VERTEBRATE FAUNA AND FLORA ASSOCIATED WITH THE KRANZBERG-TSUMEB RAIL LINK UPGRADE – Phase 1
[Desktop Study – Baseline/Scoping]]

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Vertebrate fauna and flora expected in the Kransberg-Tsumeb Rail Link Upgrade Project area – Phase 1

1 Introduction

A desktop study (i.e. literature review) was conducted between 2 and 4 May 2022 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 Kransberg-Otjiwarongo area along the Phase 1 section of the Kransberg-Tsumeb rail link upgrade project. The aim was to determine the effect that the proposed rail link upgrade project, may have on the bio-physical environment (vertebrate fauna & flora) (Figures 1 and 2a,b).

This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general Kransberg-Otjiwarongo area which falls within two broad vegetation types:

a) **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 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).

The area in general is regarded as "moderate" in overall (all terrestrial species) diversity while the overall terrestrial endemism in the area on the other hand is "high" (Mendelsohn *et al.* 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "moderate" with 3-4 species expected – e.g. gemsbok, kudu, mountain zebra and springbok – while overall diversity and density of large carnivorous mammals (large predators) is viewed as "moderate" with 4 species expected – e.g. leopard, cheetah, spotted and brown hyena (Mendelsohn *et al.* 2002).

The generally 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 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 area although 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 throughout the area with and *Acacia reficiens* (red-bark Acacia) the dominant problem species (Bester 1996, Cunningham 1998, 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/Omaruru, neither within a Freehold (i.e. commercial) Conservancy with Okawi being the closest, east of Kransberg (Mendelsohn *et al.* 2002, NACSO 2021, See: www.nacso.org.na). The closest formally protected area are

the !Dorob (size: 107,540km²) and Namib-Naukluft National Parks (size: 49,768km²) located approximately 50-100km west and southwest of Kransberg, respectively.

It is estimated that at least 75 species of reptile, 7 amphibian, 88 mammal, 217 birds (breeding residents), 74-101 larger trees and shrubs and up to 80 grass species occur in the general Kransberg-Omaruru area of which a high proportion are endemics (e.g. reptiles – 45.3%).

b) **Thornbush Savannah [Tree and Shrub Savannah]** (Giess 1971) or Thornbush Shrubland (Mendelsohn *et al.* 2002). The vegetation structure is classified as Acacia shrublands (Mendelsohn *et al.* 2002). The Thornbush Savannah is the dominant vegetation type in central Namibia. Although the vegetation in the Thornbush Savannah/Thornbush Shruband varies considerably with large areas dominated by *Acacia* species, characteristic species include *Acacia mellifera* subsp. *detinens*, *A. reficiens*, *A. hebeclada* subsp. *hebeclada*, *A. erubescens*, *A. fleckii* and in some places *A. tortilis* subsp. *heteracantha*. Another tree species usually present is *Boscia albitrunca* with *Philenoptera nelsii* and *Ziziphus mucronata* also occurring in this vegetation type (Giess 1971).

Grass cover varies depending on soil type with climax grasses such as *Anthephora pubescens, Brachiaria nigropedata* and *Digitaria* species and *Urochloa bolbodes* representative. *Stipagrostis uniplumis* and *Schmidtia pappophoroides* also occur in this vegetation type in the course of succession (Giess 1971).

The average plant production is “very high” with the variation in green vegetation biomass viewed as “medium” estimated at 10-15% (Mendelsohn *et al.* 2002). Simmons (1998b) puts the plant endemism in the general Otjiwarongo area at between 1 and 20 species depending on the locality. The overall plant diversity (all species - “higher” plants) in the general area is “high” and estimated at 300-399 species (Mendelsohn *et al.* 2002). Plant endemism is “average” with 6-15 species expected from the general area.

Bush thickening or encroachment is viewed as an economic problem in the general area with an estimated 4,000 to 12,000 plants/ha – mainly *Acacia mellifera* being the dominant problematic species (Bester 2001, Cunningham 1998, Mendelsohn *et al.* 2002).

The Otjiwarongo area is not part of the communal conservancy system in Namibia with the closest such conservancy being the Ozonahi Conservancy to the east of the Waterberg Plateau Park, east of Otjiwarongo (Mendelsohn *et al.* 2002, NACSO 2021). The closest Freehold Conservancies are the Owipuka (farms to the south of Otjiwarongo) and Waterberg (farms to the east of Otjiwarongo) Conservancies (Mendelsohn *et al.* 2002, See: www.canam.iway.na). The closest formally protected area is the Waterberg Plateau Park (size: 405km²) located approximately 50km southeast of Otjiwarongo.

It is estimated that at least 77 reptile, 9 amphibian, 84 mammal, 218 bird species (breeding residents), at least 79-109 larger trees and shrubs and up to 111 grasses are known to or expected to occur in the general Omaruru-Otjiwarongo area of which a high proportion are endemics (e.g. 35.1% endemic reptiles).

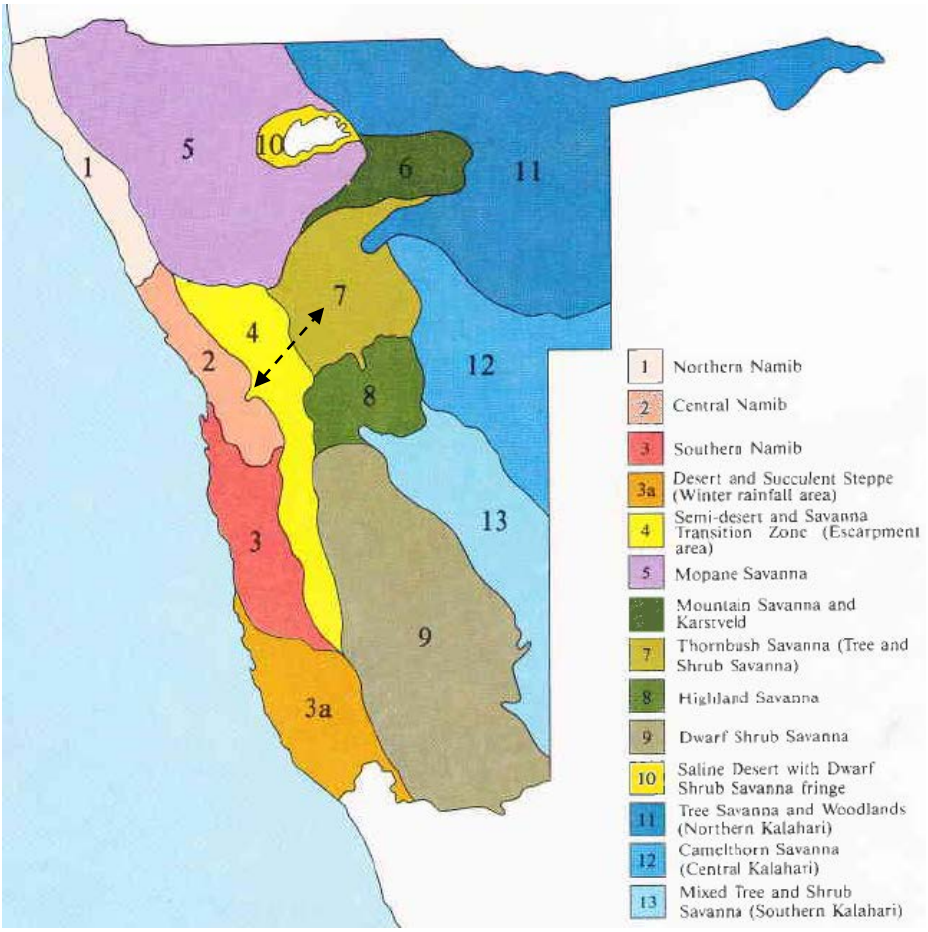
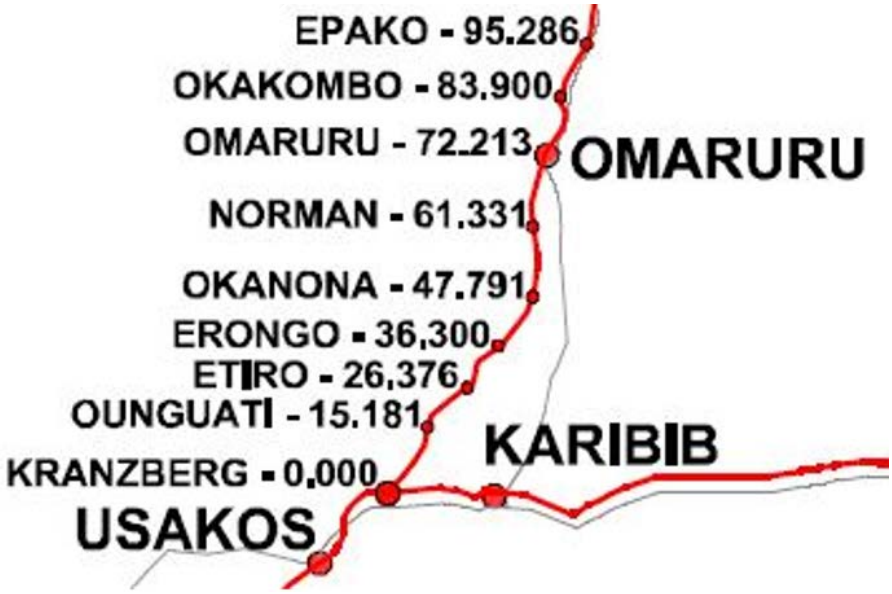
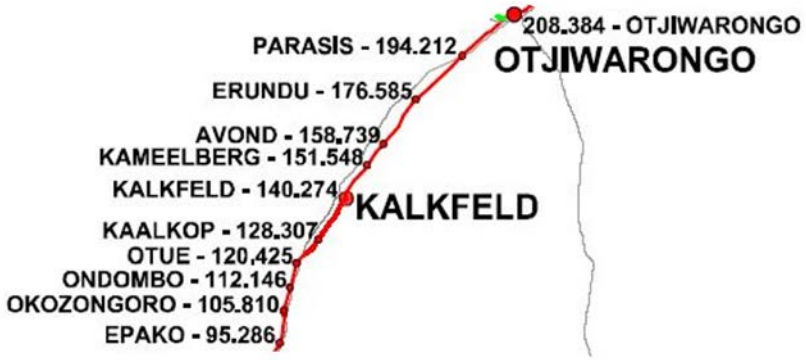


Figure 1. The Phase 1 section between Kransberg and Otjiwarongo falls within the Semi-Desert and Savannah Zone and the Thornbush Savannah vegetation types – See dashed arrow (Source: Giess 1971).





