived total ecological sensitivity was calculated as follows: each total ecological sensitivity category's upper limit was translated to a fraction and multiplied with the percentage cover of category along the servitude of the proposed alternative, these averaged values were then summed to calculate the average derived total ecological sensitivity for the proposed alternative eg Very low total ecological sensitivity's upper limit of 2 as a fraction of 100% or 1 namely 0.2 multiplied with its percentage cover of 0.96%, summed with the similar values of the other categories, determine its average derived total ecological sensitivity.

4.1.2 Centre alternative

This is the most sensitive alternative and therefore the fourth option or least preferred alternative. Its current alignment affects the highest percentage of high total ecological sensitive areas as well as the same percentage (0.04%) of very high total ecological sensitive areas than the western alternative.

This alternative's average derived total ecological sensitivity is 73.49%.

4.1.3 Eastern alternative

This is the least sensitive alternative and therefore the first choice or most preferred alternative. Its current alignment does not transect any very high total ecological sensitive areas but does cross the highest percentage (4.69%) of low total ecological sensitive

This alternative's average derived total ecological sensitivity is 72.46%.

Table 19: Overview of total ecological sensitivity per proposed alternative based on percentage coverage of total ecological sensitivity categories within each alternative

Note: Values in **bold** are the highest values per category

Total ecological sensitivity	Proposed alternatives			
	Western	Centre	Eastern	Exst765
Very low	**0.96%**	0.86%	0.75%	0.73%
Low	3.51%	3.29%	**4.69%**	1.19%
Moderate	23.15%	23.44%	26.09%	**28.49%**
High	72.34%	**72.37%**	68.47%	69.59%
Very high	**0.04%**	**0.04%**		
	100.00%	100.00%	100.00%	100.00%
Average derived ecological sensitivity	73.395%	**73.488%**	72.455%	73.390%
	3rd choice	4th choice	1st choice	2nd choice

4.1.4 Existing 765 kV power line

This is the second least sensitive alternative and therefore the second choice or second preferred alternative. Its current proposed alignment affects higher percentages of both the moderate and high total ecological sensitivity categories than the eastern alternative, but less than either the western or centre alternatives.

This alternative's average derived total ecological sensitivity is 73.39%.

4.2 Minor lines from Perseus

The results of the total ecological sensitivity assessment (Figure 17) will be used as a basis for the discussion.

4.2.1 Perseus to Beta link – 765 kV

This study area contains no high to very high sensitivity areas (Table 20). The probability of crossing moderate areas is 97%. Therefore any alignment will avoid high to very high sensitive areas within the study area.

4.2.2 Link between Perseus and the existing 400 kV Beta-Hydra Power Line

This study area contains no high to very high sensitivity areas (Table 21). The probability of crossing moderate areas is 92%. Therefore any alignment will avoid high to very high sensitive areas within the study area.

