BASELINE STUDY: VERTEBRATE FAUNA AND FLORA ASSOCIATED WITH THE KARIBIB PROJECT HELIKON & RUBICON (ML 204) – KARIBIB AREA

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Vertebrate fauna associated with the Helikon & Rubicon Lithium Project in ML 204 – Karibib area

1 Introduction

This April 2020 updated report is based on a desktop study (i.e. literature review) was conducted between 25 and 28 May 2017 on the vertebrate fauna (e.g. reptiles, amphibians, mammals and birds) and flora (larger trees and shrubs and grasses) expected to occur in the general Karibib area. This was followed by a rapid site assessment between 29 and 31 May 2017 to determine actual vertebrate fauna and flora (including unique habitats) at the proposed development areas. The aim was to determine the vertebrate fauna and flora potentially impacted should active mining operations proceed in the vicinity of the old Helikon and Rubicon mining areas (Figures 1 and 2).

This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general Karibib area and commonly referred to as the Semi-desert Savannah and Transition Zone [Escarpment area] (Giess 1971, Van der Merwe 1983) or the areas referred to by Mendelsohn *et al.* (2002) as the Western Highlands. This semi-desert and savannah transition zone as referred to by Giess (1971) is typified by shrubs ("fodder bushes") such as *Blepharis pruinosa*, *Leucosphaera bainesii* and *Monechma genistifolia*. Larger woody species such as *Acacia erioloba* are confined to the drainage lines. The Karibib area is characterised by *A. senegal* shrubs while *Cyphostemma currorii* and *C. bainesii* also occur in this region. The trees common in the area are *Commiphora glaucescens*, *C. virgata* and *C. dinteri* as well as *Boscia albitrunca* and *B. foetida*. The grass cover is sparse and consists of the climax grasses *Stipagrostis obtusa* and *S. uniplumis* (Giess 1971).

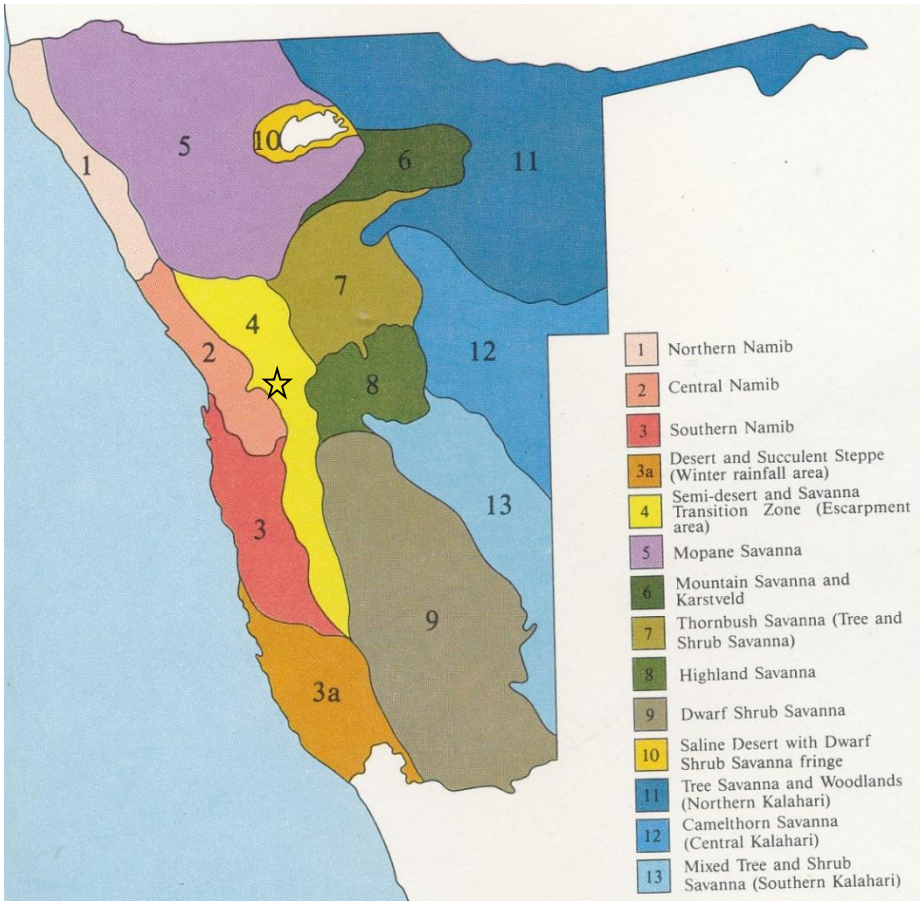

Figure 1. The Helikon and Rubicon Lithium area falls within the Semi-desert and Savanna Transition Zone vegetation type – See black star (Giess 1971).

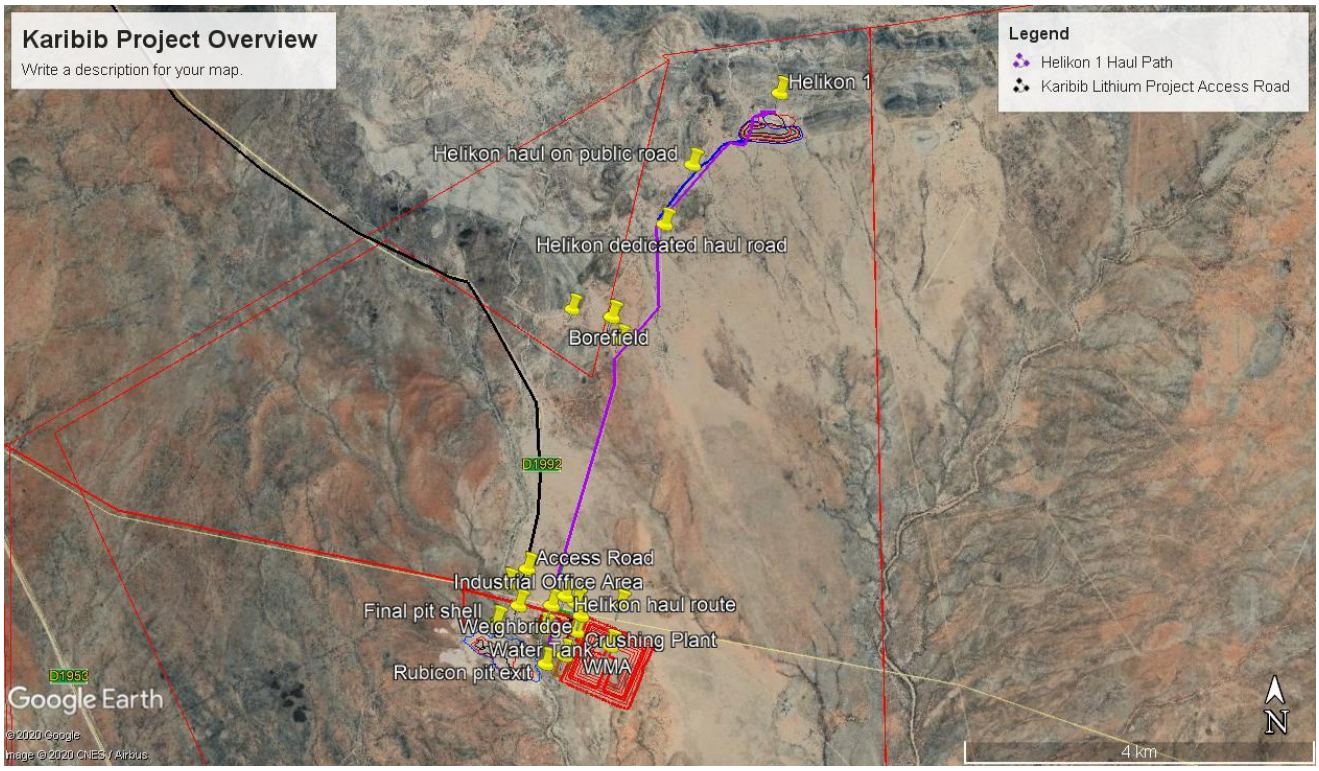

Figure 2. Overview of the key targets within the ML 204 with Helikon and Rubicon being key central proposed mining areas.

The Namib Desert biome is well protected with parks in this biome making up 69% of the network compared to only 7% of the Savannah biome being formally protected and the Mountain Savannah area being wholly under protected (Barnard 1998). Escarpments, mountains and inselbergs are generally considered as sites of special ecological importance with granite domes (Karibib & Omaruru districts) high in biotic richness and endemism (Curtis & Barnard 1998).

Central western Namibia in general is regarded as "relatively low to moderate" in overall (all terrestrial species) diversity (Mendelsohn *et al.* 2002). Overall terrestrial endemism in the area on the other hand is "moderate to high" (Mendelsohn *et al.* 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "moderate" with 3-4 species while overall diversity and density of large carnivorous mammals (large predators) is determined as "moderate" with 4 species expected – e.g. leopard, cheetah, spotted & brown hyena (Mendelsohn *et al.* 2002).

The generally Karibib area is viewed as an area of importance for local endemic plant species, especially the Erongo Mountains with between 26-35 endemic species (Mendelsohn *et al.* 2002). The overall plant diversity (all species) in the general Karibib area is estimated at between 150-299 species and the Erongo Mountain area between 400-499 species (Mendelsohn *et al.* 2002). These estimates are limited to "higher" plants as information regarding "lower" plants is sparse. The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in "unique" habitat – often transition zones – e.g. mountains, inselbergs, etc. Plant endemism, other than the Erongo Mountains, is viewed as "medium to high" – with between 6-15 endemics expected from the general area (Mendelsohn *et al.* 2002). Furthermore, Mendelsohn *et al.* (2002) views the overall plant production as medium to low in the general Karibib area and high in the Erongo Mountains, the availability of hardwoods as medium and the grazing and browse as average in the general area. Bush thickening (encroachment) is viewed as problematic between Karibib and Omaruru

with *Acacia reficiens* the problem species and patchy between Karibib and Okahandja with *A. mellifera* dominating (Bester 1996, Cunningham 1998, Mendelsohn *et al.* 2002).

The carrying capacity for the general area is 10-20kg/ha (Mendelsohn *et al.* 2002) or 12-15LAU/ha (van der Merwe 1983) and the risk of farming is viewed as relatively high. Sheep farming is the dominant farming activity in the Karibib area with between 70-80% of stock farmed with being sheep and 20-30% goats and cattle, respectively (van der Merwe 1983). The stock density is estimated at <3sheep/km² (1.5% of total sheep in Namibia) and <1cattle/km² (1.3% of total cattle in Namiba) (van der Merwe 1983). There are numerous existing tourism ventures in the area with the tourism potential viewed as relatively high (Mendelsohn *et al.* 2002).

The area does not fall within a Communal Conservancy with the closest being ǂGaingu located in the Spitskoppe area to the west of Karibib, neither within a Freehold (i.e. commercial) Conservancy with Okawi being the closest, east of Karibib (Mendelsohn *et al.* 2002, NACSO 2006, 2010).

It is estimated that at least 75 species of reptile, 7 amphibian, 87 mammal, 217 birds, 74-101 larger trees and shrubs and up to 80 grass species occur in the general/immediate Karibib area of which a high proportion are endemics (e.g. reptiles – 45.3%).

2 Methods

2.1 Literature review

A comprehensive and intensive literature review (i.e. desktop study) regarding the reptiles, amphibians, mammals, birds, larger trees and shrubs and grasses that could potentially occur in the general Karibib area (including the Helikon and Rubicon mining areas) was conducted using as many references as manageable. A list of the references consulted can be viewed in the Reference section (Page 54).

2.2 Field Survey

Vertebrate fauna
According to the original ToR, a rapid fieldwork assessment to determine the actual faunal diversity would include the following:

- Small mammal transects to determine small mammal diversity in the area
- Assess larger mammal presence in the area
- Reptile and amphibian transects to determine reptile and amphibian diversity in the area
- Bird transects to determine avian diversity in the area
- Tree/shrub transects to determine diversity in the area
- Grass transects to determine diversity in the area

Reptiles
Diurnal and nocturnal reptile transects were conducted along various transects throughout the proposed development area and were not conducted in rigid straight lines, but focused on the habitat viewed as most suitable for reptiles. Reptiles observed were either caught by hand or by using an active capture technique called ‘reptile noosing’ where an extendable fishing rod was fitted with a soft thread noose, positioned over the unsuspecting head of an individual and pulled tight. This technique does not result in the death or injury of the caught specimen. Species caught were identified *in situ*, photographed and released unharmed at the point of capture.

Amphibians
Amphibians were searched for in areas deemed suitable habitat – e.g. drainage lines, dams, etc. – with species encountered identified *in situ*.
Mammals
Small mammal trapping was conducted by active trapping using collapsible aluminium Sherman traps baited with peanut butter and oats. Traps were set at 6 sites throughout the area – 3 each in the Helikon and Rubicon mining areas. Thirty (30) traps were placed 20m apart for 2 nights (i.e. potential maximum of 30 captures) within the general area in habitats viewed as potentially suitable for small mammals in the area.

Assessing larger mammals from the area was conducted by traversing the area on foot and included actual sightings, tracks, scats and other signs – e.g. burrows, scrapes, carcasses, etc.

Birds
Bird transects (variable lengths, directions and times) were conducted on foot and by vehicle following permissible tracks throughout the area (when in vehicle) during daylight hours using binoculars to identify and confirm species.

Flora
According to the original Terms of Reference (ToR), fieldwork to determine the actual floral diversity was to include the following:

- Trees and shrubs – species composition
- Grasses – species composition
- Other species

Trees and shrubs
All the trees and shrubs encountered in the proposed development areas were identified whilst conducting the fieldwork in the area – i.e. identification was not only limited to transect only. Trees and shrubs species composition was quantified. The transect lengths varied according to the terrain and were conducted in the proposed development areas as well as the general surrounding area.

Grasses
All the grasses encountered in the proposed development areas were identified whilst conducting the fieldwork in the area – i.e. identification was not only limited to transect only. Grass species composition was quantified. The transect lengths varied according to the terrain and were conducted in the proposed development areas as well as the general surrounding area.

Other species
Other species – i.e. herbs, etc. – were also identified whenever encountered.

Fieldwork was limited to the two zoned pegmatite sites in the Helikon and Rubicon mining areas – see Figure 2 (green shaded areas). Other zoned areas were not accessible during the fieldwork and thus not surveyed.

3 Results

3.1 Reptile Diversity

Reptile diversity known and/or expected to occur in the Karibib area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 1.