Figures 2a,b. Phase 1 of the Kransberg-Tsumeb rail link upgrade with 2a (top) – Kransberg to Omaruru and 2b (bottom) – Omaruru to Otjiwarongo.

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

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 (>1m in height) and grasses that could potentially occur in the general Kransberg-Otjiwarongo area (i.e. Phase 1 section) was conducted using as many references as manageable. A list of the references consulted can be viewed in the Reference section (Page 49).

3 Results

3.1 Reptile Diversity

Reptile diversity known and/or expected to occur along the Phase 1 section of the route is divided between the Kransberg-Omaruru and Omaruru-Otjiwarongo areas, and presented in Table 1.

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continents 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. There is currently no data for the !Dorob National Park.

Kransberg-Omaruru
At least 75 species of reptiles are expected to occur in the Kransberg-Omaruru 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 and 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 and 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.

According to the Namibian legislation 3 species are viewed as rare (*Rhinotyphlops lalandei*, *Limaformosa (Mehelya) vernayi*, *Afroedura africana*), 4 species as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*), 5 species as protected game, 4 species insufficiently known and 3 species as peripheral. The IUCN (2021) classifies 37 species as least concern although not all the reptiles have yet been assessed by the IUCN Red List. The SARDB (2004) classifies 1 species as vulnerable, 1 species as safe to vulnerable and 2 species as peripheral while CITES lists 7 species under Appendix 2 and 1 species under Appendix 3.

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* and *Afroedura africana* – although very little is known about these species.

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 Kransberg-Omaruru area than presented in Table 1.

None of the reptile species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development areas.

Omaruru-Otjiwarongo

At least 77 species of reptiles are expected to occur in the general Omaruru-Otjiwarongo area with 27 species being endemic – i.e. 35.1% endemic. These consist of at least 35 snakes (3 blind snakes, 2 thread snakes, 2 python, 1 burrowing asp, 2 quill snouted and 25 typical snakes) of which 10 species (28.6%) are endemic and 1 species vulnerable/protected game, 2 tortoises (100% vulnerable and protected game), 1 terrapin, 2 worm lizard, 17 lizards of which 5 species classified as endemic (29.4% endemic), 2 plated lizards, 1 girdled lizard (endemic), 1 monitor (vulnerable/protected game), 3 agamas (1 endemic), 2 chameleon and 10 geckos of which 8 species classified as endemic (i.e. 80% endemic).

Four species expected to occur in the area of which 2 are tortoises (*Stigmochelys pardalis*, *Psammobates oculiferus, Python natalensis* and *Varanus albigularis*) are classified as vulnerable and protected game. One species – *Python anchietae* – is classified as protected game, but not as vulnerable. Fourteen species have an international conservation status (10 CITES Appendix 2 and 3 species and 4 SARDB species; *Python natalensis* has both a CITES and SARDB status) with *Python natalensis* classified as vulnerable and *Naya nigricincta* as rare although *N. nigricincta* is however more common in Namibia than South Africa. However, the IUCN has not yet assessed most reptiles for the IUCN Red List.

Snakes (35 species with 10 species being endemic) and lizards (17 species with 5 species being endemic) are the most important groups of reptiles expected from the general Otjiwarongo area followed by geckos (10 species with 8 species being endemic). Namibia

Table 1. Reptile diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area.

Species: Scientific name	Species: Common name	Kransberg-Omaruru	Omaruru-Otjiwarongo	Namibian conservation and legal status	International status		
					SARDB	IUCN	CITES
TORTOISES AND TERRAPINS							
Stigmochelys pardalis	Leopard Tortoise	√	√	Vulnerable; Peripheral; Protected Game		LC	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?			
Rhinotyphlops boylei	Boyle's Beaked Blind Snake		√	Endemic; Secure			
Rhinotyphlops schinzi	Schinz's Beaked Blind Snake		√	Endemic; Secure	P		
Rhinotyphlops schlegelii	Schlegel's Beaked Blind Snake		√	Secure			
Thread Snakes							
Namibiana (Leptotyphlops) occidentalis	Western Thread Snake	√	√	Endemic; Secure	P	LC	
Namibiana (Leptotyphlops) labialis	Damara Thread Snake	√		Endemic; Secure		LC	
Namibiana (Leptotyphlops) scutifrons	Peters' Thread Snake		√	Secure			
Pythons							
Python anchietae	Dwarf Python	√	√	Endemic; Insufficiently known; Protected game		LC	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			
Xenocalamus mechowii	Elongate Quill-snouted Snake		√	Secure			
Typical Snakes							
Boaedon (Lamprophis) fuliginosus	Brown House Snake	√	√				
Lycophidion capense	Cape Wolf Snake	√	√				
Lycophidion namibianum	Namibian Wolf Snake	√		Endemic; Secure		LC	
Mehelya capensis	Cape File Snake	√		Secure			
Limaformosa (Mehelya) vernayi	Angola File Snake	√		Insufficiently known; Rare?		LC	
Pseudaspis cana	Mole Snake	√	√	Secure			
Pythonodipsas carinata	Western Keeled Snake	√		Endemic; Secure		LC	
Prosymna bivittata	Two-striped Shovel-snout		√	Secure			

Prosymna frontalis	South-western Shovel-snout	√	√	Endemic; Secure	P	LC
Hemirhagerrhis viperinus	Viperine Bark Snake	√		Endemic; Secure		
Dipsina multimaculata	Dwarf Beaked Snake	√	√	Endemic; Secure		
Psammophylax tritaeniatus	Striped Skaapsteker		√	Secure		
Psammophis trigrammus	Western Sand Snake	√	√	Endemic; Secure		LC
Psammophis notostictus	Karoo Sand Snake	√	√	Secure		
Psammophis leightoni namibensis	Namib Sand Snake	√	√	Secure		LC
Psammophis brevirostris leopardinus	Leopard Grass Snake	√	√	Endemic; Secure		
Philothamnus semivariegatus	Spotted Bush Snake	√	√	Secure		
Dasypeltis scabra	Common/Rhombic Egg Eater	√	√	Secure		LC
Telescopus semiannulatus polystrictus	Eastern Tiger Snake	√	√	Secure		
Telescopus beetzii	Beetz's Tiger Snake		√	Secure		
Dispholidus typus	Boomslang		√	Secure		
Aspidelaps lubricus infuscatus	Coral Snake	√	√	Secure		
Aspidelaps scutatus scutatus	Shield-nose Snake	√	√	Secure		
Elapsoidea sunderwallii	Sundevall's Garter Snake		√	Endemic; Secure		
Naja anchietae	Snouted Cobra		√	Secure		
Naja nivea	Cape Cobra	√	√	Secure		
Naya nigricincta	Black-necked Spitting Cobra	√		Endemic; Secure		
Dendroaspis polylepis	Mamba		√	Secure		
Bitis arietans	Puff Adder	√	√	Secure		
Bitis caudalis	Horned Adder	√	√	Secure		
WORM LIZARDS						
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard	√	√	Secure		
Monopeltis infuscata	Dusky Spade-snouted Worm Lizard		√	Secure		
LIZARDS						
Skinks						
Typhlosaurus braini	Brain's Blind Legless Skink	√		Endemic; Secure		LC
Typhlacontias brevipes	FitzSimon's Burrowing Skink	√		Endemic; Secure		LC
Typhlosaurus lineatus lineatus	Striped Blind Legless Skink		√	Secure		
Acontias occidentalis	Percival's Legless Skink		√	Secure		
Lygosoma sundevallii	Sundevall's Writhing Skink		√	Secure		
Trachylepis acutilabris	Wedge-snouted Skink	√	√	Secure		LC
Trachylepis capensis	Cape Skink	√	√	Secure		
Trachylepis hoeschi	Hoesch's Skink	√	√	Endemic; Secure		LC
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			
Ichnotropis squamulosa	Common Rough-scaled Lizard		√	Secure			
Meroles suborbitalis	Spotted Desert Lizard	√	√	Secure		LC	
Nucras intertexta	Spotted Sandveld Lizard		√	Endemic; Secure			
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard		√	Endemic; Secure			
Pedioplanis breviceps	Short-headed Sand Lizard	√		Endemic; Secure		LC	
Pedioplanis namaquensis	Namaqua Sand Lizard	√	√	Secure			
Pedioplanis undata	Western Sand Lizard	√	√	Endemic; Secure		LC	
Pedioplanis inornata	Plain Sand Lizard	√		Endemic; Secure		LC	
Plated Lizards							
Cordylosaurus subtessellatus	Dwarf Plated Lizard	√	√	Endemic; Secure		LC	
Matabosaurus maltzahani (Gerrhosaurus validus)	Giant Plated Lizard	√	√	Secure		LC	
Girdled Lizards							
Karusasaurus (Cordylus) jordani	Jordan's Girdled Lizard	√	√	Endemic; Secure		LC	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		LC	
Agama planiceps	Namibian Rock Agama	√	√	Endemic; Secure		LC	
Chameleons							
Chamaeleo namaquensis	Namaqua Chameleon	√		Secure		LC	C2
Chamaeleo namaquensis	Namaqua Chameleon		√	Secure		LC	C2
Geckos							
Afroedura africana	African Flat Gecko	√		Endemic; Insufficiently known; Rare		LC	
Chondrodactylus angulifer	Giant Ground Gecko	√	√	Endemic; Secure		LC	
Lygodactylus bradfieldi	Bradfield's Dwarf Gecko	√	√	Endemic; Secure			
Narudasia festiva	Festive Gecko	√	√	Endemic; Secure		LC	
Pachydactylus bicolour	Velvety Thick-toed Gecko	√	√	Endemic; Secure			
Pachydactylus capensis	Cape Thick-toed Gecko	√	√	Endemic; Secure			