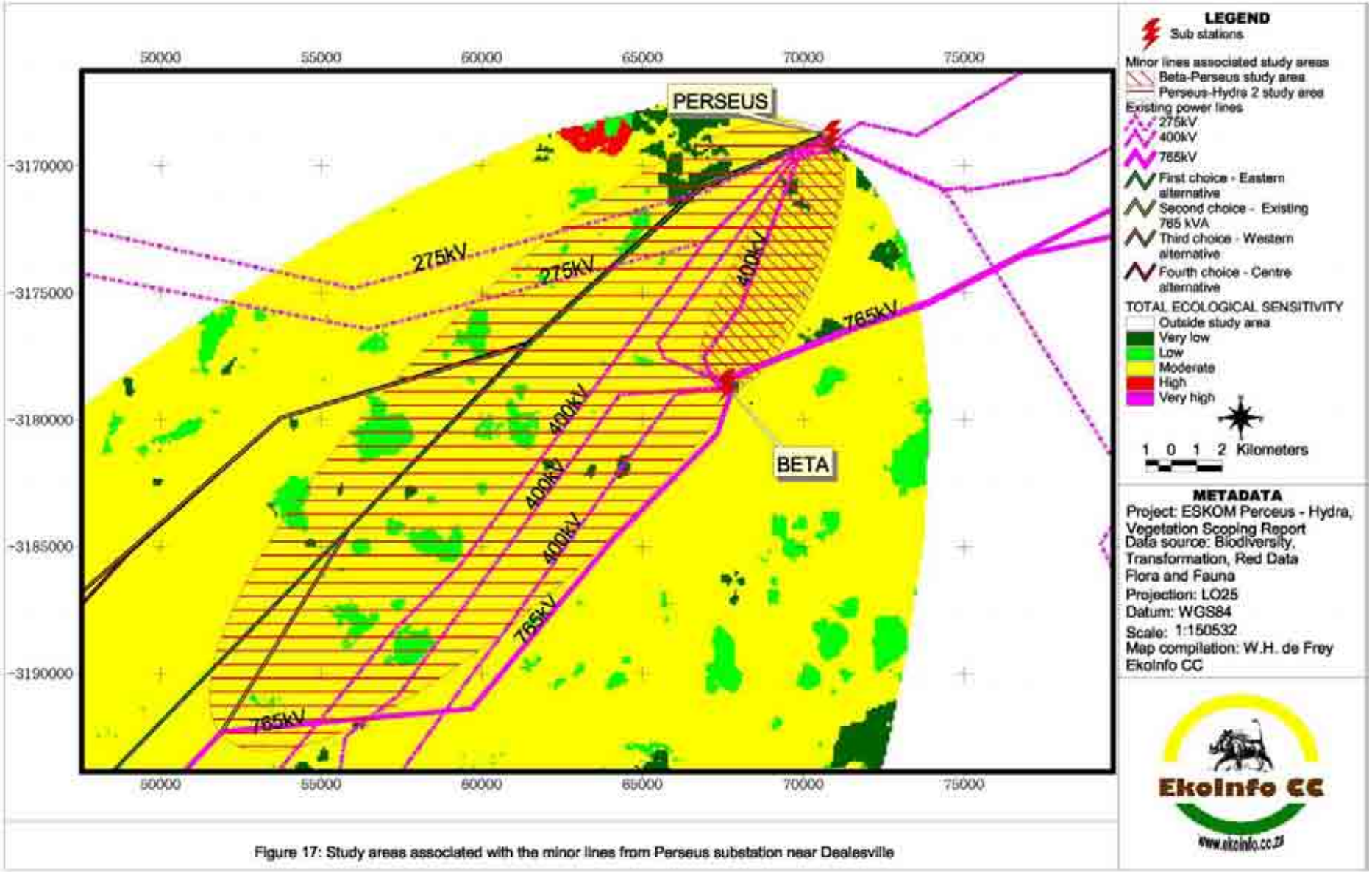

Figure 17: Study areas associated with the minor lines from Perseus substation near Dealesville

Table 20: Percentage cover of total ecological sensitive areas within the Perseus to Beta study area

Total Ecological Sensitivity Status	Hectares	% Cover
Very low	98.98319	3%
Moderate	2847.517	97%
	2946.5	100%

Table 21: Percentage cover of total ecological sensitive areas within the Perseus to 400kV line

Total Ecological Sensitivity Status	Hectares	% Cover
Very low	548.9068074	2%
Low	1749.702938	6%
Moderate	25170.72655	92%
	27469.3363	100%

5 RECOMMENDED MITIGATION MEASURES

Due to the similarity of the four proposed alternatives, which reflects the overall homogenous nature of the study area along the proposed alternatives, the expected impacts (Photo 1 to 4) and proposed mitigation measure will be discussed on a **generic level** for all four proposed alternatives.

5.1 Description and Evaluation of Impacts

5.1.1 Bush clearance

Although the intended *modus operandi* is to use existing roads, the nature of the study area will require bush clearance especially in the vicinity of the perennial rivers. It is also a requirement of the power line that vegetation taller than 4 m should be cleared, which will definitely affect areas along the perennial rivers and in close proximity to tree covered outcrops, although very little of the dominant vegetation within the area which seldom exceeds 1m (2.2 Regional Vegetation). Furthermore a 6 m wide maintenance track is kept clear along the route.

5.1.2 Erosion along access roads and servitude

The soils within vicinity of especially the drainage lines are prone to erosion due to higher percentage clay content (2.1.4 Soil), **especially in areas within the Da -, Db – and Dc soil patterns, which are associated with duplex soils, which are prone to erosion**. The removal of the herbaceous layer (grasses and forbs) and compaction of the soil will intensify the situation.

5.1.3 Red Data Flora habitat destruction

The vegetation assessment had confirmed that Red Data species do occur in the area. Therefore the probability does exist that suitable habitat for Red Data species such as rocky areas (outcrops) and wetlands will be encountered. It should be noticed that rocky areas with indigenous woody (trees and shrubs) species, should especially be avoided.

5.1.4 Construction camp erection

Construction camps are required along the route; the exact size of the camps or number of persons staying there is unknown. These camps consist of temporary constructions and therefore do not involve the excavation of soil but vegetation will have to be removed during the construction activities.

5.1.5 General vegetation degradation

General vegetation degradation results from the lack of infrastructure and facilities. Fire wood collection for cooking and heating especially during the winter months will have a detrimental effect on the vegetation in the vicinity of the construction camps. If the construction camps were located far away from medical facilities, their presence would result in an increase in muti trade (traditional medicine) or the exploitation of medicinal plants. Runaway fires during the wrong time of the year could result in

Photo 1

Photo 2

Photo 3

Photo 4

Photo 1: Bush clearing along the servitude (ESKOM presentation)

Photo 2: Unnecessary bush clearance being avoided across valleys and low-laying areas (ESKOM presentation)

Photo 3: Bush clearance in the vicinity of the towers (ESKOM presentation)

Photo 4: Layout of construction camp (ESKOM presentation)

unwanted physiognomic changes in vegetation, loss of biomass and forage for both game and domestic animals.

5.1.6 Spread of declared weeds and invader species

In terms of the Conservation of Agricultural Resource Act of 1983, a number of forbs and trees were declared as weed and invaders. The distribution and/ or planting of these species are controlled and prohibited. Thirteen species had been recorded in the study area according to the PRECIS dataset (2.4.1 Biodiversity).

The species could potential become a problem along the servitudes, access roads reserves and the areas used for the construction camps.