Table 1. Reptile diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Navachab Gold (2011)	Helikon Lithium (2013)	Namibian conservation and legal status	International status		
						SARDB	IUCN	CITES
TORTOISES & TERRAPINS								
Stigmochelys pardalis	Leopard Tortoise				Vulnerable; Peripheral; Protected Game			C2
Psammobates oculiferus	Kalahari Tent Tortoise				Vulnerable; Protected Game			C2
Pelomedusa subrufa	Marsh/Helmeted Terrapin		√		Secure			C3
SNAKES								
Blind Snakes								
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake				Insufficiently known; Rare?			
Thread Snakes								
Leptotyphlops occidentalis	Western Thread Snake				Endemic; Secure	P		
Leptotyphlops labialis	Damara Thread Snake				Endemic; Secure			
Pythons								
Python anchietae	Dwarf Python				Endemic; Insufficiently known; Protected game			C2
Python natalensis	Southern African Python	√			Vulnerable; Peripheral; Protected Game	V		C2
Burrowing Snakes								
Atractaspis bibronii	Bibron's Burrowing Asp				Secure			
Xenocalamus bicolour bicolor	Bicoloured Quill-snouted Snake				Secure			
Typical Snakes								
Lamprophis fuliginosus	Brown House Snake							
Lycophidion capense	Cape Wolf Snake							
Lycophidion namibianum	Namibian Wolf Snake				Endemic; Secure			
Mehelya capensis	Cape File Snake				Secure			
Mehelya vernayi	Angola File Snake				Insufficiently known; Rare?			
Pseudaspis cana	Mole Snake				Secure			
Pythonodipsas carinata	Western Keeled Snake				Endemic; Secure			
Prosymna frontalis	South-western Shovel-snout				Endemic; Secure	P		
Hemirhagerrhis viperinus	Viperine Bark Snake				Endemic; Secure			
Dipsina multimaculata	Dwarf Beaked Snake				Endemic; Secure			

Psammophis trigrammus	Western Sand Snake				Endemic; Secure
Psammophis notostictus	Karoo Sand Snake				Secure
Psammophis leightoni namibensis	Namib Sand Snake				Secure
Psammophis brevirostris leopardinus	Leopard Grass Snake				Endemic; Secure
Philothamnus semivariegatus	Spotted Bush Snake				Secure
Dasypeltis scabra	Common/Rhombic Egg Eater				Secure
Telescopus semiannulatus polystrictus	Eastern Tiger Snake				Secure
Aspidelaps lubricus infuscatus	Coral Snake				Secure
Aspidelaps scutatus scutatus	Shield-nose Snake				Secure
Naja nivea	Cape Cobra				Secure
Naya nigricincta	Black-necked Spitting Cobra				Endemic; Secure
Bitis arietans	Puff Adder				Secure
Bitis caudalis	Horned Adder				Secure
WORM LIZARDS					
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard				Secure
LIZARDS					
Skinks					
Typhlosaurus braini	Brain's Blind Legless Skink				Endemic; Secure
Typhlacontias brevipes	FitzSimon's Burrowing Skink				Endemic; Secure
Trachylepis acutilabris	Wedge-snouted Skink		√	√	Secure
Trachylepis capensis	Cape Skink				Secure
Trachylepis hoeschi	Hoesch's Skink				Endemic; Secure
Trachylepis occidentalis	Western Three-striped Skink				Secure
Trachylepis spilogaster	Kalahari Tree Skink				Endemic; Secure
Trachylepis striata wahlbergi	Striped Skink				Secure
Trachylepis sulcata	Western Rock Skink	√	√	√	Secure
Trachylepis variegata variegata	Variegated Skink		√		Secure
Old World Lizards					
Heliobolus lugubris	Bushveld Lizard				Secure
Meroles suborbitalis	Spotted Desert Lizard		√		Secure
Pedioplanis breviceps	Short-headed Sand Lizard				Endemic; Secure
Pedioplanis namaquensis	Namaqua Sand Lizard	√	√		Secure
Pedioplanis undata	Western Sand Lizard	√	√		Endemic; Secure
Pedioplanis inornata	Plain Sand Lizard			√	Endemic; Secure
Plated Lizards					
Cordylosaurus subtessellatus	Dwarf Plated Lizard				Endemic; Secure
Gerrhosaurus validus	Giant Plated Lizard		√		Secure

Girdled Lizards							
Cordylus jordani	Jordan's Girdled Lizard				Endemic; Secure		C2
Monitors							
Varanus albigularis	Rock or White-throated Monitor		√		Vulnerable; Peripheral; Protected Game	S to V	C2
Agamas							
Agama achuleata	Ground Agama	√	√		Secure		
Agama anchietae	Anchietae's Agama			√	Secure		
Agama planiceps	Namibian Rock Agama	√	√	√	Endemic; Secure		
Chameleons							
Chamaeleo namaquensis	Namaqua Chameleon				Secure		C2
Geckos							
Afroedura africana	African Flat Gecko				Endemic; Insufficiently known; Rare		
Chondrodactylus angulifer	Giant Ground Gecko				Endemic; Secure		
Lygodactylus bradfieldi	Bradfield's Dwarf Gecko				Endemic; Secure		
Narudasia festiva	Festive Gecko				Endemic; Secure		
Pachydactylus bicolour	Velvety Thick-toed Gecko				Endemic; Secure		
Pachydactylus capensis	Cape Thick-toed Gecko				Endemic; Secure		
Pachydactylus fasciatus	Banded Thick-toed Gecko		√		Endemic; Secure		
Pachydactylus kochii	Koch's Thick-toed Gecko				Endemic; Secure		
Pachydactylus turneri	Turner's Thick-toed Gecko		√		Secure		
Pachydactylus punctatus	Speckled Thick-toed Gecko				Secure		
Pachydactylus rugosus	Rough Thick-toed Gecko				Endemic; Secure		
Pachydactylus scherzi	Namib Variable Gecko				Endemic; Secure		
Pachydactylus weberi	Weber's Thick-toed Gecko				Secure		
Ptenopus garrulus	Common Barking Gecko				Secure		
Rhoptropus afer	Common Namib Day Gecko				Endemic; Secure		
Rhoptropus boultoni	Boulton's Namib Day Gecko	√	√		Endemic; Secure		
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko				Endemic; Secure		

Namibian conservation and legal status according to the Nature Conservation Ordinance No 4 of 1975 (Griffin 2003)
Endemic – includes Southern African Status (Branch 1998)
SARDB (2004): S to V – Safe to Vulnerable; V – Vulnerable; P – Peripheral
IUCN (2016): LC – Least Concern [All other species not yet assessed]
CITES: CITES Appendix 2/3 species
Source for literature review: Alexander and Marais (2007), Branch (1998), Branch (2008), Boycott and Bourquin (2000), Broadley (1983), Buys and Buys (1983), Cunningham (2006), Cunningham (2011), Cunningham (2013), Griffin (2003), Hebbard (n.d.), IUCN (2016), Marais (1992), SARDB (2004), Tolley and Burger (2007)

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continent's species diversity (Griffin 1998a). At least 22% or 55 species of Namibian lizards are classified as endemic. The occurrence of reptiles of "conservation concern" includes about 67% of Namibian reptiles (Griffin 1998a). Emergency grazing and large-scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998a).

The overall reptile diversity and endemism in the general Karibib area is estimated at between 41-70 species and 21-28 species, respectively (Mendelsohn *et al.* 2002). Griffin (1998a) presents figures of between 21-30 and 7-8 for endemic lizards and snakes, respectively, from the general area, while the closest protected areas, the Skeleton Coast and Namib-Naukluft National Parks, have an estimated 77 and 100 species, respectively. Reptile species observed and/or confirmed from the Navachab Gold Mine area (approximately 35km northwest of the study area) included 1 tortoise, 1 terrapin, 5 snakes, 9 lizards, 1 monitor lizard, 2 agamas and 8 geckos (i.e. 27 species) (Cunningham 2011) while reptiles confirmed from the Helikon Mine area include 2 skinks, 1 Old World lizard and 2 agamas (Cunningham 2013).

At least 75 species of reptiles are expected to occur in the Karibib area with 34 species being endemic – i.e. 45.3% endemic. These consist of at least 30 snakes (1 blind snake, 2 thread snake, 2 python, 2 burrowing snakes & 23 typical snakes), 11 of which are endemic (33.3%) to Namibia, 2 tortoises, 1 terrapin, 42 lizards (1 worm lizard, 10 skinks, 6 Old World lizards, 2 plated lizards, 1 girdled lizard, 1 monitor lizard, 3 agamas, 1 chameleon & 17 geckos), 23 (54.8%) of which are endemic to Namibia. Skink's (10 species), Old World lizards (6 species) and gecko's (17 species) are the most numerous lizards expected from the general area. Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a). Geckos have the highest occurrence of endemics in the general area with 13 of the 17 species (76.5%) expected and/or known to occur in the area, being endemic to Namibia. Due to the fact that reptiles are an understudied group of animals, especially in Namibia, it is expected that more species may be located in the general area than presented above.

During the fieldwork only 7 species were confirmed from the area which included 1 python, 1 skink, 2 Old World lizards, 2 agamas and 1 gecko (Figure 3). A total of at least 17 species are confirmed from the general area if one includes species identified by Cunningham (2011 and 2013) – See Table 1.

Figure 3. Boulton's Namib Day Gecko observed on rocky substrate in the Rubicon area.

No nocturnal fieldwork was conducted in the area due to cold weather – e.g. temperatures <16°C are generally unfavourable for reptiles – and dense grass cover – e.g. due to good summer rains the grass biomass was high which makes observing nocturnal species difficult. However, nocturnal species observed at the Navachab Gold Mine in the general area, probably also occurring in the Lithium mining area, included *Pachydactylus fasciatus* and *P. turneri* (See Cunningham 2011).

The most important species expected to occur in the general area (See Table 1) are viewed as the tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; Namibian wolf snake (*Lycophidion namibianum*) – *Varanus albigularis* and some of the endemic and little-known gecko species – e.g. *Pachydactylus* species. Tortoises, snakes and monitor lizards are routinely killed for food or as perceived threats. Other important species are those viewed as "rare" – i.e. *Rhinotyphlops lalandei*, *Mehelya vernayi* & *Afroedura africana* – although very little is known about these species.

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique reptiles are expected to be exclusively associated with these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on reptiles potentially occurring in the area.

3.2 Amphibian Diversity

Table 2 indicates the amphibian diversity expected to occur in the general Karibib area as identified during a literature study. No amphibians were observed in the area during the fieldwork with any open water in the area.

Table 2. Amphibian diversity expected (literature study) in the study area southeast of Karibib.

Species: Scientific name	Species: Common name	Species confirmed	Navachab Gold (2011)	Helikon Lithium (2013)	Namibian conservation and legal status	International Status: IUCN
Toads						
Amietophrynus poweri	Western Olive Toad					LC
Poyntonophrynus hoeschi	Hoesch's Pygmy Toad		√		Endemic	LC
Rubber Frog						
Phrynomantis annectens	Marbled Rubber Frog		√		Endemic	LC
Puddle Frog						
Phrynobatrachus mababiensis	Dwarf Puddle Frog					LC
Bullfrogs						
Pyxicephalus adspersus	Giant Bullfrog				Near threatened	LC
Sand Frogs						
Tomopterna tandyi	Tandy's Sand Frog					LC
Platannas						
Xenopus laevis	Common Platanna					LC

Endemic – (Griffin 1998b)
IUCN (2016): LC – Least Concern
Source for literature review: Carruthers (2001), Channing (2001), Channing and Griffin (1993), Cunningham (2011), Cunningham (2013), Du Preez and Carruthers (2009), IUCN (2016), Passmore and Carruthers (1995), SARDB (2004)

Amphibians are declining throughout the world due to various factors of which much has been ascribed to habitat destruction. Basic species lists for various habitats are not always available with Namibia being no exception in this regard while the basic ecology of most species is also

unknown. Approximately 4,000 species of amphibians are known worldwide with just over 200 species known from southern Africa and at least 57 species expected to occur in Namibia. Griffin (1998b) puts this figure at 50 recorded species and a final species richness of approximately 65 species, 6 of which are endemic to Namibia. This "low" number of amphibians from Namibia is not only as a result of the generally marginal desert habitat, but also due to Namibia being under studied and under collected. Most amphibians require water to breed and are therefore associated with the permanent water bodies, mainly in northeast Namibia.

According to Mendelsohn *et al.* (2002), the overall frog diversity in the general Karibib area is estimated at between 4-7 species. Griffin (1998b) puts the species richness in the general area at 10 species, while the closest protected areas, the Skeleton Coast and Namib-Naukluft National Parks, have an estimated 10 and 9 species, respectively.

According to the literature review, at least 7 species of amphibians can occur in suitable habitat in the general Karibib area. The area is under represented, with 2 toads, and 1 species each for rubber, puddle, bullfrog, sand and platanna known and/or expected (i.e. potentially could be found in the area) to occur in the area. Of these, 2 species are endemic (*Poyntonophrynus* (*Bufo*) *hoeschi* and *Phrynomantis annectens*) (Griffin 1998b) and 1 species is classified as "near threatened" (*Pyxicephalus adspersus*) (Du Preez and Carruthers 2009) – i.e. high level (42.9%) of amphibians of conservation value from the general area.

During the fieldwork no open water was located throughout the area – i.e. no likely amphibian breeding habitat – although rock pools holding water temporarily were observed which would be viewed as potential amphibian breeding sites (Figure 4).

Figure 4. Ephemeral rock pools indicate potential amphibian habitat during the rainy season.

Two species – *Poyntonophrynus hoeschi* and *Phrynomantis annectens* – were confirmed from the Navachab Gold Mine area (Cunningham 2011). Although no amphibians were confirmed from the Helikon and Rubicon Mining areas, at least 2 suitable amphibian habitats were observed in the Helikon Mine area (Cunningham 2013) although these are to the east of the surveyed key target area (See Figure 2).

Important species include the 2 endemics – *Poyntonophrynus hoeschi* & *Phrynomantis annectens* and *Pyxicephalus adspersus* which are classified as "near threatened" in southern Africa (Du Preez and Carruthers 2009). The latter species numbers are decreasing throughout

its range in Namibia mainly due to being targeted as food (Griffin pers. com). However, none of the important species were observed in the Kelikon and Rubicon mining areas while potential amphibian habitats, especially open surface water, are viewed as marginal at best.

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique amphibians are expected to be exclusively associated with these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

3.3 Mammal Diversity

Mammal diversity known and/or expected to occur in the Karibib area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 3.

Namibia is well endowed with mammal diversity with at least 250 species occurring in the country. These include the well known big and hairy as well as a legion of smaller and lesser-known species. Currently 14 mammal species are considered endemic to Namibia of which 11 species are rodents and small carnivores of which very little is known. Most endemic mammals are associated with the Namib and escarpment with 60% of these rock-dwelling (Griffin 1998c). According to Griffin (1998c) the endemic mammal fauna is best characterized by the endemic rodent family *Petromuridae* (Dassie rat) and the rodent genera *Gerbillurus* and *Petromyscus*.

Overall terrestrial diversity and endemism – all species – is classified as “average” and “high” respectively in the general Karibib area (Mendelsohn *et al.* 2002). The overall diversity (5-6 species) and abundance of large herbivorous mammals is “high” in the general area with kudu, mountain zebra and oryx having the highest densities of the larger species (Mendelsohn *et al.* 2002). The overall abundance and diversity of large carnivorous mammals is “average” (4 species) in the general area with leopard and cheetah having the highest densities of the larger species (Mendelsohn *et al.* 2002). The overall mammal diversity in the general Karibib area is estimated at between 61-75 species with 5-6 species being endemic to the area (Mendelsohn *et al.* 2002). Griffin (1998c) puts the species richness distribution of endemic mammals between 7-8 species in the general area, while the closest protected areas, the Skeleton Coast and Namib-Naukluft National Parks, at 87 and 80 species, respectively.

According to the literature at least 87 species of mammals are known and/or expected to occur in the general Karibib area of which 9 species (10.3%) are classified as endemic. The Namibian legislation classifies 5 species as “vulnerable”, 2 species as “rare”, 3 species as “specially protected game”, 9 species as “protected game”, 5 species as “insufficiently known”, 4 species as “huntable game” and 4 species as “problem animals”. Five species of bat are not listed – i.e. according to Monadjem *et al.* (2010) these bats potentially could occur in the general Karibib are according to a habitat modelling programme although not yet actually confirmed.