Pachydactylus fasciatus	Banded Thick-toed Gecko	√		Endemic; Secure	LC
Pachydactylus kochii	Koch's Thick-toed Gecko	√		Endemic; Secure	LC
Pachydactylus turneri	Turner's Thick-toed Gecko	√	√	Secure	
Pachydactylus punctatus	Speckled Thick-toed Gecko	√	√	Secure	
Pachydactylus rugosus	Rough Thick-toed Gecko	√	√	Endemic; Secure	LC
Pachydactylus serval serval	Western Spotted Thick-toed Gecko		√	Endemic; Secure	
Pachydactylus scherzi	Namib Variable Gecko	√		Endemic; Secure	LC
Pachydactylus weberi	Weber's Thick-toed Gecko	√		Secure	LC
Ptenopus garrulus	Common Barking Gecko	√	√	Secure	LC
Rhoptropus afer	Common Namib Day Gecko	√		Endemic; Secure	LC
Rhoptropus boultoni	Boulton's Namib Day Gecko	√		Endemic; Secure	LC
Rhoptropus bradfieldi	Bradfield's Namib Day Gecko	√		Endemic; Secure	LC

Namibian conservation and legal status according to the Nature Conservation Ordinance No 4 of 1975
Endemic – includes Southern African Status (Branch 1998)
SARDB (2004): S to V – Safe to Vulnerable; V – Vulnerable; P – Peripheral
IUCN (2021): LC – Least Concern [All other species not yet assessed]
CITES: CITES Appendix 2/3 species

Source for literature review: Alexander and Marais (2007), Bonin *et al.* (2006), Branch (1998), Branch (2008), Boycott and Bourquin (2000), Broadley (1983), Buys and Buys (1983), Cunningham (2006), Griffin (2003), Hebbard (n.d.), IUCN (2021), Marais (1992), SARDB (2004), Schleicher (2020),Tolley and Burger (2007)

with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a). Geckos expected and/or known to occur in the general Omaruru-Otjiwarongo area have the highest occurrence of endemics (80%) of all the reptiles in this area.

Griffin (1998a) confirms the importance of the gecko fauna in Namibia. Tortoises are viewed as the group of reptiles most under threat in Namibia (Griffin 1998a) making *Stigmochelys pardalis* and *Psammobates oculiferus* probably the most important reptiles expected in the area followed by the pythons – *P. anchietae* and *P. natalensis* – and *Varanus albigularis*. All the above mentioned species are either consumed as food or indiscriminately killed when encountered – e.g. *Python natalensis*.

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 Omaruru-Otjiwarongo area than presented in Table 1.

None of the reptile species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development areas.

Rail line upgrades impact
The impact during construction, are expected to be detrimental to reptiles associated with the affected area/habitat, especially at borrow pit sites, construction camp sites and at route deviations. This would affect relatively small areas over a short/limited period of time.

The impact of rail line infrastructure is not expected to be detrimental to reptiles – i.e. would not impede their movement, etc.

3.2 Amphibian Diversity

Amphibian diversity known and/or expected to occur along the Phase 1 section of the route is divided between the Kransberg-Omaruru and Omaruru-Otjiwarongo areas, and presented in Table 2.

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.

Kransberg-Omaruru
According to Mendelsohn *et al.* (2002), the overall frog diversity in the general Kransberg-Omaruru 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. There is currently no data for the !Dorob National Park.

At least 7 species of amphibians are expected to occur in suitable habitat in the Kransberg-Omaruru 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. *Pyxicephalus adspersus* is more common in northern Namibia where their numbers are also declining due to overutilization as food by humans (Griffin pers. com.). The IUCN (2021) lists all the species as "least concern".

The most important species are the endemic *Poyntonophrynus hoeschi* and *Phrynomantis annectens* although they are widespread in Namibia and not exclusively associated with the Kransberg-Omaruru area in particular. Permanent water bodies viewed as amphibian habitat in the area include the ephemeral Khan and Omaruru Rivers and their tributaries. Other potential habitats in the area include rocky pool areas in the Erongo Mountains, farm reservoirs and earth dams although the latter are also dependant on localised showers and temporary of nature.

Due to the fact that amphibians are an understudied group of animals, especially in Namibia, it is expected that more species may be located in the Kransberg-Omaruru area than presented in Table 2. However, the overall lack of suitable habitat around Kransberg-Omaruru is expected to negatively affect the presence of most amphibians.

None of the amphibian species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development areas.

Omaruru-Otjiwarongo

According to Mendelsohn *et al.* (2002), the overall frog diversity in the general Omaruru-Otjiwarongo area is estimated at between 12-15 species. Griffin (1998b) puts the species richness in the general area at between 14-15 species. The closest protected area – Waterberg Plateau Park – has an estimated 13 species of amphibians (Griffin 1998b).

At least 9 species of amphibians are expected to occur in suitable in the Omaruru-Otjiwarongo area. The area is under represented, with 2 toads and 1 species each for kassina, rubber, puddle, caco, 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 classified as "near threatened" due to habitat loss and development (*Pyxicephalus adspersus*) (Du Preez and Carruthers 2009) – i.e. 33.3% of amphibians of conservation value from the general area. *Pyxicephalus adspersus* is more common in northern Namibia where their numbers are also declining due to overutilization as food by humans (Griffin pers. com.). The IUCN (2021) lists all the species as "least concern".

The most important species are the endemic *Poyntonophrynus hoeschi* and *Phrynomantis annectens* although they are widespread in Namibia and not exclusively associated with the Otjiwarongo area in particular. Permanent water bodies viewed as amphibian habitat in the area include the ephemeral Omaruru and Omatjene Rivers and their tributaries, Otjiwarongo sewage works. Other potential habitats in the area include farm reservoirs and earth dams although the latter are also dependant on localised showers and temporary of nature.

Due to the fact that amphibians are an understudied group of animals, especially in Namibia, it is expected that more species may be located in the Omaruru-Otjiwarongo area than presented in Table 2. However, the overall lack of suitable habitat around Omaruru-Otjiwarongo is expected to negatively affect the presence of most amphibians.

None of the amphibian species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development area.

Table 2. Reptile diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area.

Species: Scientific name	Species: Common name	Kransberg-Omaruru	Omaruru-Otjiwarongo	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
Kassinas					
Kassina senegalensis	Bubbling Kassina		√		LC
Puddle Frog					
Phrynobatrachus mababiensis	Dwarf Puddle Frog	√	√		LC
Cacos					
Cacosternum boettgeri	Boettger's Caco		√		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)
Near threatened – (Du Preez and Carruthers 2009)
IUCN (2021): LC – Least Concern

Source for literature review: Carruthers (2001), Channing (2001), Channing and Griffin (1993), Du Preez and Carruthers (2009), IUCN (2021), Passmore and Carruthers (1995), SARDB (2004)

Rail line upgrades impact
The impact during construction is not expected to be detrimental to amphibians associated with the affected area/habitat, unless route deviations impact on ground dams and water flow. This would affect relatively small areas over a short/limited period of time.

The impact of rail line infrastructure is not expected to be detrimental to amphibians – i.e. would not impede their movement, etc.

3.3 Mammal Diversity

Mammal diversity known and/or expected to occur along the Phase 1 section of the route is divided between the Kransberg-Omaruru and Omaruru-Otjiwarongo areas, and 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*. Habitat alteration and overutilization are the two primary processes threatening most mammals (Griffin 1998c) with species probably underrepresented in Table 3 for the general areas being the bats and rodents, as these groups have not been well documented from Namibia.