Table 22: Flora Environmental Impact Assessment

Criteria	Status	Extent and Spatial Scale	Intensity or Severity	Duration	Mitigatory Potential	Acceptability	Degree of Certainty	Magnitude and Significance	
Description of elements that are central to each issue.	Positive, negative or neutral.	Low/Medium/ High.	Low/Medium/ High.	Low (short term)/ Medium (medium term)/ High (long term).	Low/Medium/ High.	Low (Acceptable)/ Medium/ High (Unacceptable).	Unsure/ Possible/ Probable/ Definite.	No impact/ Low/ Medium/ High.	Mitigation measure
Bush clearance for access roads, the servitude and tower erection	Negative	Low	High	Medium	Medium	Low	Definite	Medium	Avoid wooded areas and keep to existing transformed areas (cultivated land, plantations)
Erosion along access roads and servitude	Negative	Medium	High	Permanent	High	Medium	Probable	Medium	Avoid steep areas (5 deg or more), construct roads according civil requirements, prevent overloading, wheelspinning or getting stuck, prohibit unnecessary off-road driving
Red Data Flora Habitat destruction	Negative	Low	High	Permanent	Medium	Medium	Probable	Medium	Avoid where possible rocky areas and wetlands. If crossing of these potential sites cannot be avoided, have presence of Red Data species verified by regional specialist, especially in very high sensitive areas
Construction camp erection – would require removal of vegetation	Negative	Low	High	Medium	High	Medium	Definite	Medium	Consider use of existing infrastructure (hotels, hostels, military basis) or limit to transformed areas (cultivated land, plantations). If these options are not available or viable, the absence of Red Data flora has to be verified by a regional specialist
General vegetation degradation – fire wood removal, harvesting of medicinal plants, run away fires, oil and diesel spills	Negative	Medium	Medium	Medium	High	Medium	Probable	Medium	Construction camps should be provided with or have electricity for cooking and heating. If not practical then wood from the bush clearance activities and removal of vegetation should be used for cooking and heating. Contractors and their workmen should be officially informed that it is illegal to remove any plants from nature without a permit or the land owners written consent. Maintenance on construction vehicles and equipment should occur in dedicated areas with the necassary prevetative measures taken
Spread of declared weeds and invaders	Negative	Medium	Medium	Medium	High	Medium	Probable	Medium	The spread of the species should be prevented. If wood of these species are transported for cooking and heating, the wood should be free of seed

5.2 Mitigatory Measures

5.2.1 Bush clearance

Avoid wooded areas; keep to existing transformed areas (cultivated land, plantations)

5.2.2 Erosion along access roads and servitude

Avoid steep areas (5° or more), construct roads according civil requirements, in steep areas use required preventative measures, prevent overloading, wheelspinning or getting stuck of construction vehicles. Prohibit unnecessary off-road driving

5.2.3 Red Data Flora habitat destruction

Avoid where possible rocky areas (with or without woody cover) and wetlands. If crossing of these potential sites cannot be avoided, have the presence of Red Data species verified by regional specialist, especially in very high sensitive areas

5.2.4 Construction camp erection

Consider use of existing infrastructure (hotels, hostels, military basis) or limit to transformed areas (cultivated land, plantations). If these options are not available or viable, the absence of Red Data flora has to be verified by a regional specialist.

5.2.5 General vegetation degradation

Construction camps should be provided with or have electricity for cooking and heating. If not practical then wood from the bush clearance activities and removal of vegetation should be used for cooking and heating. Contractors and their workmen should be officially informed that it is illegal to remove any plants from nature without a permit or the landowners written consent. Maintenance on construction vehicles and equipment should occur in dedicated areas with the necessary preventative measures taken

5.2.6 Spread of declared weeds and invaders

The spread of the species should be prevented. If wood from these species is transported for cooking and heating, the wood should be free of seed.

6 CONCLUSIONS AND RECOMMENDATIONS

The literature review confirmed to a large extent, observations made during the field trip that the study area is to a large extent very homogenous**, with the expected impact of the proposed 765 kV power line being very limited irrespective of any alignment**. Inspection of photographs (Photo 5 to 8) taken from the helicopter during the field trip in the vicinity of existing power lines in the area supports this statement.

The literature review did highlight the sensitivity of the alluvial fans, pans, drainage lines and outcrops within the study area as well as the catastrophic nature of rainfall with this arid environment. Therefore it is recommended that the alignment of the proposed power line should avoid areas where pans and outcrops, which support alluvial fans, are closer than 10 km of one another (Figure 17). Such a precautionary approach will reduce the probability that:

1. Infrastructure associated with the construction and maintenance of the power line will be affected by flash floods
2. Infrastructure associated with the construction and maintenance of the power line will influence the ecological processes within these areas, specific issues are:
    a. Alteration of historic flow patterns
    b. Restriction of historic flow patterns
    c. Accelerate flow within these areas which could lead to erosion and habitat destruction

In conclusion, the results of the field trip and literature review supports ESKOM's approach to keep the power lines along the western side of the study area, even though ESKOM's decision is based on technical reasons rather than environmental perspective. From an environmental perspective, the eastern side of the study area is more rugged due to the presence of hills (Figure 4.B), presenting more topographic variety and therefore more habitat for a larger variety of species whether flora or fauna. In addition the Red Data flora assessment indicated that the outcrops (hills) within the study area are suitable habitat for at least seven species. Drainage lines (wetlands) and areas associated with duplex soils should be treated as sensitive, failure to comply will represent a contravention of both the National Water Act and the Conservation of Agricultural Resources Act.