At least 30.2% (38 species) of the mammalian fauna that occur or are expected to occur in the general Karibib area are represented by rodents of which 6 species (23.1%) are endemic. This is followed by bats 27.9% (24 species) of which 1 species is classified as “rare”. Thirty-five species (40.2%) have IUCN, CITES and SARDB international conservation status of which 1 species is classified as “endangered”, 1 species as “rare”, 3 species as “vulnerable”, 16 species as “near threatened”, 7 species as “data deficient”, 7 species as

Table 3. Mammal diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Navachab Gold (2011)	Helikon Lithium (2013)	Namibian conservation and legal status	International status		
						SARDB	IUCN	CITES
Elephant Shrews								
Macroscelides proboscideus	Round-eared Elephant-shrew				Endemic; Secure			
Elephantulus rupestris	Western Rock Elephant-shrew				Secure			
Elephantulus intufi	Bushveld Elephant-shrew	√	√	√	Secure	DD		
Aardvark								
Orycteropus afer	Aardvark	√	√		Secure; Protected Game			
Shrews					Secure	DD		
Crocidura fuscomurina	Tiny Musk Shrew							
Crocidura cyanea	Reddish-grey Musk Shrew				Secure	DD		
Hyrax								
Procavia capensis	Rock Hyrax	√	√	√	Secure; Problem animal			
Bats								
Eidolon helvum	African Straw-coloured Fruit Bat				Secure (Migrant)	NT		
Mops midas	Midas Free-tailed Bat				Secure			
Miniopterus natalensis	Natal Long-fingered Bat				Secure	NT		
Mimetillus thomasi	Thomas's Flat-headed Bat				Not listed			
Sauromys petrophilus	Flat-headed Free-tailed Bat				Secure			
Tadarida aegyptiaca	Egyptian Free-tailed Bat				Secure			
Neoromicia capensis	Cape Serotine Bat				Secure			
Neoromicia zuluensis	Zulu Serotine Bat				Secure			
Nycticeinops schlieffeni	Schleiffen's Twighlight Bat				Secure			
Pipistrellus rueppellii	Rüppell's Pipistrelle				Insufficiently known; Peripheral			
Pipistrellus rusticus	Rusty Pipistrelle				Not listed			
Cistugo seabrai	Namibian Wing-gland Bat				Endemic; Rare	V		
Eptesicus hottentotus	Long-tailed Serotine Bat				Secure			
Scotophilus dinganii	African Yellow Bat				Secure			
Nycteris thebaica	Egyptian Slit-faced Bat				Secure			
Rhinolophus fumigatus	Rüppell's Horseshoe Bat				Secure	NT		
Rhinolophus clivosus	Geoffroy's Horseshoe Bat				Secure	NT		

Rhinolophus darlingi	Darling's Horseshoe Bat				Secure	NT	
Rhinolophus denti	Dent's Horseshoe Bat				Secure	NT	DD
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat				Not listed		
Hipposideros commersoni	Commerson's Roundleaf Bat				Secure		NT
Hipposideros caffer	Sundevall's Roundleaf Bat				Secure	DD	
*Hipposideros gigas**	Giant Leaf-nosed Bat				Not listed		NT
Hipposideros vittatus	Striped Leaf-nosed Bat				Not listed		NT
Hares and Rabbits							
Lepus capensis	Cape Hare		√	√	Secure		
Lepus saxatilis	Scrub Hare				Secure		
Pronolagus randensis	Jameson's Red Rock Rabbit				Secure		
Rodents							
Porcupine							
Hystrix africaeaustralis	Cape Porcupine	√	√	√	Secure		
Rats and Mice							
Petromys typicus	Dassie Rat		√	√	Endemic; Secure	NT	
Pedetes capensis	Springhare				Secure		
Xerus inaurus	South African Ground Squirrel		√		Secure		
Xerus princeps	Damara Ground Squirrel				Endemic	NT	
Graphiurus rupicola/platyops	Western Rock Dormouse				Endemic; Secure	DD	
Graphiurus murinus	Woodland Dormouse				Secure		
Rhabdomys pumilio	Four-striped Grass Mouse		√		Secure		
Mus indutus	Desert Pygmy Mouse		√		Secure		
Mastomys natalensis	Natal Multimammate Mouse				Secure		
Mastomys coucha	Southern Multimammate Mouse				Secure		
Thallomys paedulcus	Acacia Rat				Secure		
Thallomys nigricauda	Black-tailed Tree Rat				Secure		
Aethomys chrysophilus	Red Veld Rat				Secure		
Micaelamys namaquensis	Namaqua Rock Mouse		√		Secure		
Desmodillus auricularis	Cape Short-tailed Gerbil				Secure		
Gerbillurus paeba	Hairy-footed Gerbil				Secure		
Gerbillurus setzeri	Setzer's Hairy-footed Gerbil				Endemic		
Tatera leucogaster	Bushveld Gerbil	√	√		Secure	DD	
Saccostomus campestris	Pouched Mouse	√			Secure		
Malacothrix typica	Gerbil Mouse				Secure		
Petromyscus collinus	Pygmy Rock Mouse				Endemic; Secure		

Mus musculus	House Mouse				Invasive alien			
Primates								
Galago moholi	South African Galago				Vulnerable; Protected Game			C2
Papio ursinus	Chacma Baboon		√	√	Secure; Problem animal			C2
Hedgehog								
Atelerix frontalis angolae	Southern African Hedgehog		√		Insufficiently Known; Rare; Protected Game	NT; R		
Carnivores								
Proteles cristatus	Aardwolf				Insufficiently known; (Vulnerable?) Peripheral			
Hyaena brunnea	Brown Hyena				Insufficiently known; (Vulnerable?) Peripheral	NT	NT	
Crocuta crocuta	Spotted Hyena				Secure?; Peripheral	NT		
Acinonyx jubatus	Cheetah		√	√	Vulnerable; Protected Game	V	V	C1
Panthera pardus	Leopard				Secure?; Peripheral; Protected Game		NT	C1
Caracal caracal	Caracal				Secure; Problem Animal			C2
Felis silvestris	African Wild Cat		√	√	Vulnerable			C2
Genetta genetta	Small Spotted Genet				Secure			
Suricata suricatta marjoriae	Suricate				Endemic; Secure			
Cynictis penicillata	Yellow Mongoose	√	√		Secure			
Galerella sanguinea	Slender Mongoose				Secure			
Otocyon megalotis	Bat-eared Fox				Vulnerable?; Peripheral			
Vulpes chama	Cape Fox				Vulnerable?			
Canis mesomelas	Black-backed Jackal	√	√		Secure; Problem animal			
Mellivora capensis	Honey Badger/Ratel		√		Secure; Protected Game	NT		
Ictonyx striatus	Striped Polecat				Secure			
Equidae								
Equus zebra hartmannae	Hartmann's Mountain Zebra		√	√	Endemic; Secure; Specially Protected Game	E	V	C2
Suidae								
Phacochoerus africanus	Common Warthog		√		Secure; Huntable Game			
Antelopes								
Giraffa camelopardalis	Giraffe		√		Vulnerable; Peripheral; Specially Protected Game			
Tragelaphus strepsiceros	Greater Kudu	√	√	√	Secure; Huntable Game			
Oryx gazella	Gemsbok		√		Secure; Huntable game			
Sylvicapra grimmia	Common Duiker		√		Secure			
Antidorcas marsupialis	Springbok		√		Secure; Huntable game			
Madoqua damarensis	Damara Dik-dik				Insufficiently Known; Protected Game			

Raphicerus campestris	Steenbok	√	√	√	Secure; Protected Game
Oreotragus oreotragus	Klipspringer	√	√	√	Secure; Specially Protected Game

Other species not listed are viewed as “Least Concern” by IUCN (2016)
SARDB (2004): R – Rare, E – Endangered, V – Vulnerable, NT – Near Threatened, DD – Data Deficient
IUCN (2016): V – Vulnerable, NT – Near Threatened, LC – Least Concern
CITES: CITES Appendix 1/2 species
*Monadjem *et al.* (2010)
Source for literature review: Cunningham (2011), Cunningham (2013), De Graaff (1981), Griffin and Coetzee (2005), Estes (1995), IUCN (2016), Joubert and Mostert (1975), Monadjem *et al.* (2010), SARDB (2004), Skinner and Smithers (1990), Skinner and Chimimba (2005), Stander and Hanssen (2003) and Taylor (2000)

CITES Appendix 1 or 2. The House Mouse (*Mus musculus*) is viewed as an invasive alien species to the area. *Mus musculus* are generally known as casual pests and not viewed as problematic although they are known carriers of "plague" and can cause economic losses.

Of the 87 species of mammals known and/or expected to occur in the general Karibib area, 9 species (10.3%) are classified as endemic. Rodents (of which 6 species – 23.1% – are endemic) and bats (of which 1 species is classified as "rare") are the groups least studied. Species of greatest concern in the general area are those viewed as "rare" in Namibia – i.e. Namibian wing-gland bat and Southern African hedgehog – and species classified as "near threatened" – i.e. Commerson's roundleaf bat, striped leaf-nosed bat & brown hyena, leopard – and "vulnerable" by the IUCN (2016) – i.e. cheetah & Hartmann's mountain zebra.

The only mammals confirmed (i.e. actually captured, observed and or other evidence – e.g. tracks, scats, etc.) to occur in the Helikon and Rubicon mining areas during the fieldwork conducted between 29 and 31 May 2017 were 11 species. A total of at least 28 species are confirmed from the general area if one includes species identified by Cunningham (2011 and 2013) – See Table 3. A shepherd encountered during the fieldwork furthermore confirmed cheetah and leopard in the area as well.

Thirty (30) Sherman small mammal traps were set for 2 nights at 6 sites throughout the area (Table 4). This resulted in 5 captures of 3 species – *Elephantulus intufi*, *Tatera leucogaster* and *Saccostomus campestris* – i.e. 16.7% capture success (Figures 5 to 7).

Table 4. Small mammals trap sites.

Number	Traps	Area	Habitat	Coordinates		Captures	Species
1	5	Rubicon	Plain area	22 06 09.4	16 01 45.9	2	*Elephantulus intufi*
2	5	Helikon	Plain area	22 03 58.8	16 00 17.5	0	
3	5	Rubicon	Hill area	22 06 26.7	15 58 46.0	1	*Tatera leucogaster*
4	5	Rubicon	Hill area	22 06 47.5	15 59 49.2	2	*Saccostomus campestris*
5	5	Rubicon	River	22 06 21.0	15 59 59.6	0	
6	5	Helikon	Hill area	22 04 16.6	16 00 03.1	0	

Figure 5. *Elephantulus intufi* (bushveld elephant-shrew) captured on the plains.

Figure 6. *Tatera leucogaster* (bushvekd gerbil) captured in hill area – Rubicon area.

Figure 7. *Saccostomus campestris* (pouched mouse) captured in hill area – Rubicon area.

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique mammals are expected to be exclusively associated with these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on mammals potentially occurring in the area.

3.4 Avian Diversity

Bird diversity known and/or expected to occur in the Karibib area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 5.

Table 5. Avian diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Navachab Gold (2011)	Helikon Lithium (2013)	Namibian conservation and legal status	International status	
						Southern African status	IUCN
Struthio camelus	Common Ostrich		√				
Scleroptila levaillantoides	Orange River Francolin					Near endemic	
Pternistis hartlaubi	Hartlaub's Spurfowl				Endemic	Near endemic	
Pternistis adspersus	Red-billed Spurfowl		√			Near endemic	
Pternistis swainsonii	Swainson's Spurfowl						
Coturnix coturnix	Common Quail						
Coturnix delegorguei	Harlequin Quail						
Numida meleagris	Helmeted Guineafowl	√	√	√			
Turnix sylvaticus	Kurrichane Buttonquail						
Indicator minor	Lesser Honeyguide						
Campethera abingoni	Golden-tailed Woodpecker						
Dendropicos fuscescens	Cardinal Woodpecker						
Dendropicos namaquus	Bearded Woodpecker						
Tricholaema leucomelas	Acacia Pied Barbet	√	√			Near endemic	
Tockus monteiri	Monteiro's Hornbill	√	√	√	Endemic		
Tockus damarensis	Damara Hornbill				Endemic	Near endemic	
Tockus leucomelas	Southern yellow-billed Hornbill	√	√			Near endemic	
Tockus nasutus	African Grey Hornbill		√				
Upupa africana	African Hoopoe	√	√				
Phoeniculus purpureus	Green Wood-Hoopoe						
Phoeniculus damarensis	Violet Wood-Hoopoe				E; Endemic		
Rhinopomastus cyanomelas	Common Scimitarbill	√	√	√			
Coracias caudatus	Lilac-breasted Roller		√				
Coracias naevius	Purple Roller		√				
Merops hirundineus	Swallow-tailed Bee-eater	√	√				
Merops apiaster	European Bee-eater						
Colius colius	White-backed Mousebird					Endemic	
Urocolius indicus	Red-faced Mousebird		√				
Clamator jacobinus	Jacobin Cuckoo						

Clamator glandarius	Great Spotted Cuckoo						
Cuculus clamosus	Black Cuckoo						
Cuculus gularis	African Cuckoo						
Chrysococcyx klaas	Klaas's Cuckoo						
Chrysococcyz caprius	Diderick Cuckoo		√				
Poicephalus rueppellii	Rüppell's Parrot				NT; Endemic	Near endemic	
Agapornis roseicollis	Rosy-faced Lovebird	√		√	Endemic	Near endemic	
Cypsiurus parvus	African Palm Swift		√				
Tachymarptis melba	Alpine Swift		√				
Apus bradfieldi	Bradfield's Swift		√			Near endemic	
Apus affinis	Little Swift		√				
Apus caffer	White-rumped Swift						
Corythaixoides concolor	Grey Go-away Bird		√				
Tyto alba	Barn Owl						
Otus senegalensis	African Scops Owl						
Ptilopsis granti	Southern White-faced Scops Owl						
Bubo africanus	Spotted Eagle Owl			√			
Bubo lacteus	Verreaux's Eagle-Owl						
Glaucidium perlatum	Pearl-spotted Owlet						
Caprimulgus pectoralis	Fiery-necked Nightjar						
Caprimulgus tristigma	Freckled Nightjar		√				
Caprimulgus rufigena	Rufous-cheeked Nightjar						
Caprimulgus europaeus	European Nightjar						
Columba livia	Rock Dove						
Columba guinea	Speckled Pigeon		√	√			
Streptopelia capicola	Cape Turtle Dove	√	√	√			
Streptopelia senegalensis	Laughing Dove		√				
Oena capensis	Namaqua Dove	√	√				
Neotis ludwigii	Ludwig's Bustard		√		E	Near endemic	E
Ardeotis kori	Kori Bustard		√		NT		
Lophotis ruficrista	Red-crested Korhaan	√	√			Near endemic	
Afrotis afraoides	Northern Black Korhaan					Endemic	
Eupodotis rueppellii	Rüppell's Korhaan		√		Endemic	Near endemic	
Pterocles namaqua	Namaqua Sandgrouse	√	√	√		Near endemic	
Pterocles bicinctus	Double-banded Sandgrouse	√				Near endemic	
Burhinus capensis	Spotted Thick-knee						

Charadrius tricollaris	Three-banded Plover		√				
Vanellus armatus	Blacksmith Lapwing						
Vanellus coronatus	Crowned Lapwing						
Rhinoptilus africanus	Double-banded Courser						
Rhinoptilus chalcopterus	Bronze-winged Courser						
Cursorius rufus	Burchell's Courser					Near endemic	
Cursorius temminckii	Temminck's Courser		√				
Elanus caeruleus	Black-shouldered Kite						
Milvus migrans	Black Kite		√				
Gyps africanus	White-backed Vulture		√		E		E
Aegypius tracheliotos	Lappet-faced Vulture		√		V		
Circaetus pectoralis	Black-chested Snake-Eagle	√	√				
Circaetus cinereus	Brown Snake-Eagle						
Melierax canorus	Southern Pale Chanting Goshawk	√				Near endemic	
Melierax gabar	Gabar Goshawk						
Accipiter badius	Shikra		√				
Accipiter minullus	Little Sparrowhawk						
Accipter ovampensis	Owambo Sparrowhawk						
Buteo vulpinus	Steppe Buzzard		√				
Buteo augur	Augur Buzzard						
Buteo rufofuscus	Jackal Buzzard						
Aquila nipalensis	Steppe Eagle						
Circus maurus	Black Harrier				E		
Aquila rapax	Tawny Eagle		√		E		
Aquila verreauxii	Verreaux's Eagle	√	√		NT		
Aquila spilogaster	African Hawk-Eagle						
Aquila pennatus	Booted Eagle				E		
Polemaetus bellicosus	Martial Eagle				E		NT
Sagittarius serpentarius	Secretarybird				V		V
Polihierax semitorquatus	Pygmy Falcon	√					
Falco rupicolus	Rock Kestrel	√	√	√			
Falco rupicoloides	Greater Kestrel						
Falco chicquera	Red-necked Falcon						
Falco biarmicus	Lanner Falcon		√				
Falco peregrinus	Peregrine Falcon				NT		
Egretta garzetta	Little Egret						