Kransberg-Omaruru
Overall terrestrial diversity and endemism – all species – is classified as “average” and “high” respectively in the general Kransberg-Omaruru 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 Kransberg-Omaruru 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. There is currently no data for the !Dorob National Park.

According to the literature at least 87 species of mammals are known and/or expected to occur in the general Kransberg-Omaruru area of which 10 species (11.5%) are classified as endemic. The Namibian legislation classifies 2 species as “rare”, 5 species as “vulnerable”, 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 Kransberg-Omaruru are according to a habitat modelling programme although not yet actually confirmed.

At least 31% (27 species) of the mammalian fauna that occur or are expected to occur in the general Kransberg-Omaruru b area are represented by rodents of which 5 species (18.5%) are endemic. This is followed by bats 27.6% (24 species) of which 1 species is classified as “rare”. Twenty nine species (33.3%) have IUCN, CITES and SARDB international conservation status (some species have more than one conservation status). The IUCN (2021) classifies 4 species each as vulnerable (cheetah, leopard, Hartmann’s mountain zebra, giraffe) and near threatened (African straw-coloured fruit bat, Commerson’s roundleaf

Table 3. Reptile diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area.

Species: Scientific name	Species: Common name	Kransberg-Omaruru	Omaruru-Otjiwarongo	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	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			
Chaerephon nigeriae	Nigerian 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	
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat	√	√	Not listed		
Rhinolophus blasii	Blasius's Horseshoe Bat		√	Not listed	NT	
Macronycteris (Hipposideros) commersoni	Commerson's Roundleaf Bat	√		Secure		NT
Hipposideros caffer	Sundevall's Roundleaf Bat	√		Secure	DD	
*Macronycteris (Hipposideros) gigas**	Giant Leaf-nosed Bat	√		Not listed		
Macronycteris (Hipposideros) vittatus	Striped Leaf-nosed Bat	√		Not listed		NT
Taphozous mauritianus	Mauritian Tomb Bat		√	Secure		
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		
Molerat						
Cryptomys damarensis	Damaraland Mole-Rat		√	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	

Tatera brantsii	Highveld Gerbil		√	Secure			
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		
Pangolin							
Manis temminckii	Ground Pangolin		√	Vulnerable; Peripheral; Protected Game		V	C2
Carnivores							
Proteles cristatus	Aardwolf	√	√	Insufficiently known; (Vulnerable?) Peripheral			
Parahyaena (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		V	C1
Caracal caracal	Caracal	√	√	Secure; Problem Animal			C2
Felis silvestris	African Wild Cat	√	√	Vulnerable			C2
Felis nigripes	Black-footed Cat		√	Indeterminate; Rare		V	C1
Genetta genetta	Small Spotted Genet	√	√	Secure			
Suricata suricatta marjoriae	Suricate	√	√	Endemic; Secure			
Cynictis penicillata	Yellow Mongoose	√	√	Secure			
Galerella sanguinea	Slender Mongoose	√	√	Secure			
Galerella flavescens (nigrata)	Kaokoland/Black Slender Mongoose	√		Endemic; 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		V	
Tragelaphus strepsiceros	Greater Kudu	√	√	Secure; Huntable Game			
Alcelaphus buselaphus	Red Hartebeest		√	Secure; Protected 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			

SARDB (2004): R – Rare, E – Endangered, V – Vulnerable, NT – Near Threatened, DD – Data Deficient
IUCN (2021): V – Vulnerable, NT – Near Threatened. All other species not listed are viewed as "Least Concern" by IUCN (2021)
CITES: CITES Appendix 1/2 species
*Monadjem *et al.* (2010)

Source for literature review: De Graaff (1981), Griffin and Coetzee (2005), Estes (1995), IUCN (2021), Joubert and Mostert (1975), Monadjem *et al.* (2010), Picker and Griffiths (2011), SARDB (2004), Skinner and Smithers (1990), Skinner and Chimimba (2005), Stander and Hanssen (2003) and Taylor (2000)

bat, striped leaf-nosed bat, brown hyena). The SARDB (2004) classifies 1 species as rare, 1 species as endangered, 2 species as vulnerable, 12 species as near threatened and 6 species as data deficient while CITES lists 2 species as Appendix 1 and 5 species as Appendix 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 (Picker and Griffiths 2011).

Of the 87 species of mammals known and/or expected to occur in the general Kransberg-Omaruru area, 9 species (10.3%) are classified as endemic. Rodents (of which 5 species – 18.5% – 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 vulnerable (cheetah, leopard, Hartmann's mountain zebra, giraffe) and near threatened (African straw-coloured fruit bat, Commerson's roundleaf bat, striped leaf-nosed bat, brown hyena) by the IUCN (2021). Another important and unique species known to occur in the general area is the endemic Kaokoland slender or black mongoose (See: Cowley and Cunningham 2004, Warren *et al.* 2009).

Due to the fact that bats and rodents are understudied groups of animals, especially in Namibia, it is expected that more species may be located in the Kransberg-Omaruru area than presented in Table 3.

None of the mammal species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development area.

Omaruru-Otjiwarongo

Overall terrestrial diversity and endemism – all species – is classified as "moderate to high" in the central part of Namibia (Mendelsohn *et al.* 2002). The overall diversity (7-8 species) and abundance of large herbivorous mammals is "high" in the general Omaruru-Otjiwarongo area with kudu, red hartebeest and oryx having the highest density 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 cheetah and leopard having the highest density of the larger species (Mendelsohn *et al.* 2002). The overall mammal diversity in the general Omaruru-Otjiwarongo area is estimated at between 76-90 species with 1-2 species being endemic to the area (Mendelsohn *et al.* 2002). Griffin (1998c) puts the species richness distribution of endemics also between 7-8 species. The closest protected area – Waterberg Plateau Park – has an estimated 82 species of mammals (Griffin 1998c).

According to the literature at least 84 species of mammals are known and/or expected to occur in the general Omaruru-Otjiwarongo area of which 4 species (4.8%) are classified as endemic. The Namibian legislation classifies 8 species as vulnerable, 3 species as rare, 1 species as specially protected game, 9 species as protected game, 4 species as insufficiently known, 1 species as peripheral, 1 species as migrant, 4 species as huntable game, 3 species as problem animals and 4 species not listed. At least 29.8% (25 species) of the mammalian fauna that occur or are expected to occur in general Omaruru-Otjiwarongo area are represented by rodents of which 3 species (12%) are endemic. This is followed by bats with 26.2% (22 species) of which 1 species (i.e. *Cistugo seabrai*) is endemic and rare (4.5%) and carnivores with 20.2% (17 species) of which 1 species (5.9%) are endemic.

Thirty species (35.7%) have some form of international conservation status (some species have more than one status) of which the IUCN (2016) classifies 2 species as vulnerable and 5 species as near threatened; SARDB (2004) classifies 1 species as rare, 3 as vulnerable, 12 as near threatened and 5 as data deficient while CITES classifies 3 species as Appendix 1 species and 5 species as Appendix 2 species. Furthermore Monadjem *et al.* (2010) classifies 2 species as near threatened although this is probably using old IUCN status

revised in IUCN (2021). 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 (Picker and Griffiths 2011).

The most important species from the general area are probably all those classified as near threatened (*Eidolon helvum*, *Hipposideros vittatus*, *Rhinolophus blasii*, *Hyaena brunnea* and *Panthera pardus*) and vulnerable (*Acinonyx jubatus* and *Felis nigripes*) by the IUCN (2021) and rare (*Cistugo seabrai*, *Atelerix frontalis angolae* and *Felis nigripes*) under Namibian legislation.

Due to the fact that bats and rodents are understudied groups of animals, especially in Namibia, it is expected that more species may be located in the Omaruru-Otjiwarongo area than presented in Table 3.

None of the mammal species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development area.

Rail line upgrades impact
The impact during construction, are expected to be detrimental to mammals associated with the affected area/habitat, especially at borrow pit sites, construction camp sites and at route deviations. This would affect relatively small areas over a short/limited period of time.

The impact of rail line infrastructure is not expected to be detrimental to mammals – i.e. would not impede their movement, etc.

3.4 Avian Diversity

Bird diversity known and/or expected to occur along the Phase 1 section of the route is divided between the Kransberg-Omaruru and Omaruru-Otjiwarongo areas, and presented in Table 4.

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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).

Kransberg-Omaruru
Bird diversity and endemism is viewed as "high" in the general Kransberg-Omaruru area with 171-200 species, of which 8 species being endemic (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 Kransberg-Omaruru 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.

According to the literature at least 217 bird species [mainly terrestrial "breeding residents"] occur and/or could occur in the general Kransberg-Omaruru 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 species as vulnerable (lappet-faced vulture,

Table 4. Avian diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area.