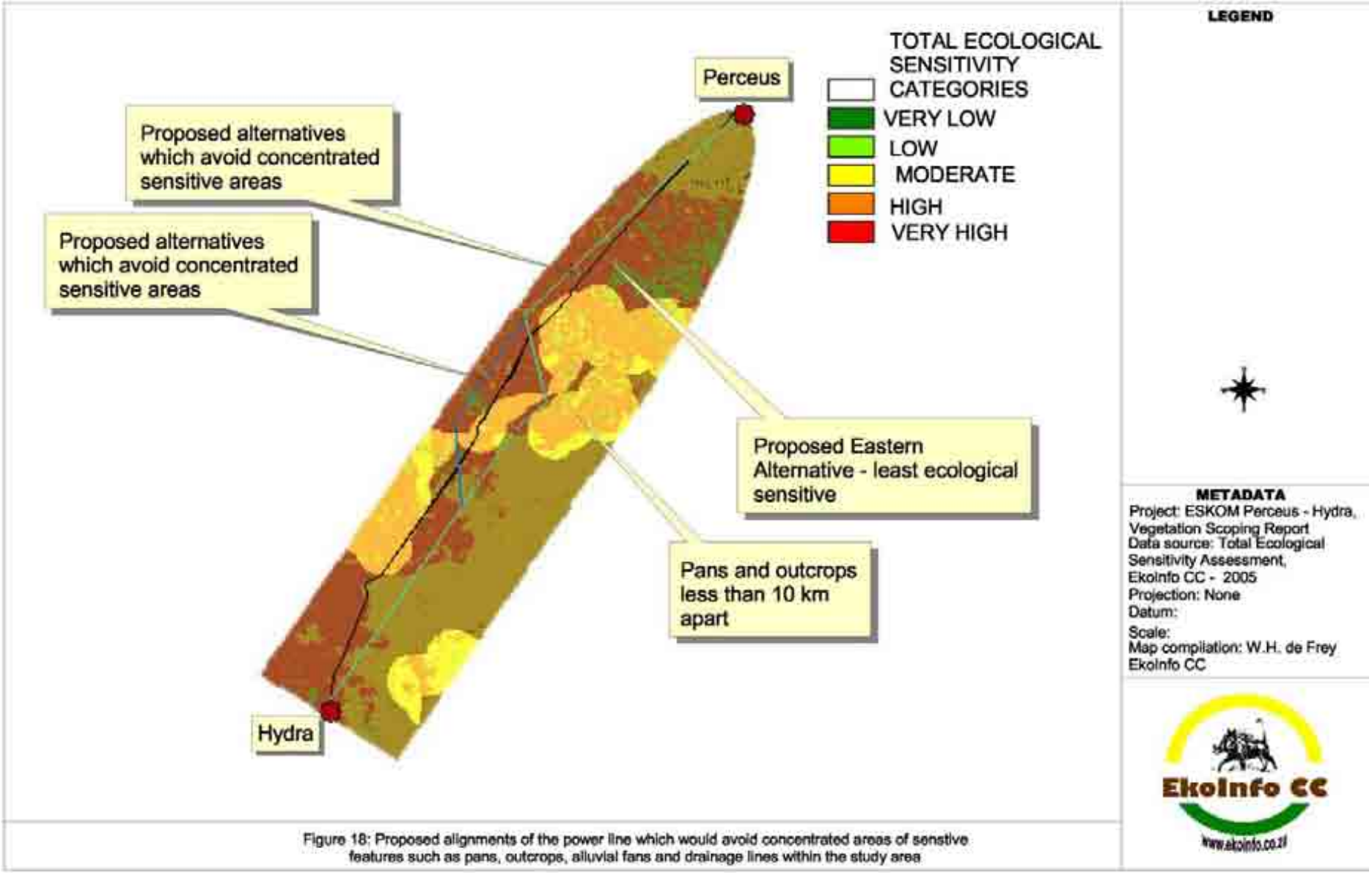

Figure 18: Proposed alignments of the power line which would avoid concentrated areas of senstive features such as pans, outcrops, alluvial fans and drainage lines within the study area

Photo 5

Photo 6

Photo 7

Photo 8

Photo 5: Substation and power lines at Dealesville in the Grassland Biome

Photo 6: Status of vegetation under existing servitude within the Grassland Biome

Photo 7: Status of vegetation under existing servitude within the Nama Karoo Biome

Photo 8: Substation and power lines at De Aar in the Nama Karoo Biome

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8 APPENDIX A - THREATENED RED DATA FLORA FROM BOTH PROVINCES

Note: Seven species in **bold** are those expected to occur within the study area along proposed alternatives depending on suitable habitat present