Egretta intermedia	Yellow-billed Egret					
Ardea cinerea	Grey Heron					
Ardea melanocephala	Black-headed Heron					
Bubulcus ibis	Cattle Egret					
Scopus umbretta	Hamerkop					
Ciconia nigra	Black Strork				E	
Ciconia abdimii	Abdim's Stork					
Leptoptilos crumeniferus	Marabou Stork				NT	
Dicrurus adsimilis	Fork-tailed Drongo	√	√			
Terpsiphone viridis	African Paradise-Flycatcher					
Nilaus afer	Brubru					
Dryoscopus cubla	Black-backed Puffback					
Tchagra australis	Brown-crowned Tchagra					
Laniarius atrococcineus	Crimson-breasted Shrike	√				Near endemic
Telophorus zeylonus	Bokmakierie					Near endemic
Prionops plumatus	White-crested Helmet-Shrike					
Lanioturdus torquatus	White-tailed Shrike	√	√		Endemic	Near endemic
Batis pririt	Pririt Batis	√	√			Near endemic
Corvus capensis	Cape Crow					
Corvus albus	Pied Crow					
Lanius collurio	Red-backed Shrike		√			
Lanius minor	Lesser Grey Shrike		√			
Lanius collaris	Common Fiscal	√	√			
Eurocephalus anguitimens	Southern White-crowned Shrike					Near endemic
Anthoscopus minutes	Cape Penduline Tit					Near endemic
Parus carpi	Carp's Tit				Endemic	Near endemic
Parus cinerascens	Ashy Tit	√				Endemic
Riparia paludicola	Brown-throated Martin					
Hirundo rustica	Barn Swallow		√			
Hirundo dimidiata	Pearl-breasted Swallow					
Hirundo cucullata	Greater Striped Swallow					
Hirundo spilodera	South African Cliff-Swallow					
Hirundo fuligula	Rock Martin	√	√	√		
Delichon urbicum	Common House Martin					
Pycnonotus nigricans	African Red-eyed Bulbul	√	√	√		Near endemic
Achaetps pycnopygius	Rockrunner		√		Endemic	Near endemic

Sylvietta rufescens	Long-billed Crombec		√			
Eremomela icteropygialis	Yellow-bellied Eremomela					
Eremomela gregalis	Karoo Eremomela					
Eremomela usticollis	Burnt-necked Eremomela					
Acrocephalus baeticatus	African Reed Warbler					
Turdoides bicolor	Southern Pied Babbler					Endemic
Parisoma layardi	Layard's Tit-Babbler					Endemic
Parisoma subcaeruleum	Chestnut-vented Tit-Babbler		√			Near endemic
Zosterops pallidus	Orange River White-eye					
Cisticola subruficapilla	Grey-backed Cisticola					Near endemic
Cisticola jaridulus	Desert Cisticola		√			
Prinia flavicans	Black-chested Prinia	√	√	√		
Malcorus pectoralis	Rufous-eared Warbler					
Camaroptera brevicaudata	Grey-backed Camaroptera					
Calamonastes fasciolatus	Barren Wren-Warbler					
Mirafra passerina	Monotonous Lark					
Mirafra fasciolata	Eastern Clapper Lark					Near endemic
Mirafra sabota	Sabota Lark		√	√		
Calendulauda africanoides	Fawn-coloured Lark					Near endemic
Pinarocorys nigricans	Dusky Lark					
Ammomanopsis grayi	Gray's Lark				Endemic	
Chersomanes albofasciata	Spike-heeled Lark	√				Near endemic
Certhilauda subcoronata	Karoo Long-billed Lark					Near endemic
Eremopterix leucotis	Chestnut-backed Sparrowlark					
Eremopterix verticalis	Grey-backed Sparrowlark	√				Near endemic
Calandrella cinerea	Red-capped Lark		√			
Alauda starki	Stark's Lark		√			Near endemic
Monticola brevipes	Short-toed Rock Thrush		√			
Psophocichla litsitsirupa	Groundscraper Thrush					
Bradornis infuscatus	Chat Flycatcher					Near endemic
Melaenornis mariquensis	Marico Flycatcher	√	√	√		Near endemic
Muscicapa striata	Spotted Flycatcher					
Cercotrichas leucophrys	White-browed Scrub-Robin					
Cercotrichas paena	Kalahari Scrub-Robin	√	√			
Namibornis herero	Herero Chat				Endemic	Near endemic
Oenanthe monticola	Mountain Wheatear	√	√	√		Near endemic

Oenanthe pileata	Capped Wheatear	√	√		
Cercomela schlegelii	Karoo Chat				Near endemic
Cercomela tractrac	Tractrac Chat	√	√		Near endemic
Cercomela familiaris	Familiar Chat		√		
Myrmecocichla formicivora	Ant-eating Chat	√	√		Endemic
Onychognathus nabouroup	Pale-winged Starling	√	√	√	Near endemic
Lamprotornis nitens	Cape Glossy Starling	√	√		
Lamprotornis australis	Burchell's Starling				
Cinnyricinclus leucogaster	Violet-backed Starling		√		
Creatophora cinerea	Wattled Starling		√		
Chalcomitra senegalensis	Scarlet-chested Sunbird		√		
Nectarinia fusca	Dusky Sunbird	√	√	√	Near endemic
Cinnyris mariquensis	Marico Sunbird				
Bualornis niger	Red-billed Buffalo-Weaver	√	√		
Sporopipes squamifrons	Scaly-feathered Finch				Near endemic
Plocepasser mahali	White-browed Sparrow-Weaver	√	√	√	
Philetairus socius	Sociable Weaver				Endemic
Ploceus intermedius	Lesser Masked-Weaver				
Ploceus velatus	Southern Masked-Weaver	√	√	√	
Ploceus rubiginosus	Chestnut Weaver	√	√		
Quelea quelea	Red-billed Quelea				
Amadina erythrocephala	Red-headed Finch				Near endemic
Estrilda erythronotos	Black-faced Waxbill		√		
Estrilda astrild	Common Waxbill				
Granatina granatina	Violet-eared Waxbill		√		
Pytilia melba	Green-winged Pytilia				
Vidua paradisaea	Long-tailed Paradise-Whydah				
Vidua regia	Shaft-tailed Whydah	√	√		
Passer domesticus	House Sparrow		√		
Passer motitensis	Great Sparrow				Near endemic
Passer melanurus	Cape Sparrow				Near endemic
Passer griseus	Southern Grey-headed Sparrow				
Motacilla capensis	Cape Wagtail		√		
Anthus cinnamomeus	African Pipit				
Anthus vaalensis	Buffy Pipit				
Anthus similes	Long-billed Pipit				

Serinus alario	Black-headed Canary				Endemic
Crithagra atrogulariis	Black-throated Canary				
Serinus flaviventris	Yellow Canary		√		Near endemic
Serinus albogularis	White-throated Canary		√	√	Near endemic
Emberiza impetuani	Lark-like Bunting	√	√		Near endemic
Emberiza tahapisi	Cinnamon-breasted Bunting				
Emberiza capensis	Cape Bunting		√		Near endemic
Emberiza flaviventris	Golden-breasted Bunting				

This table excludes migratory birds (e.g. Petrel, Albatross, Skua, etc.), aquatic species (e.g. ducks, etc.) and species breeding extralimital (e.g. stints, sandpipers, etc.) and rather focuses on birds that are breeding residents or can be found in the area during any time of the year. This would imply that many more birds (e.g. Palaearctic migrants) could occur in the area depending on “favourable” environmental conditions.
Namibian status: Simmons *et al.* (2015)
Southern African status: Hockey *et al.* (2006)
International status: IUCN (2016)
Source for literature review: Brown *et al.* (1998), Hockey *et al.* (2006), IUCN (2016), Komen (n.d.), Little and Crowe (2011), Maclean (1985) Peacock (2015), Simmons *et al.* (2015), Tarboton (2001)

Although Namibia's avifauna is comparatively sparse compared to the high rainfall equatorial areas elsewhere in Africa, approximately 658 species have already been recorded with a diverse and unique group of arid endemics (Brown *et al.* 1998, Maclean 1985). Fourteen species of birds are endemic or near endemic to Namibia with the majority of Namibian endemics occurring in the savannas (30%) of which ten species occur in a north-south belt of dry savannah in central Namibia (Brown *et al.* 1998).

Bird diversity and endemism is viewed as "high" in the general Karibib area with 171-200 species, of which 8 species being endemic, expected in the area (Mendelsohn *et al.* 2000). Simmons (1998a) suggests 7-9 endemic species and a "high" ranking for southern African endemics and "average" ranking for red data birds expected from the general area. Although the Karibib area is not classified as an Important Birding Area (IBA) in Namibia (Simmons 1998a) the closest such sites are located to the west at the coast – i.e. Walvis Bay, Sandwich and Mile 4 Saltworks – while the closest inland IBA's are Brandberg and Naukluft.

At least 217 bird species [mainly terrestrial "breeding residents"] occur and/or could occur in the general Karibib area at any time (Hockey *et al.* 2006, Maclean 1985, Tarboton 2001). Twelve of the 14 Namibian endemics are expected to occur in the general area (85.7% of all Namibian endemic species or 5.6% of all the species expected to occur in the area). Eight species are classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), 2 as vulnerable (lappet-faced vulture, secretarybird) and 5 as near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015). Fifty-seven species have a southern African conservation rating with 8 species classified as endemic (14% of southern African endemics or 3.7% of all the birds expected) and 49 species classified as near endemic (86% of southern African endemics or 22.7% of all the birds expected) (Hockey *et al.* 2006).

The only birds confirmed (i.e. actually observed and or other evidence – e.g. nests, feathers, etc.) to occur in the Helikon and Rubicon mining areas during the fieldwork conducted between 29 and 31 May 2017 were 44 species with the most important being the endemic Monteiro's hornbill and Rosy-faced Lovebird as well as those classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretarybird) and near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork). A total of at least 94 species are confirmed from the general area if one includes species identified by Cunningham (2011 and 2013) – See Table 5.

The most important bird species from the general area are those classified as endemic to Namibia of which the Damara hornbill and Herero chat are viewed as the most important due to the overall lack of knowledge of these species. Although also viewed as important, Rüppels korhaan is migratory throughout its range while the rockrunner inhabits inaccessible terrain and is widespread throughout mountainous areas in Namibia. Other species of concern are those classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretarybird) and near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015).

Figure 8. Red-billed buffalo-weaver nests in old wind pump in the Rubicon area.

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique birds are expected to be exclusively associated with these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on mammals potentially occurring in the area.

3.5 Tree and Shrub Diversity

It is estimated that at least 74-101 species of larger trees and shrubs (>1m) (Coats Palgrave 1983 [85sp.], Curtis & Mannheimer 2005 [101sp.], Mannheimer & Curtis 2009 [91], Van Wyk & Van Wyk 1997 [62sp. & 12sp. endemic]) occur in the general Karibib area.

The trees and shrubs known, and/or expected to occur in the general area (derived from Curtis & Mannheimer 2005 and Mannheimer & Curtis 2009) is presented in Table 6 below. Species indicated are know from the quarter-degree square distribution principle used and don't necessarily occur throughout the entire area. Some species indicated to possibly occur in the area according to Coats Palgrave (1983) and Van Wyk and Van Wyk (1997) is excluded here.

Table 6. Tree and shrub diversity expected (literature study) and confirmed during fieldwork in the Helikon and Rubicon areas.

Species: Scientific name	Expected: Curtis and Mannheimer (2005)	Expected: Mannheimer and Curtis (2009)	Confirmed species				Helikon Lithium (2013)	Namibian conservation and legal status
			Plains	Hills Helikon	Hills Rubicon	Rivers		
Acacia erioloba	√	√	√			√	√	Protected (F#)
Acacia erubescens	√	√	√	√	√		√	
Acacia fleckii	√							
Acacia hebeclada	√	√	√			√	√	
Acacia hereroensis	√	√						
Acacia karroo	√	√	√					
Acacia luederitzii	√	√						
Acacia mellifera	√	√	√	√		√	√	
Acacia reficiens	√	√	√	√		√	√	
Acacia senegal	√	√	√	√				
Acacia tortilis	√	√	√			√	√	
Adenia pechuelii		√						Endemic
Adenium boehmianum	√	√						Protected (F#)
Adenolobus garipensis	√			√	√		√	
Adenolobus pechuelii		√						
Albizia anthelmintica	√	√	√		√	√	√	Protected (F#)
Aloe dichotoma	√	√						Protected (F#), NC, C2, N-end
Aloe litoralis	√	√		√				NC, C2
Azima tetracantha	√					√		
Boscia albitrunca	√	√	√		√		√	Protected (F#)
Boscia foetida	√	√	√	√		√	√	
Cadaba aphylla		√						
Caesalpinia rubra	√	√						
Catophractes alexandri	√	√	√			√	√	
Combretum apiculatum	√	√		√	√		√	
Combretum hereroense	√							
Combretum imberbe	√	√						Protected (F#)
Commiphora africana	√							
Commiphora angolensis	√							
Commiphora dinteri	√	√						Protected (F#), Endemic
Commiphora glandulosa	√	√		√			√	
Commiphora glaucescens	√	√		√			√	Near endemic

Commiphora pyracanthoides	√	√						
Commiphora saxicola	√	√						Protected (F#), Endemic
Commiphora tenuipetiolata	√	√		√			√	
Commiphora virgata	√	√						Protected (F#), Endemic
Cordia sp. [C. monoica]	√							
Cordia sinensis	√	√						
Croton gratissimus	√	√						
Cyphostemma bainesii	√	√						Protected (F#), Endemic, NC
Cyphostemma currorii	√	√					√	Protected (F#), NC
Dichrostachys cinerea	√	√	√			√	√	
Diospyros lycioides	√	√		√				
Dombeya rotundifolia	√	√		√	√		√	
Ehretia alba	√	√					√	
Erythrina decora	√	√						Protected (F#), Endemic
Elephantorrhiza suffruticosa	√			√	√		√	
Euclea pseudebenus	√	√				√		Protected (F#)
Euclea undulata	√	√					√	
Euphorbia avasmontana	√	√						C2
Euphorbia damarana	√	√						Endemic, C2
Euphorbia guerichiana	√	√			√			C2
Euphorbia virosa	√	√						C2
Faidherbia albida	√	√				√		Protected (F#)
Flueggea virosa	√							
Ficus cordata	√	√			√		√	Protected (F#)
Ficus ilicina	√	√					√	
Ficus sycomorus	√	√						Protected (F#)
Gossypium anomalum		√						
Grewia avellana	√							
Grewia bicolor	√	√		√	√			
Grewia flava	√	√		√		√	√	
Grewia flavescens	√	√			√			
Grewia retinervis	√							
Grewia tenax	√	√						
Grewia villosa	√	√		√	√			
Gymnosporia buxifolia	√							
Gymnosporia linearis		√						
Gymnosporia maranguensis	√							
Gymnosporia senegalensis	√	√					√	
Lycium bosciifolium	√	√	√				√	

Lycium cinereum		√						
Lycium eenii	√	√	√			√		
Lycium hirsitum		√						
Maerua juncea	√	√					√	
Maerua parvifolia	√	√						
Maerua schinzii	√	√			√		√	Protected (F#)
Manuleopsis dinteri	√	√						Endemic
Montinia caryophyllacea	√	√		√	√			
Moringa ovalifolia	√	√					√	Protected (F#), NC, N-end
Mundulea sericea	√	√		√			√	
Nymania capensis	√	√						
Obetia carruthersiana	√	√						N-end
Osyris lanceolata	√							
Ozoroa crassinervia	√	√						Protected (F*)
Parkinsonia africana	√	√	√			√		Protected (F*)
Pechuel-Loeschea leubnitziae		√	√				√	
Phaeoptilum spinosum	√	√						
Rotheca myricoides	√	√						
Rhigozum brevispinosum	√							
Rhigozum trichotomum	√	√	√					
Salvadora persica	√	√						
Searsia lancea	√	√						Protected (F#)
Searsia marlothii	√	√		√			√	
Searsia pyroides		√						
Searsia tenuinervis	√	√						
Searsia undulata	√	√		√				
Steganotaenia araliacea	√	√					√	
Sterculia africana	√	√		√			√	Protected (F#)
Sterculia quinqueloba	√							Protected (F#)
Strophanthus amboensis	√							
Tamarix usneoides	√	√						Protected (F#)
Tarchonanthus camphoratus	√	√						
Tinnea rhodesiana	√	√						
Terminalia pruniodes	√							
Vangueria cyanescens	√							
Vangueria infausta	√	√						
Vernonia cinerascens		√						
Ximenia americana	√	√		√	√	√	√	
Ximenia caffra	√							

Ziziphus mucronata	√	√	√	√	√	√	√	Protected (F#)

Endemic and Near-endemic – (Craven 1999, Curtis and Mannheimer 2005, Mannheimer and Curtis 2009)
F# – Forest Act No. 12 of 2001
F* – Curtis and Mannheimer (2005) + Mannheimer and Curtis (2009)
NC – Nature Conservation Ordinance No. 4 of 1975
C2 – CITES Appendix 2 species (Curtis and Mannheimer 2005)

Eight species of trees and shrubs (7.9%) expected to occur in the general Karibib area are classified as endemics, 4 species as near endemics, 23 species (22.8%) are protected by the Forest Act No 12. of 2001 and another 2 species by various other Forestry laws (Curtis and Mannheimer 2005 and Mannheimer and Curtis 2009), 5 species (4.9%) are protected under the Nature Conservation Ordinance No. 4 of 1975 while 6 species (5.9%) are classified as CITES Appendix 2 species. All the trees with some kind of conservation and/or protected status are viewed as important in the general Karibib area.