Species: Scientific name	Species: Common name	Kransberg-Omaruru	Omaruru-Otjiwarongo	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 bennettii	Bennett's Woodpecker		√			
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 garrulus	European Roller		√	NT		
Coracias caudatus	Lilac-breasted Roller	√	√			
Coracias naevius	Purple Roller	√	√			
Merops hirundineus	Swallow-tailed Bee-eater	√	√			
Merops apiaster	European Bee-eater	√	√			

Merops persicus	Blue-cheeked 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 horus	Horus 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	√	√			
Glaucidium capense	African Barred 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		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	
Pterocles burchelli	Burchell's 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		CE
Gyps coprotheres	Cape Vulture		√	CE		V
Aegypius tracheliotos	Lappet-faced Vulture	√	√	V		E
Terathopius ecaudatus	Bateleur		√	E		E
Haliaeetus vocifer	African Fish-Eagle		√	V		
Circaetus pectoralis	Black-chested Snake-Eagle	√	√			
Circaetus cinereus	Brown Snake-Eagle	√	√			
Circus maurus	Black Harrier		√	E		E
Circus macrourus	Pallid Harrier		√	NT		NT
Polyboroides typus	African Harrier-Hawk		√			
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	√				
Aquila rapax	Tawny Eagle	√	√	E		V
Aquila verreauxii	Verreaux's Eagle	√	√	NT		
Aquila spilogaster	African Hawk-Eagle	√	√			
Aquila pennatus	Booted Eagle	√	√	E		
Aquila wahlbergi	Wahlberg's Eagle		√			
Polemaetus bellicosus	Martial Eagle	√	√	E		E
Sagittarius serpentarius	Secretarybird	√	√	V		E
Polihierax semitorquatus	Pygmy Falcon	√	√			
Falco rupicolus	Rock Kestrel	√	√			
Falco rupicoloides	Greater Kestrel	√	√			
Falco chicquera	Red-necked Falcon	√	√			
Falco vespertinus	Red-footed Falcon		√	NT		V
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		
Ephippiorhynchus senegalensis	Saddle-billed Stork		√	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	√	√		
Hirundu albigularis	White-throated Swallow		√		
Hirundo dimidiata	Pearl-breasted Swallow		√		
Hirundo rustica	Barn Swallow	√			
Hirundo dimidiata	Pearl-breasted Swallow	√	√		
Hirundo cucullata	Greater Striped Swallow	√	√		
Hirundo semirufa	Red-breasted 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 chiniana	Rattling Cisticola		√		
Cisticola rufilatus	Tinkling Cisticola		√		
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	√	√		
Cisticola juncidis	Zitting Cisticola		√		
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	√	√	
Euplectes orix	Southern Red Bishop		√	
Ortygospiza atricollis	African Quailfinch		√	
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 macroura	Pin-tailed Whydah		√	
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 aguimp	African Pied Wagtail		√	
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: E – Endangered, V- Vulnerable, NT – Near Threatened (Simmons *et al.* 2015)
Southern African status: Hockey *et al.* (2006)
IUCN (2021): CE – Critically Endangered, E – Endangered, V- Vulnerable, NT – Near Threatened. All other species not listed are viewed as "Least Concern" by IUCN (2020)

Source for literature review: Brown *et al.* (1998), Hockey *et al.* (2006), IUCN (2021), Komen (n.d.), Little and Crowe (2011), Maclean (1985), Peacock (2015), Simmons *et al.* (2015), Tarboton (2001)

secretarybird) and 5 species as near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015). The IUCN (2021) classifies 1 species as critically endangered (white-backed vulture), 4 species as endangered (Ludwig's bustard, lappet-faced vulture, martial eagle, secretarybird), 1 species as vulnerable (tawny eagle) and 1 species as near threatened (kori bustard). 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 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, black harrier, tawny eagle, booted eagle, martial eagle, black stork) and near threatened (Rűppel's parrot, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015) and those species classified by the IUCN (2021) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard).

None of the bird species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development areas.

Omaruru-Otjiwarongo

Bird diversity is viewed as "high" in the general Omaruru-Otjiwarongo area with 201-230 species estimated and 4-5 species being endemic (Mendelsohn *et al.* 2000). Simmons (1998a) suggests 1-3 endemic species and "average" rankings for southern African endemics and red data birds expected from the general area. Although the Otjiwarongo area is not classified as an Important Birding Area (IBA) in Namibia (Simmons 1998a) the closest such site is located at the Waterberg approximately 50km to the southeast. The Omatako Dam area located approximately 90km southeast of Otjiwarongo is viewed as important breeding, feeding and roosting sites for a variety of aquatic birds (Brown *et al.* 2006).

At least 218 species of terrestrial ["breeding residents"] birds occur and/or could occur in the general Omaruru-Otjiwarongo area at any time (Hockey *et al.* 2006, Maclean 1985, Tarboton 2001). All the migrant and aquatic species have been excluded here. Ten of the 14 Namibian endemics are expected to occur in the general area (71.4% of all Namibian endemic species or 4.6% of all the species expected to occur in the area). One species (Cape vulture) is viewed as critically endangered, 10 species as endangered, 4 species as vulnerable and 8 species as near threatened (Simmons *et al.* 2015). Other species of conservation concern although not listed in Table 4 above as they are aquatic species are maccoa duck (NT), black-necked grebe (NT), rufous-bellied heron (E) and great white pelican (V). The IUCN (2021) classifies 1 species as critically endangered (white-backed vulture), 6 species as endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), 3 species as vulnerable (Cape vulture, tawny eagle, red-footed falcon) and 2 species as near threatened (kori bustard, pallied harrier).

Sixty one (28% of all the birds expected) species have a southern African conservation rating with 13 species classified as endemic (21.3% of southern African endemics or 6% of all the birds expected) and 48 species classified as near endemic (78.7% of southern African endemics or 22.1% of all the birds expected) (Hockey *et al.* 2006).

The most important endemic species known/expected to occur in the general area are viewed as Monteiro's hornbill (*Tockus monteiri*), Damara hornbill (*Tockus damarensis*), *Ammomanopsis grayi* (Gray's Lark), *Namibornis herero* (Herero chat), *Eupodotis rueppellii*

(Rüppell's korhaan) and *Poicephalus rueppellii* (Rüppell's parrot). The species listed as critically endangered (Cape vulture), endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, bateleur, black harrier, tawny eagle, booted eagle, martial eagle, black stork, saddle-billed stork), vulnerable (lappet-faced vulture, white-headed vulture, African fish eagle, secretarybird) and near threatened (European roller; Rűppel's parrot, kori bustard, pallid harrier, Verreaux's eagle, red-footed falcon, peregrine falcon, marabou stork) by Simmons *et al.* (2015) as well as those listed by the IUCN (2021) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (Cape vulture, tawny eagle, red-footed falcon) and near threatened (kori bustard, pallied harrier). The Cape vulture is a cliff breeder and although the last remnants are known to occur in the Waterberg Area (i.e. greater Otjiwarongo area). The larger raptors (e.g. vultures, eagles, etc.) are often persecuted due to actual and perceived livestock mortalities or succumb when feeding on poisoned carcasses set for problem predators while the bustards are viewed as pylon sensitive birds and prone to pylon strikes.

None of the bird species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development areas.

Rail line upgrades impact
The impact during construction, are expected to be detrimental to birds associated with the affected area/habitat, especially at borrow pit sites, construction camp sites and at route deviations. This would affect relatively small areas over a short/limited period of time.

The impact of rail line infrastructure is not expected to be detrimental to birds – i.e. would not impede their movement, etc.

3.5 Tree and Shrub Diversity

Kransberg-Omaruru
It is estimated that at least 74-101 species of larger trees and shrubs (>1m) (Coats Palgrave 1983 [85 spp.], Curtis and Mannheimer 2005 [101 spp.], Mannheimer and Curtis 2009 [91 spp.], Mannheimer and Curtis 2018 [101 spp.], Van Wyk and Van Wyk 1997 [62 spp. and 12 spp. endemic]) occur in the general Kransberg-Omaruru area.

According to Mannheimer and Curtis (2018) at least 91 species of larger trees and shrubs are known and/or expected to occur in the general area of which 8 species are classified as endemic (7.9%), 4 species as near endemic (4%), 21 species (20.8%) are protected by the Forest Act No 12. of 2001, 5 species (5%) 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 Kransberg-Omaruru area.

The most important species are viewed as *Commiphora dinteri*, *Commiphora saxicola*, *Commiphora virgata*, *Cyphostemma bainesii*, *Cyphostemma currorii* and *Erythrina decora* (e.g. most often associated with rocky substrate) (See Table 5).

None of the larger tree and shrub species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development areas.

Omaruru-Otjiwarongo
It is estimated that at least 60-110 species of larger trees and shrubs (>1m) (Coats Palgrave 1983 [81 spp.], Curtis and Mannheimer 2005 [79 spp.], Mannheimer and Curtis 2009 [110 spp.], Mannheimer and Curtis (2018) [107 spp.], Van Wyk and Van Wyk 1997 [60 spp.]) occur in the general Omaruru-Otjiwarongo area.

Table 6. Tree and shrub diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area. The trees and shrubs known, and/or expected to occur in the general area are derived from Mannheimer and Curtis (2018).