Taxon	Frequency	Family	Hilton-Taylor 1996	Victor 2002	Summary	SA Endemic	Rarity	Growth form	Plant height (m)	Altitude (m)	Flower period
Acanthosicyos horridus Welw. ex Hook.f.	1	Cucurbitaceae	nt	VU D2	Threatened			Shrub, ,	0,5-1m	25-150m	
Aloe buhrii Lavranos	1	Asphodelaceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, herb,	0.3-0.7m	900-1700m	Aug - Oct
Aloe chlorantha Lavranos	1	Asphodelaceae	E	EN B1B2e	Threatened	Endemic	Rare	Dwarf shrub, herb,	0.5-1m	1250-1450m	October
Aloe comosa Marloth & A.Berger	1	Asphodelaceae	R	VU B1B2c	Threatened	Endemic	Rare	Tree, ,	1-2m	300-650m	Dec-Jan
Aloe dabenorisana Van Jaarsv.	1	Asphodelaceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	Up to 300mm	900-1000m	Aug-Nov
Aloe khamiesensis Pillans	1	Asphodelaceae	Not listed	VU B1B2e	Threatened	Endemic		Shrub, ,	0.5-2m	75-1450m	June - July
Aloe meyeri Van Jaarsv.	1	Asphodelaceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	0.3m	300-1200m	Dec-Feb
Aloe pearsonii Schönland	1	Asphodelaceae	V	EN B1B2abce	Threatened	Endemic		Shrubs, ,	1-2m	300-1550m	Dec - Jan
Aloe pillansii L.Guthrie	1	Asphodelaceae	E	CR A2ace	Threatened	Endemic		Tree, ,	8-12m	250-1000m	October
Aloe polyphylla Schönland ex Pillans	1	Asphodelaceae	E	NE	Threatened			Shrub, dwarf shrub,	0.3-1.2m	2000-2440m	Sep-Oct
Aloe ramosissima Pillans	1	Asphodelaceae	V	VU A1ce	Threatened	Endemic		Shrubs/Tree, ,	2-3 m		June -Aug
Aloe striata Haw. subsp. komaggasensis (Kritzinger & Van Jaarsv.) Glen & D.S.Hardy	1	Asphodelaceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	0.3-1m	500-750m	Dec-Jan
Amaryllis paradisicola Snijman	1	Amaryllidaceae	Not listed	VU D2	Threatened	Endemic		Geophyte, ,	500-800mm	550m	
Anacampseros filamentosa (Haw.) Sims subsp. filamentosa	2	Portulacaceae	R/V	NE	Threatened	Endemic		Herb, ,	0.03-0.07m	350-1600m	Oct - Jan
Athanasia spathulata (DC.) D.Dietr.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Shrub, ,	Up to 0.5m	670-840m	
Brachystelma dimorphum R.A.Dyer subsp. gratum R.A.Dyer	1	Apocynaceae	I	VU D2	Threatened	Endemic		Geophyte, ,	10-50mm	1200-1400m	
Brunsvigia herrei F.M.Leight. ex W.F.Barker	1	Amaryllidaceae	R	VU B1B2e	Threatened		Rare	Geophyte, ,	250-400mm	650-1000m	March.
Brunsvigia radula Aiton	1	Amaryllidaceae	Not listed	EN A2c	Threatened	Endemic		Geophyte, ,	80-120mm	100m	Feb-April
Carex acocksii C.Archer	1	Cyperaceae	Not listed	VU D2	Threatened	Endemic		Herb, cyperoid, mesophyte	Up to 0.46m	?-1580m	
Cephalophyllum fulleri L.Bolus	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	0.06m	Up to 450m	
Cephalophyllum tetrastichum H.E.K.Hartmann	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.1m	10-200m	
Ceropegia occidentalis R.A.Dyer	1	Apocynaceae	V	DD	Threatened	Endemic		Succulent climber, ,	20-200mm	5-1200m	
Cheiridopsis pearsonii N.E.Br.	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.05m	1200-1700m	
Cheiridopsis peculiaris N.E.Br.	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.04m	600-1000m	Aug-Sep
Cheiridopsis umdausensis L.Bolus	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.08m	600-1120m	
Coelidium obtusilobum Granby	1	Fabaceae	E	NE	Threatened			Dwarf shrub, ,	? - 0.3m		
Conophytum achabense S.A.Hammer	1	Mesembryanthemaceae	R	VU D2	Threatened	Endemic	Rare	Succulent, ,	Up to 0.01m	1050-1160m	
Conophytum auriflorum Tischer subsp. turbiniforme (Rawé) S.A.Hammer	1	Mesembryanthemaceae	Not listed	VU D2	Threatened	Endemic		Succulent, ,	Up to 0.02m	540-860m	
Conophytum burgeri L.Bolus	1	Mesembryanthemaceae	V	VU D2	Threatened	Endemic		Succulent, ,	Up to 0.03m	1050-1100m	
Conophytum herreanthus S.A.Hammer subsp. herreanthus	1	Mesembryanthemaceae	E	CR A1acdB1B2abceC2bD1	Threatened	Endemic		Succulent, ,	Up to 0.1m	780m	
Conophytum phoeniceum S.A.Hammer	1	Mesembryanthemaceae	Not listed	VU D2	Threatened	Endemic		Succulent, ,	Up to 0.01m	700-800m	
Conophytum roodiae N.E.Br. subsp. sanguineum (S.A.Hammer) T.C.Smale	1	Mesembryanthemaceae	Not listed	VU D2	Threatened	Endemic		Succulent, ,	Up to 0.03m	780-1250m	
Conophytum schlechteri Schwantes	1	Mesembryanthemaceae	R	VU D2	Threatened	Endemic	Rare	Succulent, ,	Up to 0.05m	700-1050m	
Conophytum smorenskaduense de Boer subsp. hermarium S.A.Hammer	1	Mesembryanthemaceae	E	VU D2	Threatened	Endemic		Succulent, ,	Up to 0.04m	1000-1190m	
Conophytum smorenskaduense de Boer subsp. smorenskaduense	1	Mesembryanthemaceae	R	VU D2	Threatened	Endemic	Rare	Succulent, ,	Up to 0.02m	1000-1190m	
Conophytum vanheerdei Tischer	1	Mesembryanthemaceae	R	VU D2	Threatened	Endemic	Rare	Succulent, ,	Up to 0.04m	850-1200m	
Cotula loganii Hutch.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Herb, ,	0.03m		
Crassula brevifolia Harv. subsp. psammophila Toelken	1	Crassulaceae	R/V	NE	Threatened	Endemic		Dwarf shrub, succulent,	0.2m	20-300m	
Crassula plegmatoides Friedrich	1	Crassulaceae	R/V	NE	Threatened			Herb, succulent,	0.15m	100-300m	March-April
Cynanchum virens D.Dietr.	1	Apocynaceae	V	NE	Threatened			Herb, climber,	0.5-2m	1200-2000m	Nov - Feb
Daubenya aurea Lindl.	1	Hyacinthaceae	V	NE	Threatened	Endemic		Geophyte, ,	Up to 0.05m	1500m	July-Aug