Although between 91 and 101 larger species of trees and shrubs are known and/or expected to occur in the general area (Curtis and Mannheimer 2005, Mannheimer and Curtis 2009) only 21, 16, 27 and 17 species were identified in the following habitats – plains, hills Helikon, hills Rubicon and rivers, throughout the proposed development area, respectively (Although not included in Table 6, *Leucosphaera bainesii* and *Monechma gentisifolium*, were observed and included in the totals for the plains and hills Helikon areas). A total of 53 species were identified throughout the area (See above sentence and Table 6).

The most important protected species (including endemic/near endemic, etc.) are viewed as:

Plains

- *Acacia erioloba*, *Albizia anthelmintica* and *Boscia albitrunca*

Hills – Helikon

- *Aloe litoralis*, *Commiphora glaucescens*, *Ficus cordata* and *Sterculia africana*

Hills – Rubicon

- *Albizia anthelmintica*, *Boscia albitrunca*, *Euphorbia guerichiana*, *Ficus cordata* and *Maerua schinzii*

Rivers

- *Acacia erioloba*, *Albizia anthelmintica*, *Euclea pseudebenus*, *Faidherbia albida* and *Ziziphus mucronata*

Plains

Fourteen (14) species of larger trees and shrubs were encountered along various transects totalling 1,000m in the plains habitat. *Leucosphaera bainesii* (33%) and *Monechma gentisifolium* (24%) were the most dominant species – shrubs – observed during the fieldwork in the plains habitat (Figure 9). *Acacia* species account for 29% of the tree/shrub species composition in the plains area while protected species – *Acacia erioloba* (2%) and *Ziziphus mucronata* (1%) – account for only 3%. The protected species are widespread throughout Namibia and not exclusively associated with the Karibib area. Permits would however still be required to remove these species before mining commences.

Hills – Helikon

Twenty two (22) species of larger trees and shrubs were encountered along various transects totalling 1,000m in the Helikon hills habitat. *Acacia reficiens* (35%), *Acacia erubescens* (9%) and *Commiphora tenuipetiolata* (7%) were the most dominant species observed during the fieldwork in this habitat (Figure 10). *Acacia* species account for 45% of the tree/shrub species composition in this area while protected species – *Aloe litoralis* (6%), *Boscia albitrunca* (3%), *Ficus cordata* (2%), *Sterculia africana* (4%) and *Maerua schinzii* (1%) – account for 16%. The protected species are widespread throughout Namibia and not exclusively associated with the Karibib area. Permits would however still be required to remove these species before mining commences.

Hills – Rubicon

Thirteen (13) species of larger trees and shrubs were encountered along various transects totalling 1,000m in the Rubicon hills habitat. *Acacia reficiens* (40%), *Acacia erubescens* (18%)

and *Catophractes alexandri* (9%) were the most dominant species observed during the fieldwork in this habitat (Figure 10). *Acacia* species account for 60% of the tree/shrub species composition in this area while protected species – *Albizia anthelmintica* (5%), *Boscia albitrunca* (2%) and *Ziziphus mucronata* (2%) – account for 9%. The protected species are widespread throughout Namibia and not exclusively associated with the Karibib area. Permits would however still be required to remove these species before mining commences.

Rivers

Fifteen (15) species of larger trees and shrubs were encountered along various transects totalling 1,000m in the river habitat. *Acacia reficiens* (22), *Acacia erioloba* (19%) and *Ziziphus mucronata* (13%) were the most dominant species observed during the fieldwork in this habitat (Figure 11). *Acacia* species account for 55% of the tree/shrub species composition in this area while protected species – *Albizia anthelmintica* (2%), *Acacia erioloba* (19%), *Euclea pseudebenus* (6%) and *Ziziphus mucronata* (13%) – account for 40%. The protected species are widespread throughout Namibia and not exclusively associated with the Karibib area. However, along river/drainage lines these trees are usually large specimens. Permits would however still be required to remove these species before mining commences.

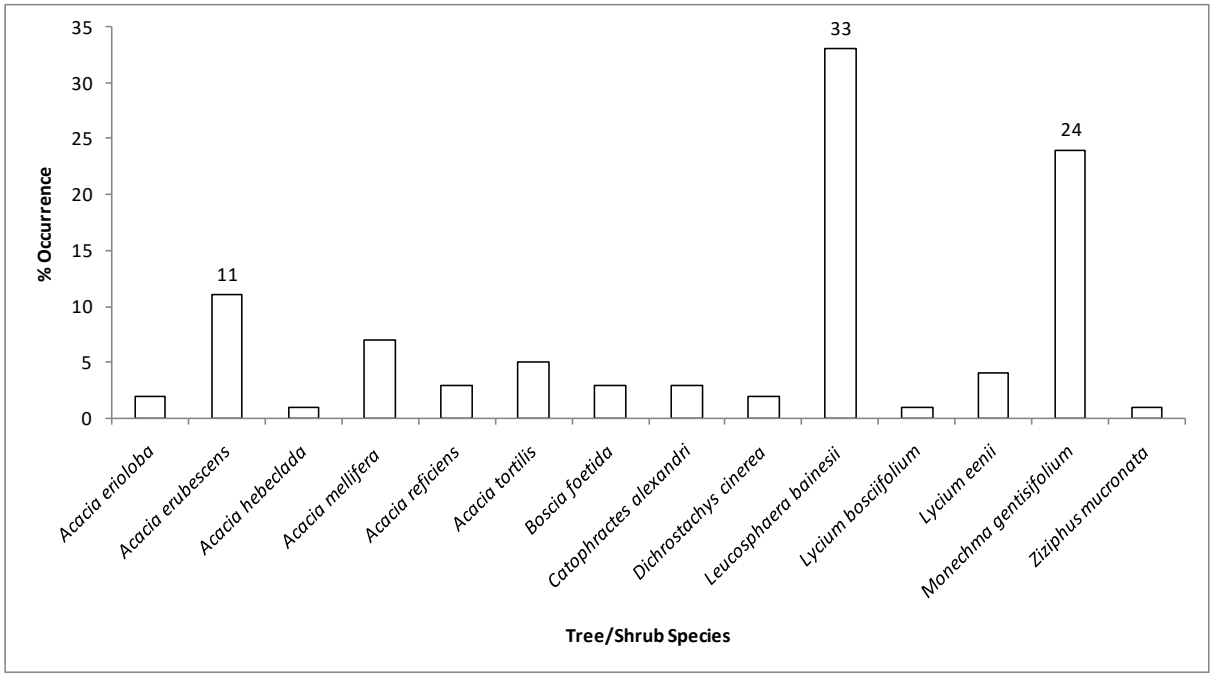

Figure 9. Tree & shrub species composition along various transects (total length – 1,000m @ 10m intervals) in the plains habitat (n=100 points).

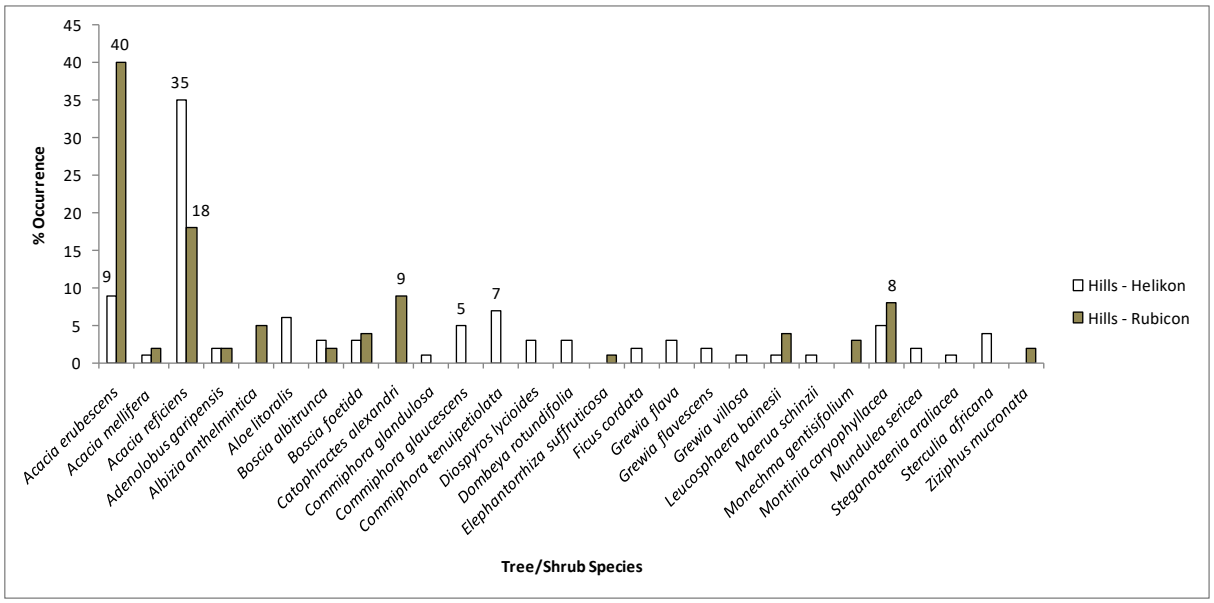

Figure 10. Tree & shrub species composition along various transects (total length – 1,000m @ 10m intervals) in the hills habitat – Helikon and Rubicon areas (n=100 points).

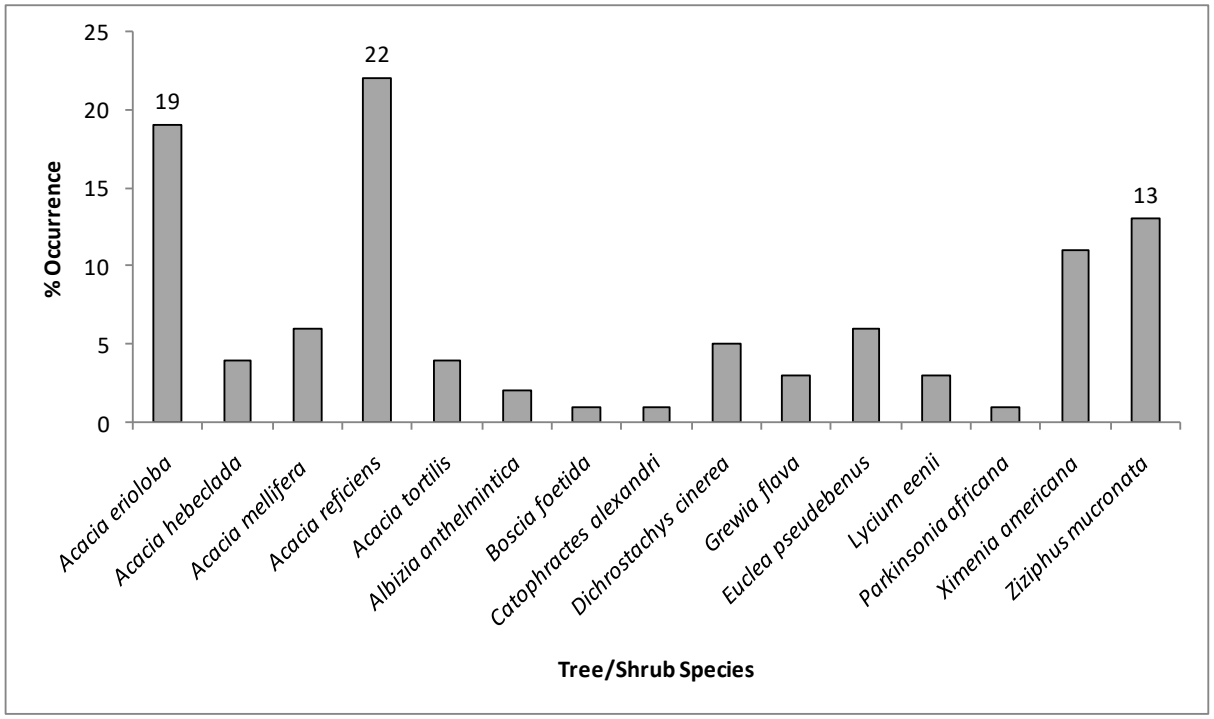

Figure 11. Tree & shrub species composition along various transects (total length – 1,000m @ 10m intervals) in the river habitat (n=100 points).

The protected species and/or unique species occur widespread throughout Namibia and not limited to the Helikon and Rubicon mining areas. However, unique habitats such as rivers/drainage lines have larger specimens which often serve as habitat for a variety of species – e.g. raptor breeding sites, bark and cavity dwelling species (bats, birds and reptiles), etc. – while hills have a higher diversity of species including unique species – e.g. *Aloe litoralis*. However, *A. litoralis* transplant relatively easily and could be relocated to other similar habitat should mining activities be necessary in the area they occur in – i.e. northern slope of hill in the Helikon area (See Important Habitats).

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique trees/shrubs are expected to be exclusively associated with

these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on trees/shrubs potentially occurring in the area.

Figure 12. *Aloe litoralis* and *Sterculia africana* (See arrow) – both protected species – on north facing slope of hill in the Helikon area.

Figure 13. *Acacia erioloba* and *Euclea pseudebenus* (See arrow) – both protected species – in river habitat.

Figure 14. *Albizia anthelmintica* – protected – in the plain habitat.

Figure 15. The hills are much more diverse floristically than the pain areas.

Figure 16. The ephemeral rivers/drainage lines have larger specimens of a variety of trees – often protected species such as *Acacia erioloba*, *Euclea pseudebenus* and *Ziziphus mucronata*.

3.6 Grass Diversity

It is estimated that at least 52-72 grasses (Müller 2007 [72sp.], Van Oudshoorn 1999 [52sp.]) – approximate total of 80 species – occur in the general Karibib, central western, Namibia area.

The grasses known and/or expected to occur in the general area ([1]Müller 2007 and [2]Van Oudtshoorn 1999) is presented in Table 7 below.

Table 7. Grass diversity expected (literature study) and confirmed during fieldwork in the Helikon and Rubicon areas.