Species Expected: Scientific name	Kransberg-Omaruru	Omaruru-Otjiwarongo	Namibian conservation and legal status
Acacia ataxacantha		√	
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	√		End
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 collinum		√	
Combretum hereroense	√	√	
Combretum imberbe	√	√	Protected (F#)
Commiphora africana	√	√	
Commiphora angolensis		√	

Commiphora dinteri	√		Protected (F#), End
Commiphora glandulosa	√	√	
Commiphora glaucescens	√	√	N-end
Commiphora pyracanthoides	√	√	
Commiphora saxicola	√		Protected (F#), End
Commiphora tenuipetiolata	√	√	
Commiphora virgata	√		Protected (F#), End
Cordia sinensis	√	√	
Croton gratissimus	√	√	
Cyphostemma bainesii	√	√	Protected (F#), End, NC
Cyphostemma currorii	√	√	Protected (F#), NC
Dichrostachys cinerea	√	√	
Diospyros lycioides	√	√	
Dombeya rotundifolia	√	√	
Ehretia alba	√	√	
Ehretia namibiensis		√	
Erythrina decora	√		Protected (F#), End
Elephantorrhiza suffruticosa	√	√	
Euclea pseudebenus	√		Protected (F#)
Euclea undulata	√	√	
Euphorbia avasmontana	√	√	C2
Euphorbia damarana	√		End, 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	√		
Gossypium triphyllum	√		
Grewia avellana	√	√	
Grewia bicolor	√	√	
Grewia falcistipula		√	
Grewia flava	√	√	
Grewia flavescens	√	√	
Grewia olukondae		√	

Grewia retinervis		√	
Grewia schinzii		√	
Grewia subspathulata		√	
Grewia tenax	√	√	
Grewia villosa	√	√	
Gossypium triphyllum		√	
Gymnosporia buxifolia		√	
Gymnosporia senegalensis	√	√	
Ipomoea adeniodes	√	√	
Kirkia acuminata		√	
Laggera decurrens	√	√	
Lycium bosciifolium	√	√	
Lycium cinereum	√	√	
Lycium eenii	√	√	
Maerua juncea	√	√	
Maerua parvifolia	√	√	
Maerua schinzii	√	√	Protected (F#)
Manuleopsis dinteri	√	√	End
Melianthus comosus		√	
Montinia caryophyllacea	√	√	
Moringa ovalifolia	√	√	Protected (F#), NC, N-end
Mundulea sericea	√	√	
Obetia carruthersiana	√	√	N-end
Olea europaea	√	√	
Osyris lanceolata		√	
Ozoroa crassinervia	√	√	
Ozoroa insignis		√	
Ozoroa paniculosa		√	
Parkinsonia africana	√		
Pechuel-Loeschea leubnitziae	√	√	
Phaeoptilum spinosum	√	√	
Philenoptera nelsii		√	
Pouzolzia mixta		√	
Rhigozum brevispinosum		√	
Rhigozum trichotomum	√	√	
Rotheca myricoides	√	√	
Salsola spp.	√		

Securidaca longepedunculata		√	
Salvadora persica	√		
Searsia ciliata	√	√	
Searsia lancea	√	√	Protected (F#)
Searsia marlothii	√	√	
Searsia pyroides	√	√	
Searsia tenuinervis		√	
Searsia undulata		√	
Steganotaenia araliacea	√	√	
Sterculia africana	√	√	Protected (F#)
Strophanthus amboensis	√	√	
Tamarix usneoides	√		Protected (F#)
Tarchonanthus camphoratus	√	√	
Tetradenia riparia	√		
Tinnea rhodesiana	√		
Terminalia pruniodes	√	√	
Terminalia sericea		√	
Vangueria cyanescens	√	√	
Vangueria infausta	√	√	
Vernonia cinerascens	√		
Ximenia americana	√	√	
Ximenia caffra var. *caffra*		√	
Ziziphus mucronata	√	√	Protected (F#)

Endemic and Near-endemic – (Mannheimer and Curtis 2018)
F# – Forest Act No. 12 of 2001
NC – Nature Conservation Ordinance No. 4 of 1975
C2 – CITES Appendix 2 species

Source for literature review: CITES (2021), Coats Palgrave (1983), Curtis and Mannheimer (2005), Loots (2005), Mannheimer and Curtis (2009), Mannheimer and Curtis (2018), Rothmann (2004), Steyn (2003), Van Wyk and Van Wyk (1997)

According to Mannheimer and Curtis (2018) at least 107 species of larger trees and shrubs are known and/or expected to occur in the general area of which 3 species are classified as endemic (2.8%), 4 species classified as near endemic (3.7%), 13 species are protected by the Forest Act No. 12 of 2001 (12.1%), 4 species are protected by the Nature Conservation Ordinance No. 4 of 1975 (3.7%) and 3 species are classified as CITES Appendix 2 species (2.8%) – i.e. 22 species (including endemic and near endemic) have some form of conservation status (20.6%).

The most important species are viewed as *Cyphostemma currorii*, *Cyphostemma juttae*, *Erythrina decora* and *Manuleopsis dinteri* (e.g. most often associated with rocky substrate) (See Table 5).

None of the larger tree and shrub species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development areas.

Rail line upgrades impact
The impact during construction, are expected to be detrimental to larger trees/shrubs, especially unique species associated with the affected area/habitat, especially at borrow pit sites, construction camp sites and at route deviations. This would affect a relatively small area over a short/limited period of time.

Various protected tree/shrub species occur in the general area and these species (See Tables 5, 7 and 8), especially the larger specimens, should be avoided as they potentially serve as habitat to a variety of vertebrate fauna (Further, see the Forest Act for tree harvesting limitations – i.e.18cm diameter, etc.).

Larger tree/shrub specimens (including protected species – e.g. Acacia erioloba, Ziziphus mucronata, etc.) are usually associated with ephemeral drainage lines in the general area. Development in these areas should be limited and carefully managed as the trees potentially serve as habitat to a variety of vertebrate fauna and stabilise soils around these drainage lines (Further, see the Forest Act for harvesting limitations – i.e.100m from streams, etc.).

These negative impacts would depend on the scale and intensity of the proposed development.

3.6 Grass Diversity

Kransberg-Omaruru
It is estimated that at least 52-72 grasses (Müller 2007 [72 spp.], Van Oudshoorn 2012 [52 spp.]) – approximate total of 80 species – occur in the general Kransberg-Omaruru area.

Of the approximately 80 grasses that are expected in the general area, 2 species are viewed as endemic (*Eragrostis omahekensis*) – *Eragrostis omahekensis* is virtually only found on disturbed soils – e.g. close to watering points – while *Eragrostis scopelophila* is associated with mountainous areas under trees and shrubs (Table 6).

None of the grass species known/expected to occur in the general Kransberg-Omaruru area are however exclusively associated with the proposed development areas.

Omaruru-Otjiwarongo
It is estimated that at least 106 grasses (Müller 2007 [88 spp.], Van Oudshoorn 1999 [73 spp.]) – approximate total of 73 to 88 species – occur in the general Omaruru-Otjiwarongo area.

Up to 106 grasses are expected in the general Omaruru-Otjiwarongo area of which 4 species are viewed as endemic (*Eragrostis omahekensis*, *Eragrostis scopelophila*,

Table 6. Grass diversity known and/or expected to occur in the general Kransberg-Otjiwarongo (Phase 1) – i.e. central-western Namibia – area. The grasses known, and/or expected to occur in the general area (derived from [1]Müller 2007 and [2]Van Oudtshoorn 2012).

Species: Scientific name	Kransberg-Omaruru	Omaruru-Otjiwarongo	Ecological Status *	Grazing Value *
[1,2]*Andropogon chinensis*		√	Decreaser	High
[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]*Aristida stipitata*		√	Increaser 2	Low
[1]*Aristida stipoides*		√	?	Low
[1,2]*Brachiaria deflexa*	√	√	Increaser 2	Average
[2]*Brachiaria eruciformis*		√	Increaser 2	Average
[1]*Brachiaria malacodes*	√	√	?	Low
[1]*Brachiaria glomerata*	√		Decreaser	Average
[,2]*Brachiaria marlothii*		√	Increaser 2	Low
[1,2]*Brachiaria nigropedata*	√	√	Decreaser	High
[,2]*Bothriochloa radicans*		√	Increaser 2	Low
[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]*Cymbopogon caesius*		√	Increaser 1	Low
[2]*Cymbopogon plurinodis*		√	Increaser 1	Low
[1,2]*Cymbopogon pospischilii*		√	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

[1,2]*Digitaria eriantha*		√	Decreaser	High
[1,2]*Digitaria velutina*		√	Increaser 2	Low
[2]*Diplachne fusca*	√	√	Decreaser	High
[1]*Echinochloa colona*	√		?	Low
[1,3]*Echinochloa holubii*		√	Increaser 2	Average
[2]*Eleusine coracana*		√	Increaser 2	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
[1,2]*Eragrostis bicolor*		√	?	Low
[2]*Eragrostis biflora*	√	√	Increaser 2	Low
[2]*Eragrostis cilianensis*	√	√	Increaser 2	Low
[2]*Eragrostis curvula*		√	Increaser 2	High
[1]*Eragrostis cylindriflora*		√	Increaser 2	Low
[1]*Eragrostis dinteri*		√	Increaser 2	Average
[1,2]*Eragrostis echinochloidea*	√	√	Increaser 2	Average
[2]*Eragrostis gummiflua*		√	Increaser 2	Low
[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* [E]	√	√	?	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
[2]*Imperata cylindrica*		√	Increaser 1	Low