Taxon	Frequency	Family	Hilton-Taylor 1996	Victor 2002	Summary	SA Endemic	Rarity	Growth form	Plant height (m)	Altitude (m)	Flower period
Diascia lewisiae K.E.Steiner	1	Scrophulariaceae	V	NE	Threatened	Endemic		Herb, ,	0.14-0.28m	730-840m	
Dinteranthus vanzylii (L.Bolus) Schwantes	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.02m	870-930m	
Disa macrostachya (Lindl.) Bolus	1	Orchidaceae	Not listed	VU D2	Threatened	Endemic		Herb, geophyte,	Up to 0.3m	?-1500m	
Disperis purpurata Rchb.f. subsp. pallescens Bruyns	1	Orchidaceae	R	VU D2	Threatened	Endemic	Rare	Herb, geophyte,	0.045-0.14m	?-1350m	
Dregeochloa pumila (Nees) Conert	1	Poaceae	V	NE	Threatened			Graminoid, ,	0.04-0.07m	50-200m	
Ectadium virgatum E.Mey.	1	Apocynaceae	Not listed	VU D2	Threatened			Shrub, ,	Up to 3m	70-200m	
Encephalartos ghellinckii Lem.	1	Zamiaceae	V	NE	Threatened	Endemic		Tree, shrub,	0.5-2.1m	600-2000m	
Euphorbia albertensis N.E.Br.	1	Euphorbiaceae	R/V	NE	Threatened	Endemic		Dwarf shrub, succulent,	0.05-0.1m	1450-1550m	
Euphorbia cylindrica A.C.White, R.A.Dyer & B.Sloane	1	Euphorbiaceae	V	NE	Threatened	Endemic		Shrub, succulent,	0.2-0.5m	1325-1675m	
Euphorbia oxystegia Boiss.	1	Euphorbiaceae	V/E	NE	Threatened	Endemic		Dwarf shrub, succulent,	0.2-0.5m	700-800m	
Euryops mirus B.Nord.	1	Asteraceae	V	VU D2	Threatened	Endemic		Shrub, ,	Up to 0.25m	600-1000m	
Euryops pleiodontus B.Nord.	1	Asteraceae	I	VU D2	Threatened	Endemic		Dwarf shrub, ,	Up to 0.2m	600-900m	
Euryops rosulatus B.Nord.	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Shrub, ,	Up to 0.25m	550-700m	
Euryops subcarnosus DC. subsp. minor B.Nord.	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Shrub, ,	Up to 1.5m	900-1200m	
Euryops virgatus B.Nord.	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	0.2-0.5m	600-900m	
Felicia deserti Schltr. ex Grau	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Shrub, ,	Up to 0.2m	300-500m	
Felicia diffusa (DC.) Grau subsp. khamiesbergensis Grau	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	Up to 0.25m	1200-1400m	
Geissorhiza splendidissima Diels	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.08-0.2m		
Gethyllis lata L. Bolus subsp. lata	1	Amaryllidaceae	Not listed	VU D2	Threatened	Endemic		Geophyte, ,	30-40mm	700m	
Gethyllis lata L. Bolus subsp. orbicularis D. Mull.-Doblies	1	Amaryllidaceae	Not listed	VU D2	Threatened	Endemic		Geophyte, ,	30-40mm		
Gethyllis latifolia Masson ex Baker	1	Amaryllidaceae	Ex	DD	Threatened	Endemic		Geophyte, ,	120mm		
Gethyllis pectinata D. Mull.-Doblies	1	Amaryllidaceae	Not listed	CR B1+2abce C2b	Threatened	Endemic		Geophyte, ,	75mm	800m	
Gladiolus lapeirousioides Goldblatt	1	Iridaceae	E	NE	Threatened	Endemic		Herb, geophyte,	0.08-0.15m		Mid-August to end September
Gladiolus mostertiae L.Bolus	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.15-0.3m		Mid Nov to Mid Dec
Haemanthus graniticus Snijman	1	Amaryllidaceae	R	VU B1B2abc	Threatened	Endemic	Rare	Geophyte, ,	250mm	600-1150m	
Haemanthus namaquensis R.A.Dyer	1	Amaryllidaceae	R	VU B1B2e	Threatened	Endemic	Rare	Geophyte, ,	200mm	300-900m	
Haworthia nortieri G.G.Sm. var. globosiflora (G.G.Sm.) M.B.Bayer	1	Asphodelaceae	V	NE	Threatened	Endemic		Succulent, ,	45-250mm	1000-1500m	
Helichrysum haygarthii Bolus	1	Asteraceae	I	VU D2	Threatened	Endemic		Dwarf shrub, ,	0.03-0.05m	2000-2230m	
Hessea pusilla Snijman	1	Amaryllidaceae	R	VU D2	Threatened	Endemic	Rare	Geophyte, ,	120mm	800m	
Hessea tenuipedicellata Snijman	1	Amaryllidaceae	V	VU D2	Threatened	Endemic		Geophyte, ,	150mm	550m	
Hypoxis uniflorata Mark.	1	Hypoxidaceae	Not listed	VU D2	Threatened	Endemic		Geophyte, ,	40-60mm	1200-1500m	
Jamesbrittenia incisa (Thunb.) Hilliard	1	Scrophulariaceae	V	NE	Threatened	Endemic		Dwarf shrub, ,	Up to 0.3m	1190-1610m	
Jordaaniella uniflora (L.Bolus) H.E.K.Hartmann	1	Mesembryanthemaceae	R/V	NE	Threatened	Endemic		Succulent, ,	Up to 0.08m	10-100m	
Lachenalia duncanii W.F.Barker	1	Hyacinthaceae	V	NE	Threatened	Endemic		Geophyte, ,	0.15-0.18m		
Lachenalia minima W.F.Barker	1	Hyacinthaceae	E	NE	Threatened	Endemic		Geophyte, ,	0.02-0.17m		
Lasiopogon minutus (B.Nord.) Hilliard & B.L.Burtt	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Herb, ,	0.015-0.04m		
Lithops comptonii L.Bolus	1	Mesembryanthemaceae	E	NE	Threatened	Endemic		Succulent, ,	Up to 0.03m	800-1550m	
Lithops divergens L.Bolus	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.02m	380-1100m	
Lithops dorotheae Nel	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.02m	1050-1160m	
Lithops salicola L.Bolus	2	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.02m	1000-1350m	
Mitrophyllum roseum L.Bolus	1	Mesembryanthemaceae	R/V	NE	Threatened	Endemic		Succulent, ,	Up to 0.15m	540-700m	
Moraea flexuosa Goldblatt	1	Iridaceae	E	NE	Threatened			Herb, geophyte,	0.06-0.1m		
Moraea longiflora Ker Gawl.	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.05-0.1m	1200m	
Namaquanula bruce-bayeri D. & U. Mull.-Doblies	1	Amaryllidaceae	V	VU B1+2b,c	Threatened			Geophyte, ,	75-100mm	100m	
Neohenricia sibbettii (L.Bolus) L.Bolus	2	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.01m	1120-1380m	
Otholobium argenteum (Thunb.) C.H.Stirt.	1	Fabaceae	V	NE	Threatened	Endemic		Resprouting subshrub, ,	Up to 1m		
Otholobium bolusii (H.M.L.Forbes) C.H.Stirt.	1	Fabaceae	V	NE	Threatened	Endemic		Shrublet, ,	Up to 0.4m	30-1000m	