Species: Scientific name	Confirmed species			Helikon Lithium (2013)	Ecological Status *	Grazing Value *
	Plains	Hills	Rivers			
[1,2]*Andropogon chinensis*					Increaser 1	Average
[2]*Andropogon eucomus*					Increaser 2	Low
[1]*Anthephora argentea*					Decreaser	High
[1,2]*Anthephora pubescens*		√			Decreaser	High
[1]*Anthephora schinzii*	√				Increaser 2	Low
[1,2]*Aristida adscensionis*	√	√			Increaser 2	Low
[1,2]*Aristida congesta*					Increaser 2	Low
[1]*Aristida effusa*					Increaser 2	Low
[1,2]*Aristida meridionalis*					Increaser 2	Low
[1]*Aristida rhiniochloa*					Increaser 2	Low
[1,2]*Bachiaria deflexa*					Increaser 2	Average
[1]*Brachiaria malacodes*					?	Low
[1]*Brachiaria glomerata*					Decreaser	Average
[1,2]*Brachiaria nigropedata*					Decreaser	High
[1,2]*Cenchrus ciliaris*	√	√		√	Decreaser	High
[1,2]*Centropodia glauca*					Decreaser	High
[1,2]*Chloris virgata*					Increaser 2	Average
[2]*Cladoraphis spinosa*					Increaser 1	Low
[1,2]*Cynodon dactylon*					Increaser 2	High
[1,2]*Dactyloctenium aegyptium*					Increaser 2	Low
[1]*Danthoniopsis ramosa*					?	High
[1,2]*Dichanthium annulatum*					Decreaser	High

[2]*Diplachne fusca*					Decreaser	High
[1]*Echinochloa colona*					?	Low
[2]*Elionurus muticus*					Increaser 2	Low
[1,2]*Enneapogon cenchroides*	√	√	√	√	Increaser 2	Low
[1,2]*Enneapogon desvauxii*		√		√	Intermediate	Average
[1,2]*Enneapogon scaber*					?	Low
[1,2]*Enneapogon scoparius*					Increaser 2	Low
[1]*Entoplocamia aristulata*	√				Intermediate	Low
[1,2]*Eragrostis annulata*					Increaser 2	Low
[1]*Eragrostis cylindriflora*	√	√		√	?	Low
[2]*Eragrostis biflora*					Increaser 2	Low
[2]*Eragrostis cilianensis*					Increaser 2	Low
[1,2]*Eragrostis echinochloidea*	√	√			Increaser 2	Average
[1]*Eragrostis homomalla*					?	Low
[2]*Eragrostis lehmanniana*					Increaser 2	Average
[1,2]*Eragrostis nindensis*	√	√		√	Increaser 2	Average
[1]*Eragrostis omahekensis* [E]					?	Low
[1]*Eragrostis porosa*	√				Intermediate	Low
[1]*Eragrostis rigidior*					Increaser 2	Average
[1,2]*Eragrostis rotifer*		√			Intermediate	Low
[1]*Eragrostis scopelophila*					?	High
[1,2]*Eragrostis superba*	√				Increaser 2	Average
[1,2]*Eragrostis trichophora*	√				Increaser 2	Average
[1,2]*Eragrostis viscosa*					Increaser 2	Low
[1,2]*Fingerhuthia africana*				√	Decreaser	Average
[1,2]*Heteropogon contortus*					Increaser 2	Average
[1,2]*Hyparrhenia hirta*					Increaser 1	Average
[1]*Leptochloa fusca*					?	Average
[1,2]*Microchloa caffra*					Increaser 2	Low
[1]*Monelytrum luederitzianum*					?	Average
[1,2]*Melinis repens*	√	√		√	Increaser 2	Low
[1]*Odyssea paucinervis*					?	Average
[1,2]*Oropetium capense*					?	Low
[1,2]*Panicum coloratum*					Decreaser	High
[1,2]*Panicum maximum*					Decreaser	High
[2]*Panicum repens*					Decreaser	High
[1]*Pogonarthria fleckii*		√			Increaser 2	Low
[2]*Polypogon monspeliensis*					?	Average
[1,2]*Schmidtia kalahariensis*			√		Increaser 2	Low
[1,2]*Schmidtia pappophoroides*					Decreaser	High
[1]*Setaria appendiculata*					?	Average
[1,2]*Setaria verticillata*	√				Increaser 2	Average
[1]*Sorghum bicolour*					?	Average
[1,2]*Sporobolus festivus*					Increaser 2	Low
[1,2]*Stipagrostis ciliata*					Decreaser	High
[1]*Stipagrostis giessii*					?	Average
[1,2]*Stipagrostis hirtigluma*					Increaser 2	Low
[1]*Stipagrostis hochstetteriana*	√		√		Decreaser	Average
[1,2]*Stipagrostis namaquensis*			√		?	Average
[1,2]*Stipagrostis obtusa*					Decreaser	High
[1,2]*Stipagrostis uniplumis*	√	√		√	Increaser 2	Average
[1,2]*Tricholaena monachne*					Increaser 2	Average
[1]*Triraphis purpurea*					?	Low
[1]*Triraphis ramosissima*		√		√	?	Average
[1,2]*Tragus berteronianus*					Increaser 2	Low
[1]*Tragus racemosus*					Increaser 2	Low
[1]*Urochloa brachyura*					?	Average
[1]*Urochloa panicoides*					?	Low

Endemic – Müller (2007)

? – not classified in literature, but often similar to other species within the genus

Of the approximately 80 grasses that are expected in the general area, 1 species viewed as endemic (*Eragrostis omahekensis*), 15, 14 and 4 species were observed on the plains, hills and rivers habitats, respectively. However, many more species are expected to occur in the general area. During the below average 2012/13 rainfall season only 9 grass species were encountered in the Helikon Mine area (Cunningham 2013).

Figure 17. The general area received above average rainfall during the 2016/2017 rainy season resulting in good grass cover.

Plains

Twelve (12) species of grass were encountered along various transects totalling 200m in the proposed development area. *Enneapogon cenchroides* (20%), *Stipagrostis hochstetteriana* (20%), *Stipagrostis uniplumis* (18%) and *Entoplocamia aristulata* (15%) were the most dominant grass species observed during the fieldwork (Figure 18). The high percentage of *Enneapogon cenchroides* and *Entoplocamia aristulata* – 35% – indicates long term disturbances – e.g. overgrazing.

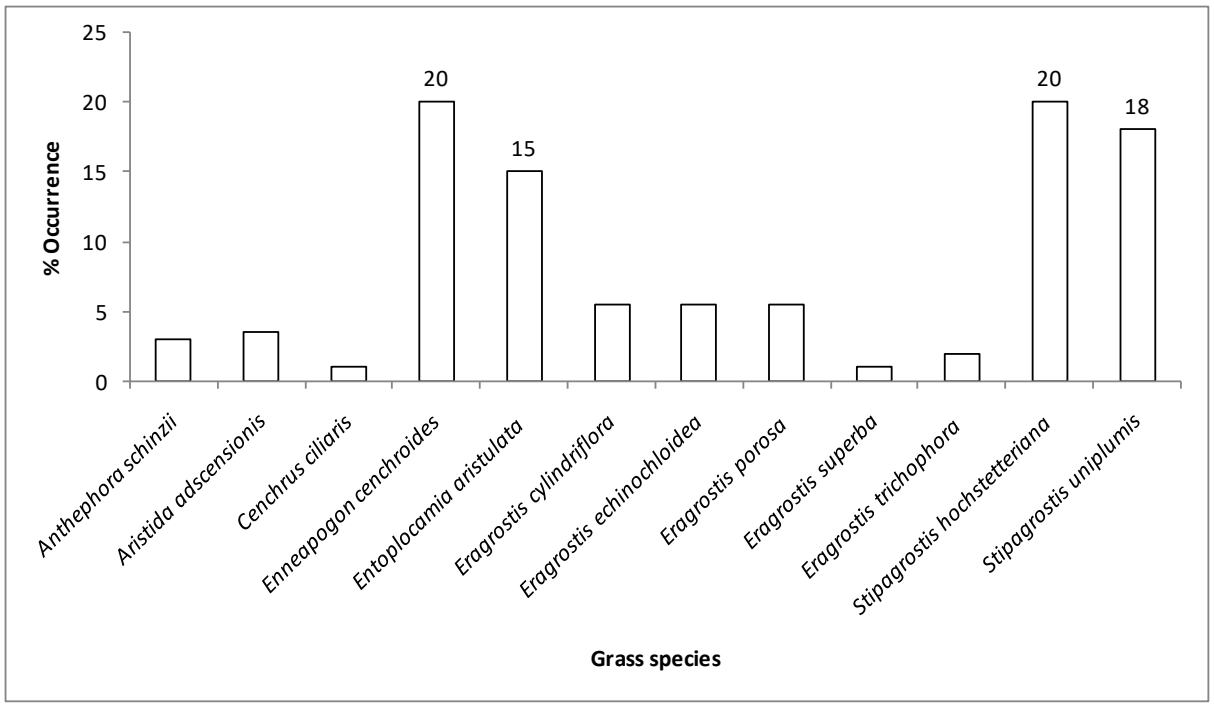

Figure 18. Grass species composition along various transects (total length - 200m @ 1m intervals) in the plains habitat (n=200 points).

Hills – Helikon

Eleven (11) species of grass were encountered along various transects totalling 200m in the proposed development area. *Enneapogon desvauxii* (26%), *Enneapogon cenchroides* (25.5%) and *Eragrostis nindensis* (14.5%) were the most dominant grass species observed during the fieldwork (Figure 19). The high percentage of *Enneapogon desvauxii* and *Eragrostis nindensis* – 40.5% – is typical of hill areas in the general area.

Hills – Rubicon

Eight (8) species of grass were encountered along various transects totalling 200m in the proposed development area. *Stipagrostis uniplumis* (31.5%), *Aristida adscensionis* (21%), (18%) and *Eragrostis nindensis* (20.5%) were the most dominant grass species observed during the fieldwork (Figure 19). The high percentage of *Aristida adscensionis* – 21% – indicates long term disturbances – e.g. overgrazing. These hills are generally more accessible to grazers and therefore the difference in species composition between these two sites.

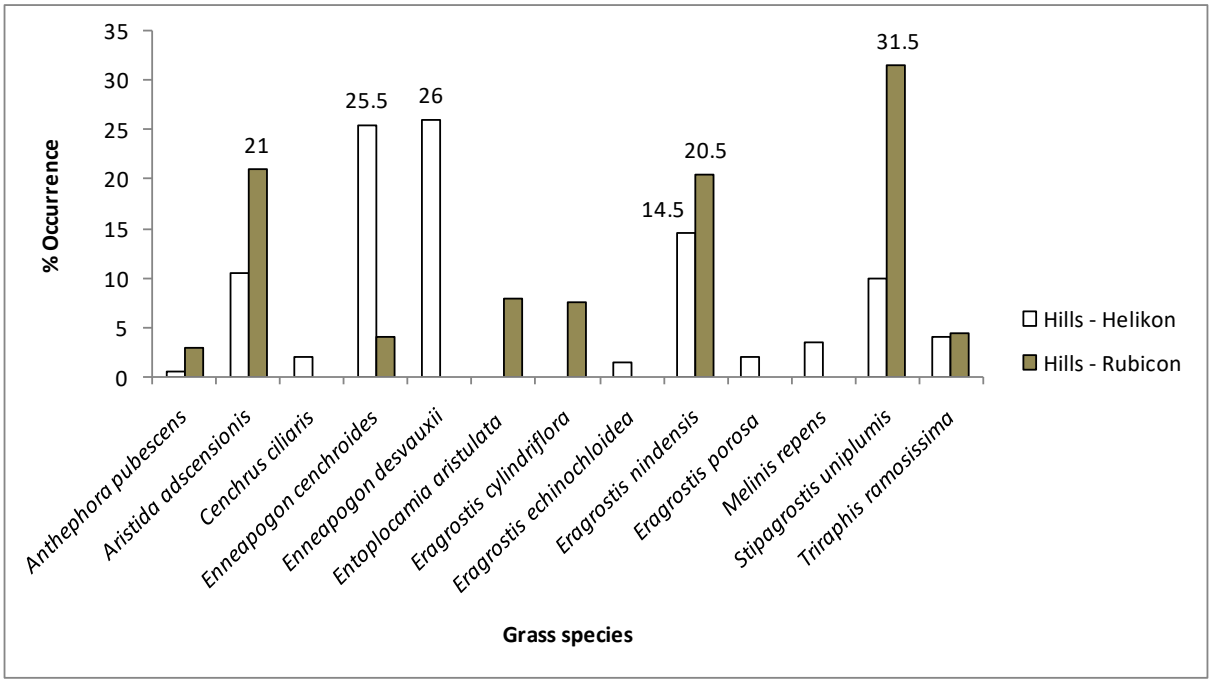

Figure 19. Grass species composition along various transects (total length - 200m @ 1m intervals) in the Helikon and Rubicon hills habitat (n=200 points).

Rivers

Six (6) species of grass were encountered along various transects totalling 200m in the proposed development area. *Enneapogon cenchroides* (62.5%), *Stipagrostis uniplumis* (13%) and *Schmidtia kalahariensis* (9.5%) were the most dominant grass species observed during the fieldwork (Figure 20). The high percentage of *Enneapogon cenchroides* and *Schmidtia kalahariensis* – 72% – both annual species, indicates long term disturbances – e.g. overgrazing. However, perennial species are limited in drainage lines due to ease of access fpr grazers and occasional water movement.

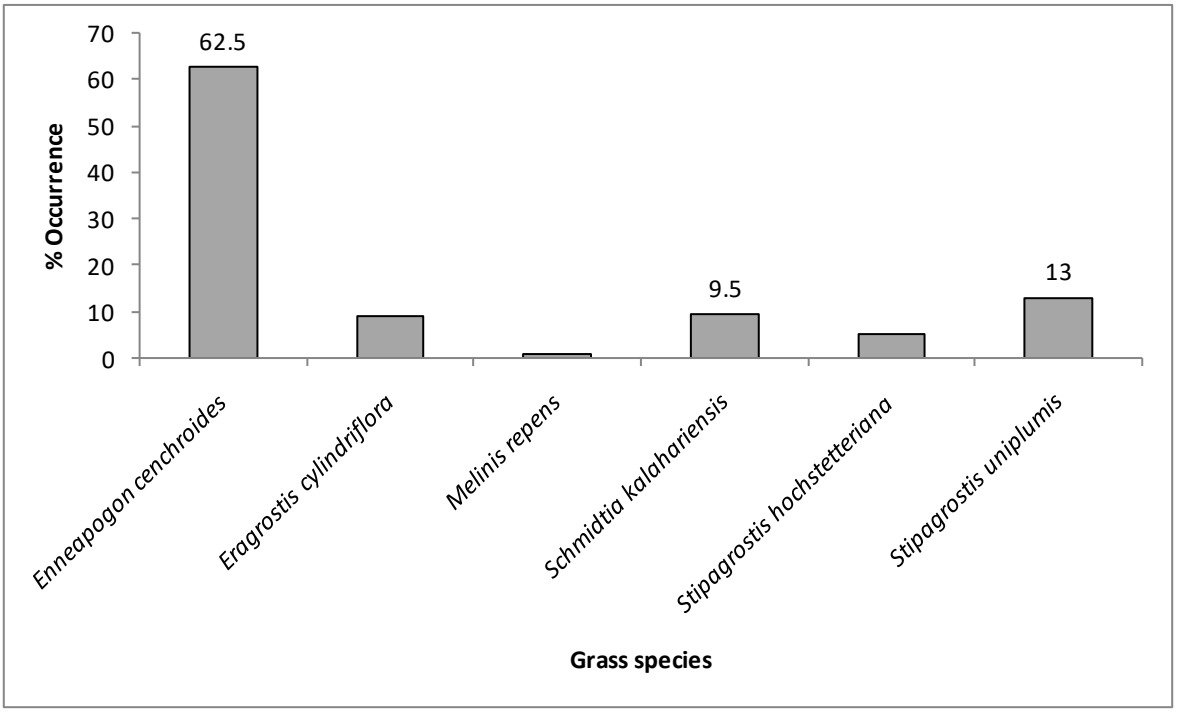

Figure 20. Grass species composition along various transects (total length - 200m @ 1m intervals) in the river habitats (n=200 points).

The Helikon and Rubicon mining areas have been heavily impacted due to past mining activities and none of the unique grasses are expected to be exclusively associated with these mining areas. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on grasses potentially occurring in the area.

3.7 Other Species

Other species observed throughout the proposed development area included the following herbs, etc. (Table 9). This list is not comprehensive – i.e. many more species are known and/or expected to occur in the area – as most herbs are annuals; dry season conditions and exceptional grass cover and biomass; long term domestic stock grazing probably resulted in fewer herbs being present.

Table 8. Other species – mainly herbs – confirmed during fieldwork in the Helikon and Rubicon areas.

Species	Habitat	Status
Abutilon rehmannii	H	
Aptosimum arenarium	H	End
Asparagus sp.	H	
Barleria lanceolata	P	End
Barleria lancifolia	H	
Bidens bipinnata	P	Alien
Blepharis obmitrata	P	
Citrullus lanatus	P	
Cleome angustifolia	H	
Cleomeelegantissima	H	
Corallocarpus welwitschii	P	
Crotalaria sp.	P	
Dactyliandra welwitschii	P	
Dicoma anomala	H	
Geigeria ornativa	P	
Geigeria pectidia	P	
Gossypium triphyllum	P	
Helichrysum zeyheri	H	
Hermbstaedtia argenteiformis	H, R	N-end
Hibiscus elliottiae	H	
Hibiscus sp.	P	
Hirpicium gazanioides	P	
Ingigophera alternans	P	
Jamesbrittenia sp.	H	
Justicia guerkeana	H	
Leucas pechuelii	P	
Leucosphaera bainesii	P, H	
Monechma genistifolium	P, H	
Myrothamnus flabellifolius	H	
Pegolettia senegalensis	H	
Rhynchosia sublobata	H	
Sesamum capense	R	
Sonchus oleraceus	P	Alien
Tribulus terrestris	H	

Invasive alien species

Invasive alien species were limited to the old Rubicon mining site and include:
Opuntia sp. x two species
Prosopis sp.
Sisal sp.