[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]*Panicum lanipes*		√	?	High
[1,2]*Panicum maximum*	√	√	Decreaser	High
[1]*Panicum novemnerve*		√	Decreaser	High
[2]*Panicum repens*	√	√	Decreaser	High
[1]*Panicum stapfianum*		√	Decreaser	High
[1]*Pennisetum foermeranum* [E]		√	?	Low
[1]*Pogonarthria fleckii*	√	√	Increaser 2	Low
[1,2]*Pogonarthria squarrosa*		√	Increaser 2	Low
[2]*Polypogon monspeliensis*	√		?	Average
[1,2]*Schizachyrium sanguineum*		√	Increaser 1	Low
[1,2]*Schmidtia kalahariensis*	√	√	Increaser 2	Low
[1,2]*Schmidtia pappophoroides*	√	√	Decreaser	High
[1]*Setaria appendiculata*	√		?	Average
[1]*Setaria finita* [E]		√	?	Low
[2]*Setaria incrassata*		√	Decreaser	High
[2]*Setaria pallide-fusca*		√	Increaser 2	Average
[1,2]*Setaria verticillata*	√	√	Increaser 2	Average
[1]*Sorghum bicolour*	√	√	?	Average
[1,2]*Sporobolus festivus*	√	√	Increaser 2	Low
[1,2]*Sporobolus fimbriatus*		√	Decreaser	High
[1,2]*Sporobolus ioclados*		√	Increaser 2	Average
[2]*Sporobolus pyramidalis*		√	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]*Themeda triandra*		√	Decreaser	High

[1,2]*Tricholaena monachne*	√	√	Increaser 2	Average
[2]*Trichoneura grandiglumis*		√	Increaser 2	Low
[1]*Triraphis purpurea*	√	√	?	Low
[1]*Triraphis ramosissima*	√	√	?	Average
[1,2]*Tragus berteronianus*	√	√	Increaser 2	Low
[1]*Tragus racemosus*	√	√	Increaser 2	Low
[1]*Urochloa bolbodes*		√	Decreaser	High
[1]*Urochloa brachyura*	√	√	?	Average
[1,2]*Urochloa oligotricha*		√	Decreaser	High
[1]*Urochloa panicoides*	√	√	?	Low
[1]*Urochloa trichopus*		√	?	Low
[1]*Willkommia sarmentosa*		√	?	High

Endemic – (Müller 2007)
? – not classified in literature, but often similar to other species within the genus
Source for literature review: Müller (2007), Van Oudtshoorn (2012)

Pennisetum foermeranum and *Setaria finita*). *Pennisetum foermeranum* is associated with rocky mountainous terrain and consequently only expected is such suitable habitat. *Eragrostis omahekensis* is virtually only found on disturbed soils – e.g. close to watering points – while *Eragrostis scopelophila* is associated with mountainous areas under trees and shrubs. The endemic *Setaria finita* is associated with drainage lines in the general area; never very common and probably the grass species most likely to be affected most by development in the area (Table 6).

None of the grass species known/expected to occur in the general Omaruru-Otjiwarongo area are however exclusively associated with the proposed development areas.

Rail line upgrades impact
The impact during construction, are expected to be detrimental to grasses, especially unique species associated with the affected area/habitat, at borrow pit sites, construction camp sites and at route deviations. This would affect relatively small areas over a short/limited period of time.

These negative impacts would depend on the scale and intensity of the proposed development.

3.7 Important Species

Reptiles
Kransberg-Omaruru
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* and *Afroedura africana* – although very little is known about these species.

Omaruru-Otjiwarongo
The most important species expected to occur in the general area (See Table 1) are viewed as the tortoises *Stigmochelys pardalis* and *Psammobates oculiferus* probably; pythons – *P. anchietae* and *P. natalensis* – and *Varanus albigularis*. All the above mentioned species are either consumed as food or indiscriminately killed when encountered – e.g. *Python natalensis*.

Amphibians
Kransberg-Omaruru
The most important species are the endemic *Poyntonophrynus hoeschi* and *Phrynomantis annectens* although they are widespread in Namibia and not exclusively associated with the Kransberg-Omaruru area in particular. Permanent water bodies viewed as amphibian habitat in the area include the ephemeral Khan and Omaruru Rivers and their tributaries. Other potential habitats in the area include rocky pool areas in the Erongo Mountains, farm reservoirs and earth dams although the latter are also dependant on localised showers and temporary of nature.

Omaruru-Otjiwarongo
The most important species are the endemic *Poyntonophrynus hoeschi* and *Phrynomantis annectens* although they are widespread in Namibia and not exclusively associated with the Otjiwarongo area in particular. Permanent water bodies viewed as amphibian habitat in the area include the ephemeral Omaruru and Omatjene Rivers and their tributaries, Otjiwarongo sewage works. Other potential habitats in the area include farm reservoirs and earth dams although the latter are also dependant on localised showers and temporary of nature.

Mammals

Kransberg-Omaruru

The most important species from the general area are probably all those classified as vulnerable (cheetah, leopard, Hartmann's mountain zebra, giraffe) and near threatened (African straw-coloured fruit bat, Commerson's roundleaf bat, striped leaf-nosed bat, brown hyena) by the IUCN (2021) and rare (Namibian wing-gland bat and Southern African hedgehog) under Namibian legislation. Another important and unique species known to occur in the general area is the endemic Kaokoland slender or black mongoose (See: Cowley and Cunningham 2004, Warren *et al.* 2009).

Omaruru-Otjiwarongo

The most important species from the general area are probably all those classified as near threatened (African straw-coloured fruit bat, Commerson's roundleaf bat, striped leaf-nosed bat, brown hyena and leopard) and vulnerable (cheetah and black-footed cat) by the IUCN (2021) and rare (Namibian wing-gland bat and Southern African hedgehog and black-footed cat) under Namibian legislation.

Birds

Kransberg-Omaruru

The most important endemic species known/expected to occur in the general area are viewed as Damara hornbill and Herero chat. Although also viewed as important, Rüppell's 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, black harrier, tawny eagle, booted eagle, martial eagle, black stork) and near threatened (Rűppel's parrot, Verreaux's eagle, peregrine falcon, marabou stork) (Simmons *et al.* 2015) and those species classified by the IUCN (2021) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, martial eagle, secretarybird), vulnerable (tawny eagle) and near threatened (kori bustard).

Omaruru-Otjiwarongo

The most important endemic species known/expected to occur in the general area are viewed as Monteiro's hornbill, Damara hornbill, Gray's lark, Herero chat, Rüppell's korhaan and Rüppell's parrot. The species listed as critically endangered (Cape vulture), endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, bateleur, black harrier, tawny eagle, booted eagle, martial eagle, black stork, saddle-billed stork), vulnerable (lappet-faced vulture, white-headed vulture, African fish eagle, secretarybird) and near threatened (European roller; Rűppel's parrot, kori bustard, pallid harrier, Verreaux's eagle, red-footed falcon, peregrine falcon, marabou stork) by Simmons *et al.* (2015) as well as those species classified by the IUCN (2021) as critically endangered (white-backed vulture), endangered (Ludwig's bustard, lappet-faced vulture, bateleur, black harrier, martial eagle, secretarybird), vulnerable (Cape vulture, tawny eagle, red-footed falcon) and near threatened (kori bustard, pallied harrier). The Cape vulture is a cliff breeder and although the last remnants are known to occur in the Waterberg Area (i.e. greater Otjiwarongo area).

Flora

Kransberg-Omaruru

The most important species are viewed as *Commiphora dinteri*, *Commiphora saxicola*, *Commiphora virgata*, *Cyphostemma bainesii*, *Cyphostemma currorii* and *Erythrina decora* (e.g. most often associated with rocky substrate).

Important plant species known and/or expected from the general Kransberg-Omaruru area and included in the Red Data Book for Namibia include at least 16 species of which 1 species is listed as rare (*Diclis tenuissima*), 1 species as vulnerable (*Lithops werneri*) and 1 species as near threatened (*Adenia pechuelii*) (Table 7) (Loots 2005). All the species included in Table 7 are viewed as important.

Table 7. Important species – i.e. Red Data spp. – known to occur in the general Kransberg-Omaruru area according to Loots (2004).

Species: Scientific name	Conservation status
Adenia pechuelii	Endemic, NT
Aloe dinteri	Endemic, NC, C2, LC
Aloe namibensis	Endemic, NC, C2, LC
Australluma peschii	Endemic, LC
Chamaegigas intrepidus	Endemic, LC
Crassula capitella subsp. *nodulosa*	LC
Cyphostemma bainesii	Endemic, LC
Diclis tenuissima	Endemic, Rare
Dombeya rotundifolia var. *velutina*	Endemic, LC
Euphorbia monteiroi subsp. *brandbergensis*	Endemic, C2, LC
Lithops gracilidelineata subsp. *gracilidelineata*	NC, LC
Lithops ruschiorum	Endemic, NC, LC
Lithops werneri	Endemic, NC, V
Namacodon schinzianum	Endemic, LC
Nicotiana africana	Endemic, LC
Trema orientalis	LC

Endemic (Loots 2005)
NC – Nature Conservation Ordinance No. 4 of 1975
Rare; V – Vulnerable; NT – Near Threatened; LC – Least Concern (Loots 2005)
C2 – CITES Appendix 2 spp.