Taxon	Frequency	Family	Hilton-Taylor 1996	Victor 2002	Summary	SA Endemic	Rarity	Growth form	Plant height (m)	Altitude (m)	Flower period
Othonna cacalioides L.f.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Shrub, geophyte, succulent	0.02-0.08m	750-920m	July to Oct
Othonna cakilifolia DC.	1	Asteraceae	R/V	VU D2	Threatened	Endemic		Herb, geophyte, succulent	0.05-0.4m	300-440m	
Othonna hallii B.Nord.	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Dwarf shrub, geophyte, succulent	0.1-0.25m	815m	
Othonna lepidocaulis Schltr.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Dwarf shrub, succulent,	0.15-0.25m	600m	
Othonna rechingeri B.Nord.	1	Asteraceae	R/V	VU D2	Threatened	Endemic		Herb, geophyte, succulent	0.1-0.3m	670m	
Othonna spinescens DC.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Shrub, ,			
Pachypodium namaquanum (Wyley ex Harv.) Welw.	1	Apocynaceae	V	NE	Threatened			Succulent, ,	1-3m	244-1060m	July to Sep
Prionanthium dentatum (L.f.) Henrard	1	Poaceae	V	NE	Threatened	Endemic		Graminoid, ,	0.03-0.43m	300-700m	
Psoralea glaucescens Eckl. & Zeyh.	1	Fabaceae	V	NE	Threatened	Endemic		Shrub, ,	Up to 2m	760-1260m	
Pteronia pillansii Hutch.	1	Asteraceae	K	VU D2	Threatened	Endemic	Rare	Dwarf shrub, ,	0.3-0.45m		
Romulea amoena Schltr. ex Bég.	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.05-0.2m	800-850m	Aug-Sep
Romulea membranacea M.P.de Vos	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.1-0.15m	800-1500m	July-Aug
Romulea neglecta (Schult.) M.P.de Vos	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.15-0.3m	1500m	Aug-Sep
Romulea toximontana M.P.de Vos	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.1-0.25m	800m	Aug-Sep
Romulea unifolia M.P.de Vos	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.15-0.3m	1000-1500m	
Schwantesia borcherdsii L.Bolus	1	Mesembryanthemaceae	V	NE	Threatened	Endemic		Succulent, ,	Up to 0.15m	700-950m	
Sparaxis elegans (Sweet) Goldblatt	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.1-0.3m	700-765m	
Sparaxis tricolor (Schneev.) Ker Gawl.	1	Iridaceae	V	NE	Threatened	Endemic		Herb, geophyte,	0.1-0.25m		
Spiloxene umbraticola (Schltr.) Garside	1	Hypoxidaceae	K	VU B1B2abcd	Threatened	Endemic	Rare	Geophyte, ,	60-230mm	450-680m	
Stapelia rubiginosa Nel	1	Apocynaceae	R/V	NE	Threatened	Endemic		Succulent, ,	0.15-0.3m	200-800m	
Stapeliopsis neronis Pillans	1	Apocynaceae	E	NE	Threatened			Succulent, ,	0.05-0.15m	200-1200m	
Strumaria aestivalis Snijman	1	Amaryllidaceae	R	VU D2	Threatened	Endemic	Rare	Geophyte, ,	60-100mm	950m	
Strumaria perryae Snijman	1	Amaryllidaceae	R	VU D2	Threatened	Endemic	Rare	Geophyte, ,	100-250mm	800m	
Strumaria unguiculata (W.F.Barker) Snijman	1	Amaryllidaceae	V	VU D2	Threatened	Endemic		Geophyte, ,	100-350mm	180m	
Tridentea pachyrrhiza (Dinter) L.C.Leach	1	Apocynaceae	R/V	NE	Threatened			Succulent, ,	10-30mm	5-50m	
Tromotriche herrei (Nel) Bruyns	1	Apocynaceae	R/V	NE	Threatened	Endemic		Succulent, ,	0.15-0.3m	500-700m	
Tylecodon singularis (R.A.Dyer) Toelken	1	Crassulaceae	E	NE	Threatened			Geophyte, succulent,	0.05-0.15m	800-1100m	
Vellereophyton lasianthum (Schltr. & Moeser) Hilliard	1	Asteraceae	R	VU D2	Threatened	Endemic	Rare	Herb, prostate,	Up to 0.15m	1500-2500m	
Xiphotheca canescens (Thunb.) A.L.Schutte & B.-E.van Wyk	1	Fabaceae	V	NE	Threatened	Endemic		Shrub, ,	1-2m	?-820m	