Figure 21. *Opuntia* sp. observed at in the vicinity of the old Rubicon Mine.

Figure 22. *Opuntia* sp. observed at in the vicinity of the old Rubicon Mine.

Figure 23. *Prosopis* sp. in the Rubicon area.

Figure 24. *Sisal* sp. (See arrows) – probably originally planted as ornamental plants – in the old Rubicon mining area.

3.8 Important Species

Reptiles

The high percentage of endemic reptile species (45.3%) associated with the rocky escarpment region of central western Namibia underscores the importance of this area without formal state protection. The most important species expected to occur in the general area (See Table 1) are viewed as the tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; Namibian wolf snake (*Lycophidion namibianum*) – *Varanus albigularis* and some of the endemic and little known gecko species – e.g. *Pachydactylus* species. Tortoises, snakes and monitor lizards are routinely killed for food or as perceived threats. Other important species are those viewed as "rare" – i.e. *Rhinotyphlops lalandei*, *Mehelya vernayi* & *Afroedura africana* – although very little is known about these species.

Amphibians

Of the seven species of amphibians that potentially could occur in the general area of which 2 species are endemic (*Poyntonophrynus hoeschi* and *Phrynomantis annectens*) (Griffin 1998b) and 1 species is classified as "near threatened" (*Pyxicephalus adspersus*) (Du Preez and Carruthers 2009) – i.e. high level (42.9%) of amphibians of conservation value from the general area. With the exception of these important species and due to the fact that there is no open permanent surface water in the area, amphibians are not viewed as very important in the general area.

Mammals

Of the 87 species of mammals known and/or expected to occur in the general Karibib area, 9 species (10.3%) are classified as endemic. Rodents (of which 6 species – 23.1% – are endemic) and bats (of which 1 species is classified as "rare") are the groups least studied. Species of greatest concern in the general area are those viewed as "rare" in Namibia – i.e. Namibian wing-gland bat and Southern African hedgehog – and species classified as "near threatened" – i.e. Commerson's roundleaf bat, striped leaf-nosed bat & brown hyena, leopard – and "vulnerable" by the IUCN (2016) – i.e. cheetah & Hartmann's mountain zebra.

Birds

At least 217 bird species [mainly terrestrial "breeding residents"] occur and/or could occur in the general Karibib area at any time and include 12 of the 14 Namibian endemics (85.7% of all Namibian endemic species or 5.6% of all the species expected to occur in the area). The most important bird species from the general area are those classified as endemic to Namibia of which the Damara hornbill and Herero chat are viewed as the most important due to the overall lack of knowledge of these species. Although also viewed as important, Rüppels korhaan is migratory throughout its range while the rockrunner inhabits inaccessible terrain and is widespread throughout mountainous areas in Namibia. Other species of concern are those classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretarybird) and near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015).

Flora

Trees/shrubs and Grasses

At least 91 to 101 larger species of trees and shrubs are known and/or expected to occur in the general area of which 8 species (7.9%) expected to occur in the general Karibib area are classified as endemics, 4 species as near endemics, 23 species (22.8%) are protected by the Forest Act No 12. of 2001 and another 2 species by various other Forestry laws (Curtis and Mannheimer 2005 and Mannheimer and Curtis 2009), 5 species (4.9%) are protected under the Nature Conservation Ordinance No. 4 of 1975 while 6 species (5.9%) are classified as CITES Appendix 2 species. All the trees with some kind of conservation and/or protected status are viewed as important in the general Karibib area. The endemic grass – *Eragrostis omahekensis* – is viewed as the most important species potentially occurring in the general area.

Other

Aloes

Aloes are protected throughout Namibia with 3 other aloe species not included in Table 6, but which potentially occur in the general area, and also viewed as important are *Aloe asperifolia*, *A. hereroensis* and *A. zebrina* (Rothmann 2004).

Commiphora

Many endemic Commiphora species are found throughout Namibia with Steyn (2003) indicating that *Commiphora crenato-serrata* (not included in the Table 6) potentially also occurring in the general area.

Lithops

Lithops species – all protected (See Nature Conservation Ordinance No. 4 of 1975) – are also known to occur in the general area and often difficult to observe, especially during the dry season when their aboveground structures wither. The closest species are currently only known to occur west of Usakos and include *Lithops gracilidelineata* var. *gracilidelineata* and *L. werneri* (Cole and Cole 2005).

Ferns
At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general Karibib area include at least 15 indigenous species (*Actiniopteris radiata*, *Asplenium cordatum*, *Cheilanthes dinteri*, *C. eckloniana*, *C. marlothii*, *C. parviloba*, *Marselia aegyptiaca*, *M. ephippiocarpa*, *M. farinosa*, *M. macrocarpa*, *M. nubica*, *M. unicornis*, *M. vera*, *Ophioglossum polyphyllum* & *Pellaea calomelanos*) (Crouch *et al.* 2011). The general area is undercollected with more species probably occurring in the general area than presented above.

Lichens
The overall diversity of lichens is poorly known from Namibia, especially the coastal areas and statistics on endemicity is even sparser (Craven 1998). More than 100 species are expected to occur in the Namib Desert with the majority being uniquely related to the coastal fog belt (Wirth 2010). Lichen diversity is related to air humidity and generally decreases inland form the Namibian coast (Schults and Rambold 2007). Off road driving is the biggest threat to these lichens which are often rare and unique to Namibia. To indicate how poorly known lichens are from Namibia, the recent publication by Schultz *et al.* (2009) indicating that 37 of the 39 lichen species collected during BIOTA surveys in the early/mid 2000's were new to science (i.e. new species), is a case in point. Lichens are known to occur on rocky terrain in the mountainous terrain in the general area.

Other species with commercial potential that could occur in the general Karibib area include *Harpagophytum procumbens* (Devil's claw) – harvested for medicinal purposes and often over-exploited – and *Citrullus lanatus* (Tsamma melon) which potentially has a huge economic benefit (Mendelsohn *et al.* 2002).

3.9 Important Areas

The most important areas in the Helikon and Rubicon mining areas are:

1. Hills

Rocky areas generally have high biodiversity and consequently viewed as important habitat for all vertebrate fauna and flora. A hill in the Helikon area has a high density of *Aloe litoralis* (protected) as well as *Ficus cordata* (protected), *Sterculia africana* (protected) and *Commiphora glaucescens* (near endemic) individuals (See Figures 12, 15, 25, 26 and 27).

2. Ephemeral drainage lines

The various ephemeral drainage lines are important habitat to larger trees, especially *Acacia erioloba* (protected), *Euclea pseudebenus* (protected), *Faidherbia albida* (protected) and *Ziziphus mucronata* (protected) (See Figures 13, 16, 26, 27).

Figure 25. Hill with a high density of *Aloe litoralis* and other protected species on its northern aspect.

Figure 26. The patch of *Aloe litoralis* (and other protected species – See 3.9 (1) is located on the northern aspect of the hill (red oblong) in the Helikon area. Other important habitats are the hills indicated in white and the ephemeral drainage lines in blue.

Figure 27. The important habitats in the Rubicon mining area are the hills indicated in white and the ephemeral drainage lines in blue.

The proposed Helikon Haul Road (purple line in Figure 28) passes along/through a recognised important habitat (See Figures 25 and 26) in the area indicated by a white oblong in Figure 28 below. It is recommended that this route be realigned further to the east (i.e. 500m) to avoid impacting on this habitat (See dotted black arrow).

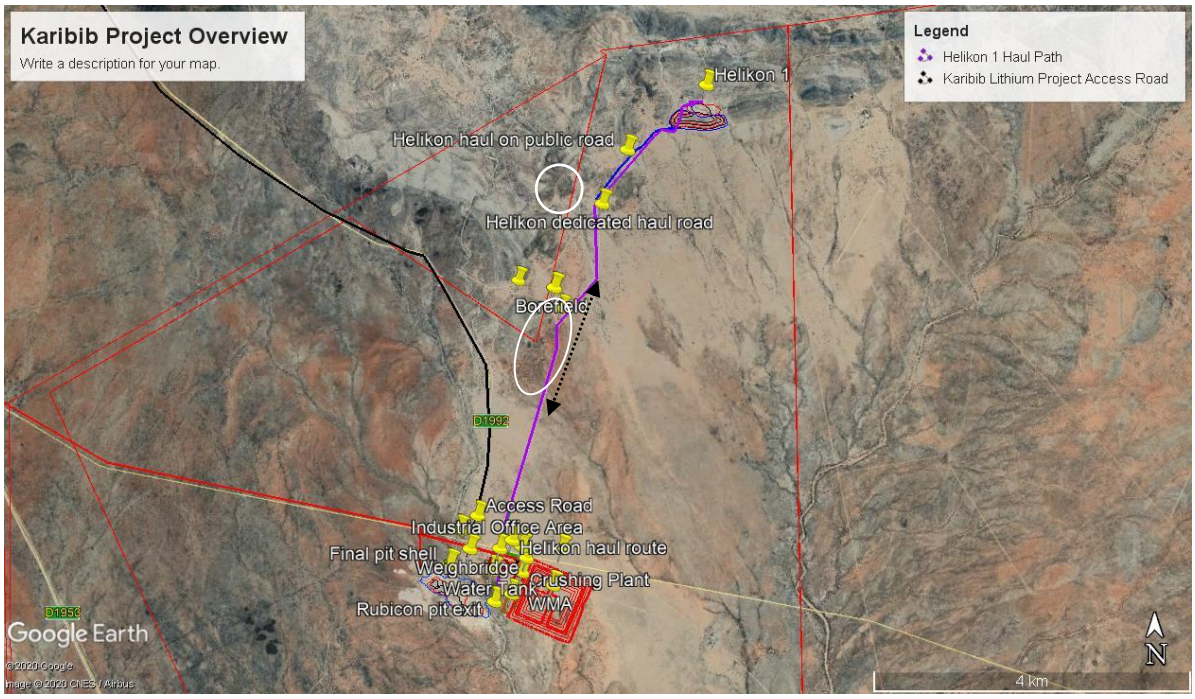

Figure 28. Important habitats (See Figures 25 and 26) along the Helikon Haul Route. Part of this proposed haul route passes along/through an important habitat – See white oblong – with protected tree species – e.g. *Aloe litoralis*, *Sterculia africana*, etc.

The proposed Rubicon Waste Management Area (WMA) – See Figure 29 below – is expected to cover some small rocky outcrops on its eastern boundary (See white circle). Although this area has not been identified as an important habitat (See Figure 27 and elsewhere in this report), it remains a potentially important habitat and it is recommended that the proposed WMA design be adapted to avoid impacting on this habitat. This could be extended towards the east along the NamWater Pipeline route and/or towards the south between the ephemeral drainage line (which is an important habitat) and the rocky outcrops (See dotted black arrows).

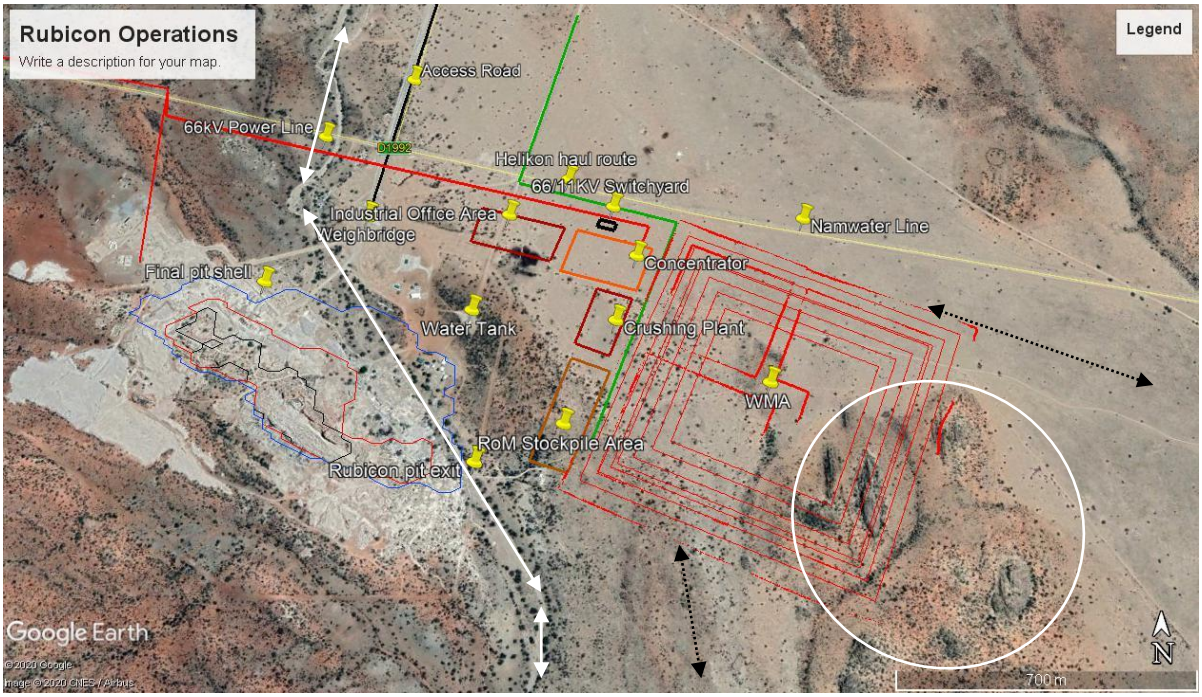

Figure 29. The proposed Waste Management Area (WMA) would cover some rocky outcrops to the east (See white circle). Although these are not viewed as confirmed important habitat from the immediate area (See Figure 27), such rocky areas are nevertheless potentially important habitat throughout the general area.

The proposed Helikon Waste Management Area (WMA) – See Figure 30 below – is not expected to affect any important habitats.

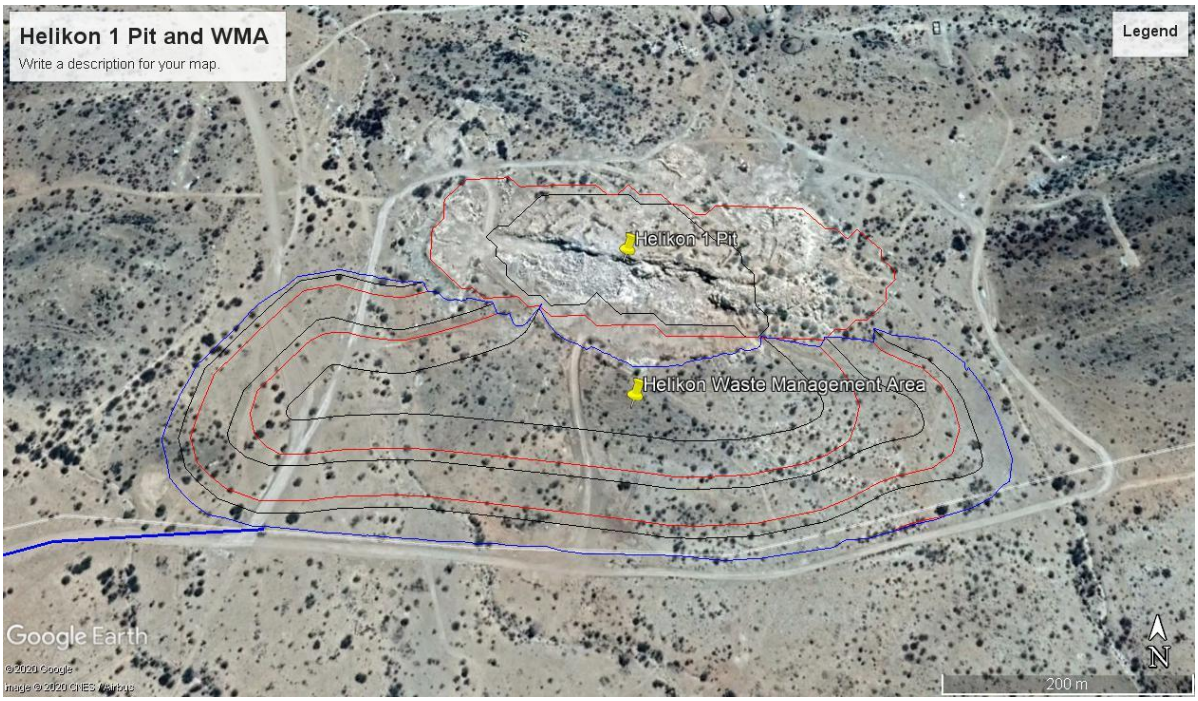

Figure 30. The Helikon 1 Pit and WMA are not expected to affect any important habitats according to the proposed layout.