9 APPENDIX B – NO OF PLANT FAMILIES RECORDED WITHIN THE STUDY AREA

Family	No of species	% of total species	Cumulative %
Asteraceae	167	15%	15%
Poaceae	150	13%	28%
Mesembryanthemaceae	58	5%	33%
Fabaceae	53	5%	37%
Scrophulariaceae	50	4%	42%
Hyacinthaceae	44	4%	45%
Chenopodiaceae	32	3%	48%
Apocynaceae	29	3%	51%
Solanaceae	27	2%	53%
Euphorbiaceae	27	2%	55%
Crassulaceae	22	2%	57%
Cyperaceae	22	2%	59%
Iridaceae	21	2%	61%
Aizoaceae	20	2%	63%
Brassicaceae	20	2%	65%
Sterculiaceae	19	2%	66%
Lamiaceae	16	1%	68%
Asphodelaceae	14	1%	69%
Convolvulaceae	14	1%	70%
Boraginaceae	12	1%	71%
Malvaceae	12	1%	72%
Molluginaceae	12	1%	73%
Anacardiaceae	11	1%	74%
Portulacaceae	10	1%	75%
Acanthaceae	10	1%	76%
Zygophyllaceae	10	1%	77%
Amaranthaceae	10	1%	78%
Geraniaceae	10	1%	78%
Caryophyllaceae	10	1%	79%
Pottiaceae	9	1%	80%
Apiaceae	9	1%	81%
Amaryllidaceae	9	1%	82%
Polygalaceae	8	1%	82%
Cucurbitaceae	8	1%	83%
Thymelaeaceae	7	1%	84%
Asparagaceae	7	1%	84%
Verbenaceae	7	1%	85%
Santalaceae	7	1%	85%
Lobeliaceae	6	1%	86%
Colchicaceae	6	1%	87%
Capparaceae	6	1%	87%
Campanulaceae	6	1%	88%
Rubiaceae	6	1%	88%
Ranunculaceae	6	1%	89%
Gentianaceae	5	0%	89%

Family	No of species	% of total species	Cumulative %
Oxalidaceae	5	0%	89%
Pedaliaceae	5	0%	90%
Commelinaceae	5	0%	90%
Polygonaceae	5	0%	91%
Ricciaceae	5	0%	91%
Tiliaceae	4	0%	92%
Bryaceae	4	0%	92%
Ebenaceae	4	0%	92%
Pteridaceae	4	0%	93%
Alliaceae	3	0%	93%
Nyctaginaceae	3	0%	93%
Juncaceae	3	0%	93%
Marsileaceae	3	0%	94%
Hypoxidaceae	3	0%	94%
Orobanchaceae	3	0%	94%
Orchidaceae	3	0%	94%
Plantaginaceae	2	0%	95%
Resedaceae	2	0%	95%
Celastraceae	2	0%	95%
Bignoniaceae	2	0%	95%
Rhamnaceae	2	0%	95%
Onagraceae	2	0%	95%
Buddlejaceae	2	0%	96%
Dracaenaceae	2	0%	96%
Papaveraceae	2	0%	96%
Funariaceae	2	0%	96%
Exormothecaceae	2	0%	96%
Melianthaceae	2	0%	97%
Hydrocharitaceae	2	0%	97%
Eriospermaceae	2	0%	97%
Urticaceae	2	0%	97%
Ptychomitriaceae	1	0%	97%
Zannichelliaceae	1	0%	97%
Viscaceae	1	0%	97%
Vahliaceae	1	0%	97%
Aytoniaceae	1	0%	97%
Aponogetonaceae	1	0%	98%
Anthericaceae	1	0%	98%
Aspleniaceae	1	0%	98%
Sapindaceae	1	0%	98%
Rosaceae	1	0%	98%
Ruppiaceae	1	0%	98%
Araliaceae	1	0%	98%
Salicaceae	1	0%	98%
Tecophilaeaceae	1	0%	98%
Dipsacaceae	1	0%	98%
Hymenophyllaceae	1	0%	98%
Lythraceae	1	0%	99%
Grimmiaceae	1	0%	99%

Family	No of species	% of total species	Cumulative %
Gisekiaceae	1	0%	99%
Meliaceae	1	0%	99%
Frankeniaceae	1	0%	99%
Flacourtiaceae	1	0%	99%
Phytolaccaceae	1	0%	99%
Elatinaceae	1	0%	99%
Proteaceae	1	0%	99%
Dicranaceae	1	0%	99%
Oleaceae	1	0%	99%
Ophioglossaceae	1	0%	99%
Combretaceae	1	0%	100%
Hypericaceae	1	0%	100%
Celtidaceae	1	0%	100%
Pittosporaceae	1	0%	100%
Potamogetonaceae	1	0%	100%
Myrsinaceae	1	0%	100%