4 Envisaged impacts

4.1 Introduction

All developments change or are destructive to the local fauna and flora to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development – i.e. development, once initiated, may have a different effect on the fauna and flora as originally predicted. Thus continuing monitoring of such impacts during the development phase(s) is imperative.

4.2 Faunal disturbance

Faunal disturbance with the proposed mining activities would be localised. The following table indicates the potential/envisaged impacts expected regarding faunal disturbance (which is obviously closely linked to habitat destruction):

Description	Faunal disturbance will vary depending on the scale/intensity of the development operation and associated and inevitable infrastructure.
Extent	**1.** Access routes - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual routes. This however, would be a relatively small area with localised implications. **2.** Mining/Prospecting sites - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual sites. This however, would be a relatively small area – depending on scale of operations – with localised implications. **3.** Infrastructure - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual sites. This however, would be a relatively small area – especially if the existing old Helikon and Rubicon infrastructure areas are used rather than affecting new sites – with localised implications.

Duration	**1.** Access route(s) - The duration of the impact is expected to be permanent along the route(s). This however, would be a relatively small area(s) with localised implications. **2.** Mining/Prospecting sites - The duration of the impact is expected to be permanent at the site. This however, would be relatively small area(s) with localised implications. **3.** Infrastructure - The duration of the impact is expected to be permanent at the site(s). This however, would be relatively small area(s) with localised implications.
Intensity	**1.** Access route(s) - The actual sites where construction of the route(s) would be located would be permanently altered. This however, would be relatively small area(s) with localised implications. **2.** Mining/Prospecting - The actual prospecting/mining site(s) would be permanently altered. This however, would be relatively small area(s) with localised implications. **3.** Infrastructure - The actual construction sites associated with the various mining infrastructures would be permanently altered. This however, would be relatively small area(s) with localised implications. The areas adjacent the mining site(s) and other associated infrastructure should not be significantly affected. This however, would depend on control over the contractors during the road building, construction phase(s) & prospecting/mining phase(s), but should be limited to localised implications. Areas not directly affected by the prospecting/mining and associated infrastructure although within the immediate area would be affected minimally. This would include dust, noise, light & other associated disturbances in the area, but be limited to the prospecting/mining & construction periods.
Mitigation	**General** **1.** Limit the development to actual sites to be mined/prospected and avoid affecting adjacent areas, especially mountainous areas and ephemeral drainage lines, throughout the entire area. **2.** Avoid development & associated infrastructure in sensitive areas – e.g. hills and drainage lines in the immediate area (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various vertebrate fauna species. **3.** Remove (e.g. capture) unique fauna and sensitive fauna before commencing with the development activities and/or species serendipitously located during this period and relocate to a less sensitive/disturbed sites in the immediate area. **4.** Prevent and discourage the setting of snares (poaching), illegal collecting of veld foods (e.g. tortoises, etc.), indiscriminate killing of perceived dangerous species (e.g. snakes, etc.) and collecting of wood as this would diminish and negatively affect the local fauna – especially during the development phase(s). **5.** Attempt to avoid the removal of bigger trees during the development phase(s) – especially with the development of access routes – as these serve as habitat for a myriad of fauna. **6.** Prevent and discourage fires – especially during the development phase(s) – as this could easily cause runaway veld fires affecting the local fauna, but also causing problems (e.g. loss of grazing & domestic stock mortalities, etc.) for the neighbouring farmers. **7.** Rehabilitation of the disturbed areas – i.e. initial development access route "scars" and associated tracks as well as associated mining infrastructures. Preferably workers should be transported in/out to the construction sites on a

	daily basis to avoid excess damage to the local environment (e.g. fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company's environmental integrity, but also show true local commitment to the environment. **8.** Prevent domestic pets – e.g. cats & dogs – accompanying the workers during the construction phase as cats decimate the local fauna and interbreed & transmit diseases to the indigenous African Wildcat found (and confirmed) in the area. Dogs often cause problems when bonding on hunting expeditions thus negatively affecting the local fauna. The indiscriminate and wanton killing of the local fauna by such pets should be avoided at all costs. **9.** Initiate a suitable waste removal system (i.e. remove to Karibib and not store on site) as this often attracts wildlife – e.g. baboons & black-backed jackal, crows, etc. – which may result in human-wildlife conflict issues. **10.** Educate/inform contractors and staff on protected species (See Tables 1 to 4) to avoid and the consequences of illegal collection of such species. **11.** Investigate the idea of employing an Environmental Officer during the construction phase(s) to ensure compliance and minimise the overall impact on the fauna and the environment. **Tracks** **12.** Avoid placing access routes (roads & tracks) trough sensitive areas – e.g. over hills and along drainage lines. This would minimise the effect on localised potentially sensitive habitats in the area. **13.** Avoid driving randomly through the area (i.e. "track discipline"), but rather stick to permanently placed roads/tracks – especially during the construction phase. This would minimise the effect on localised potentially sensitive habitats in the area. **14.** Stick to speed limits of maximum 30km/h as this would result in fewer faunal road mortalities. Speed humps could also be used to ensure the speed limit. Lower speeds would also minimise dust pollution. **15.** Implement erosion control. – i.e. avoid constructing tracks up steep gradients; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards & adjacent the drainage line(s) are easily eroded and further development may exacerbate this problem. Avoid construction within 20m of the main drainage line(s) to minimise erosion problems as well as preserving the riparian associated flora and fauna. **Helikon Haul Route** **16.** Move the proposed Helikon Haul Route to the east (i.e. 500m) to avoid sensitive habitat (i.e. rocky outcrop with protected tree species) (See Figures 26 and 28). **Rubicon WMA** **17.** Realign the proposed Rubicon WMA to the east and/or south to avoid potentially important habitat (i.e. rocky outcrops) (See Figure 29). **18.** The WMA should be terraced and each layer covered with topsoil to facilitate grass growth and ensure rehabilitation.
Frequency of occurrence	Expected to be a "once off" issue affecting the selected site(s). Further prospecting & associated road construction (should this become necessary/evident during the mining operations) throughout the area would however increase the frequency of occurrence.

Probability	Definite (100%) negative impact on fauna is expected in the actual mining areas as well as the access route(s) and infrastructure development sites. This however, would be much localised and cover only a small area(s) and should avoid sensitive areas. Highly Probable (75%) negative impact on fauna is expected in the general areas especially during the construction and mining phase(s) as a result of noise, increased activities, etc. Probable (50%) negative impact on fauna is expected from the infrastructure (roads/tracks/buildings, etc.). Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. hills, mountainous areas & drainage lines) with associated fauna would bear the brunt of this proposed development, but be limited in extent and only permanent at the actual mining site(s) and access routes and infrastructure sites.
Legal requirements	Fauna related: Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN and SARDB Habitat – Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES
Degree of confidence in predictions	As an ecologist I am sure of the above mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local fauna in the area.

4.3 Floral disturbance

Floral disturbance with the mining would be localised. The following table indicates the potential/envisaged impacts expected regarding floral disturbance (which is obviously closely linked to habitat destruction):

Description	Floral disturbance will vary depending on the scale/intensity of the development operation and associated and inevitable infrastructure.
Extent	**1.** Access routes - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual routes. This however, would be a relatively small area(s) with localised implications. **2.** Mining/Prospecting sites - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual sites. This however, would be relatively small area(s) – depending on scale of operations – with localised implications. **3.** Infrastructure - Localised disruption/destruction of the habitat and thus consequently flora associated directly with the actual sites. This however, would be relatively small area(s) – especially if the existing old Helikon and Rubicon infrastructure areas are used rather than affecting new sites – with localised implications.

Duration	**1.** Access route(s) - The duration of the impact is expected to be permanent along the route(s). This however, would be relatively small area(s) with localised implications. **2.** Mining/Prospecting sites - The duration of the impact is expected to be permanent at the site(s). This however, would be relatively small area(s) with localised implications. **3.** Infrastructure - The duration of the impact is expected to be permanent at the site(s). This however, would be relatively small area(s) with localised implications.
Intensity	**1.** Access route(s) - The actual sites where construction of the route(s) would be located would be permanently altered. This however, would be relatively small area(s) with localised implications. **2.** Mining/Prospecting - The actual mining/prospecting site(s) would be permanently altered. This however, would be relatively small area(s) with localised implications. **3.** Infrastructure - The actual construction sites associated with the various mining infrastructures would be permanently altered. This however, would be relatively small area(s) with localised implications. The areas adjacent the mining/prospecting site(s) and other associated infrastructure should not be significantly affected. This however, would depend on control over the contractors during the road building, construction phase(s) & mining/prospecting phase(s), but should be limited to localised implications. Areas not directly affected by the mining/prospecting and associated infrastructure although within the immediate area would be affected minimally. This would include dust & other associated disturbances in the area, but is limited to the mining/prospecting & construction periods.
Mitigation	**General** **1.** Limit the development to actual sites to be mined/prospected and avoid affecting adjacent areas, especially mountainous areas and ephemeral drainage lines, throughout the entire area. **2.** Avoid development & associated infrastructure in sensitive areas – e.g. in/close to *Aloe litoralis* Hill (Helikon area); hills and drainage lines in the immediate area (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various flora species. **3.** Remove unique and sensitive flora (e.g. *Aloe litoralis* on Aloe Hill – See 3.9 & all other *Aloe* sp., etc.) before commencing with the development activities and relocate to a less sensitive/disturbed sites in the immediate area. **4.** Prevent and discourage the collecting of firewood as dead wood has an important ecological role – especially during the development phase(s). Such collecting of firewood, especially for economic reasons, often leads to abuses – e.g. chopping down of live and/or protected tree species such as *Acacia erioloba* which is a good quality wood. **5.** Attempt to avoid the removal of bigger trees during the development phase(s) – especially with the development of access routes – as these serve as habitat for a myriad of fauna. Avoid the destruction of larger trees associated with the ephemeral drainage lines. **6.** Prevent and discourage fires – especially during the development phase(s) – as this could easily cause runaway veld fires causing problems (e.g. loss of grazing & domestic stock mortalities, etc.) for the neighbouring farmers.

7. Rehabilitation of the disturbed areas – i.e. initial development access route "scars" and associated tracks as well as associated mining/prospecting infrastructures. Preferably workers should be transported in/out to the construction sites on a daily basis to avoid excess damage to the local environment (e.g. fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company's environmental integrity, but also show true local commitment to the environment.

8. Prevent the planting of potentially invasive alien plant species (e.g. *Tecoma stans*, *Pennisetum setaceum*, etc.) for ornamental purposes as part of the landscaping – e.g. office buildings, etc. Alien species often "escape" and become invasive causing further ecological damage as is evident from previous human habitation in the area (i.e. invasive aliens on site include *Opuntia* sp., *Prosopis* sp. & *Sisal* sp.).

9. Eradicate – destroy – all invasive alien plants encountered on site – e.g. *Opuntia* sp., *Prosopis* sp. & *Sisal* sp., etc. This would ensure that the spread is limited and show environmental commitment.

10. Incorporate indigenous vegetation – especially the protected species e.g. *Acacia erioloba*, *Boscia albitrunca*, etc. – into the overall landscaping. Indigenous species require less water and overall maintenance.

11. Educate/inform contractors and staff on protected species (See Table 5 & Section 3.8) to avoid and the consequences of illegal collection of such species.

12. Investigate the idea of employing an Environmental Officer during the construction phase(s) to ensure compliance and minimise the overall impact on the flora and the environment.

Tracks

13. Avoid placing access routes (roads & tracks) trough sensitive areas – e.g. *Aloe litoralis* Hill – Helikon area; hills and along drainage lines. This would minimise the effect on localised potentially sensitive habitats in the area.

14. Avoid driving randomly through the area (i.e. "track discipline"), but rather stick to permanently placed roads/tracks – especially during the construction phase. This would minimise the effect on localised potentially sensitive habitats in the area.

15. Stick to speed limits of maximum 30km/h. Speed humps could also be used to ensure the speed limit. Lower speeds would also minimise dust pollution.

16. Implement erosion control. – i.e. avoid constructing tracks up steep gradients; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards & adjacent the drainage line(s) are easily eroded and further development may exacerbate this problem. Avoid construction within 20m of the main drainage line(s) to minimise erosion problems as well as preserving the riparian associated flora and fauna.

Helikon Haul Route

17. Move the proposed Helikon Haul Route to the east (i.e. 500m) to avoid sensitive habitat (i.e. rocky outcrop with protected tree species) (See Figures 26 and 28).

Rubicon WMA

18. Realign the proposed Rubicon WMA to the east and/or south to avoid potentially important habitat (i.e. rocky outcrops) (See Figure 29).

	19. The WMA should be terraced and each layer covered with topsoil to facilitate grass growth and ensure rehabilitation.
Frequency of occurrence	Expected to be a "once off" issue affecting the selected site(s). Further prospecting & associated road construction (should this become necessary/evident during the mining operations) throughout the area would however increase the frequency of occurrence.
Probability	Definite (100%) negative impact on flora is expected in the actual mining/prospecting area(s) as well as the access route(s) and infrastructure development sites. This however, would be much localised and cover only a small area and should avoid sensitive areas. Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts. Highly Probable (75%) negative impact on flora is expected in the general areas especially with large scale extraction of groundwater for prospecting/mining activities. Probable (50%) negative impact on flora is expected from the infrastructure (roads/tracks/buildings, etc.). Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. *Aloe litoralis* Hill – Helikon area; mountainous areas & drainage lines) with associated flora would bear the brunt of this proposed development, but be limited in extent and only permanent at the actual mining site and access routes and infrastructure sites.
Legal requirements	Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN
Degree of confidence in predictions	As an ecologist I am sure of the above mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local flora in the area.

5 Conclusion

As all development have potential negative environmental consequences, identifying the most important faunal species including high risk habitats beforehand, coupled with environmentally acceptable mitigating factors, lessens the overall impact of such development.
Vertebrate fauna species most likely to be adversely affected by the proposed mining/prospecting in the Helikon/Rubicon areas would be sedentary species (i.e. species with limited mobility) such as unique reptiles (i.e. tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; Namibian wolf snake (*Lycophidion namibianum*) – *Varanus albigularis*; some of the endemic and little known gecko species – e.g. *Pachydactylus* species and species viewed as "rare" – i.e. *Rhinotyphlops lalandei*, *Mehelya vernayi* & *Afroedura africana* – although very little is known about these

species). Amphibians are not viewed as important in the area and mammals are more mobile and although important species are known to occur and/or pass through the area (see elsewhere in this report) none are expected to be specifically associated and/or expected to be negatively affected by the developments. Although general disturbances could affect bird species of concern – i.e. species classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretarybird) and near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) – birds are also mobile and not limited to the area.

Flora species most likely to be adversely affected by mining/prospecting would be the various protected species – See Table 5 – and especially the patch of *Aloe litoralis* on a hill in the Helikon area – See 3.9 – although these species are not specifically associated with the development sites.

Important areas in the general vicinity are viewed as hills (rocky areas, especially *Aloe litoralis* hill) and ephemeral drainage lines – See 3.9.

It is not expected that mining/prospecting developments will adversely affect any unique vertebrate fauna and flora in the Helikon and Rubicon areas, especially if the proposed recommendations (mitigation measures) are incorporated – See Sections 3.8, 3.9 and 4.

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