Omaruru-Otjiwarongo
The most important species are viewed as *Cyphostemma currorii*, *Cyphostemma juttae*, *Erythrina decora* and *Manuleopsis dinteri* (e.g. most often associated with rocky substrate).

Important plant species known and/or expected from the general Omaruru-Otjiwarongo area and included in the Red Data Book for Namibia include at least 10 species of which 2 species is listed as rare (*Eriospermum citrinum*, *Eriospermum flexum*), and 2 species as near threatened (*Ceropegia mafekingensis*, *Dintera pterocaulis*) (Table 8) (Loots 2005). All the species included in Table 8 are viewed as important.

Table 8. Important species – i.e. Red Data spp. – known to occur in the general Kransberg-Omaruru area according to Loots (2004).

Species: Scientific name	Conservation status
Brachystelma schultzei	LC
Ceropegia dinteri	Endemic, NC, LC
Ceropegia mafekingensis	NC, NT
Crinum paludosum	LC
Cyphostemma juttae	Endemic, LC
Dintera pterocaulis	Endemic, NT
Eriospermum citrinum	Endemic, Rare
Eriospermum flexum	Endemic, Rare
Lithops pseudotruncatella subsp. pseudotruncatella	Endemic; NC, LC
Pentatrichia avasmontana	Endemic, LC

Endemic (Loots 2005)
NC – Nature Conservation Ordinance No. 4 of 1975
Rare; V – Vulnerable; NT – Near Threatened; LC – Least Concern (Loots 2005)
C2 – CITES Appendix 2 spp.

Other species

Aloes

Aloes are protected throughout Namibia with 3 other aloe species not included in Table 5, but which potentially occur in the general Kransberg-Omaruru area, and also viewed as important are *Aloe asperifolia*, *A. hereroensis* and *A. zebrina*. Three other Aloe species also potentially occur in the Omaruru-Otjiwarongo area and include *Aloe dinteri*, *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 5) potentially also occurring in the general Kransberg-Omaruru and Omaruru-Otjiwarongo areas. *Commiphora* species have economic potential (i.e. resin properties used in the perfume industry – e.g. *C. wildii*) making them an important species (Nott and Curtis 2006).

Euphorbias

At least 47 species of Euphorbia occur throughout Namibia of which 4 species are listed as rare, 1 endangered, 1 vulnerable and 1 near threatened (Möller and Becker 2019). Euphorbia species known/expected to occur in the general Kransberg-Omaruru and Omaruru-Otjiwarongo area include at least 7 species (*Euphorbia avasmontana*, *E. gariepina*, *E. guerichiana*, *E. lignosa*, *E. mauritanica*, *E. monteiroi* and *E. virosa*).

Ferns

At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general Kransberg-Omaruru 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* and *Pellaea calomelanos*) while in the Omaruru-Otjiwarongo area at least 23 indigenous species (*Actiniopteris radiata*, *Adiantum capillus-veneris*, *A. poiretii*, *Asplenium cordatum*, *Blechnum australe*, *Cheilanthes dinteri*, *Cheilanthes involuta*, *C. marlothii*, *C. viridis*, *Christella chaseana*, *Marsilea aegyptiaca*, *M. ephippiocarpa*, *M. farinosa*, *M. marcocarpa*, *M. nubica*, *M. unicornis*, *M. vera*, *Microlepia speluncae*, *Ophioglossum polyphyllum, Pellaea calomelanos*, *P. pectiniformis*, *Thelypteris confluens*) are known/expected (Crouch *et al.* 2011). Although ferns require specific habitat – often rocky substrate – the general Kransberg-Omaruru-Otjiwarongo area is undercollected with more species probably occurring 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 Kransberg-Omaruru-Otjiwarongo area.

Lithops

Lithops species – all protected (See Nature Conservation Ordinance No. 4 of 1975) – are also known to occur in the general Kransberg-Omaruru 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 Kransberg and include *Lithops gracilidelineata* var. *gracilidelineata* and *L. werneri* while the closest species in the

Otjiwarongo area is *Lithops pseudotruncatella* subsp. *pseudotruncatella* var. *elisabethiae* located south-east of Otjiwarongo (Cole and Cole 2005, Earle and Round n.d.).
Other species with commercial potential that could occur in the general Kransberg-Omaruru-Otjiwarongo 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).

3.8 Important Areas

The most important areas along the Kransberg-Omaruru and Omaruru-Otjiwarongo rail upgrade route are:

1. Ephemeral rivers and associated drainage lines

The Khan and Omaruru Rivers (Kransberg-Omaruru) and the Omaruru and Omatjene Rivers (Omaruru-Otjiwarongo) as well as all the larger well vegetated other ephemeral drainage lines are important habitat to larger trees, especially protected species such as *Acacia erioloba*, *Euclea pseudebenus*, *Faidherbia albida* and *Ziziphus mucronata*, etc. These larger trees serve as habitat to a wide variety of important vertebrate fauna (e.g. large raptor breeding and roosting sites; cavity dwelling birds (e.g. hornbill and parrots), bark and cavity dwelling small mammals (e.g. bats, gallago) and reptiles (e.g. monitor lizard, various geckos) (See Table 5, Figures 3 and 4). These larger trees also stabilise river banks and prevent erosion related issues – i.e. valuable ecosystem service function.

2. Erongo Mountains

Escarpments, mountains and inselbergs are generally considered as sites of special ecological importance in Namibia (Curtis and Barnard 1998). The Erongo Mountains have a high number of endemic species (26-35) and a high overall plant diversity (all species) of between 400-499 species (Mendelsohn *et al.* 2002). Pockets of high diversity are found throughout Namibia in "unique" habitat – often transition zones – e.g. mountains, inselbergs, etc.

3. Granite outcrops/ridges

Escarpments, mountains and inselbergs are generally considered as sites of special ecological importance with granite domes (Karibib and Omaruru districts) high in biotic richness and endemism (Curtis and Barnard 1998).

4. Ephemeral dams and pans

The various ephemeral ground dams, albeit artificial, and pans are important habitat, mainly for amphibians, although the larger trees associated with such features serve as habitat to a variety of vertebrate fauna.

5. Otjiwarongo sewage works

The Otjiwarongo sewage works located just to the north of the town is an important site, albeit an artificial habitat, especially for aquatic bird species.

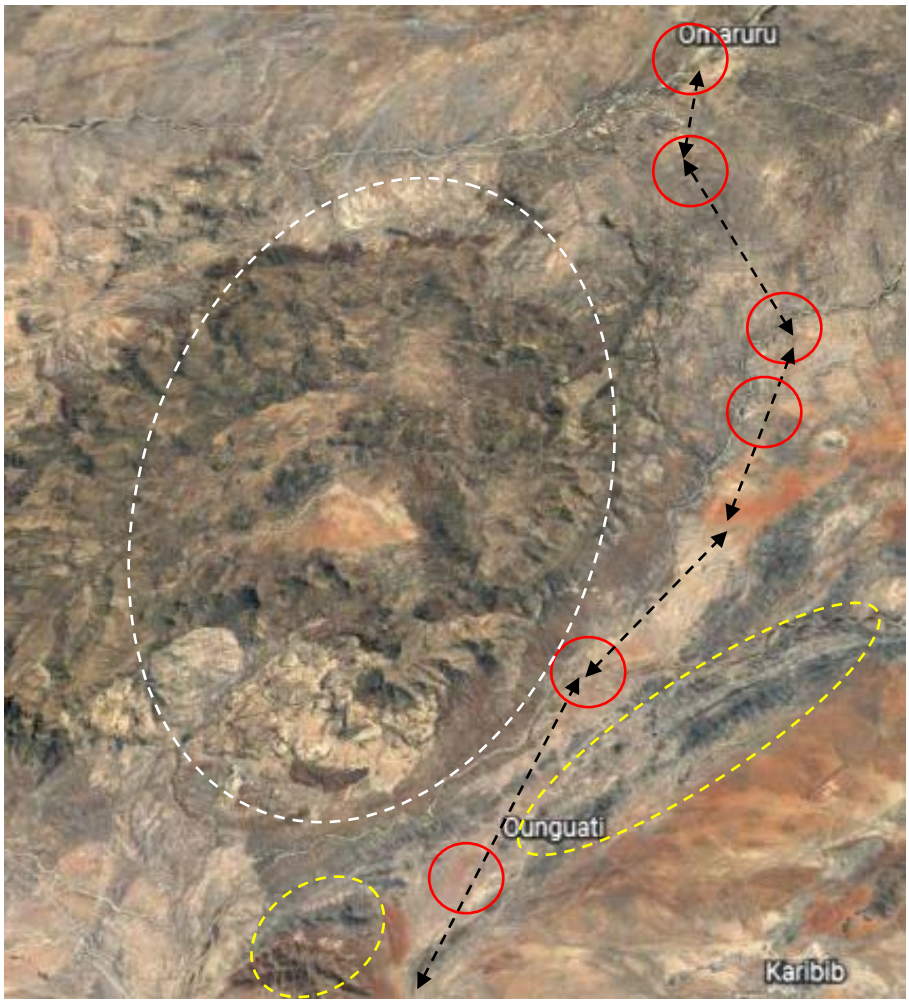

Figure 3. The approximate route of the Kransberg-Omaruru rail link upgrades (black barred arrows) east of the Erongo Mountain. Red circles indicate ephemeral drainage line crossing points (e.g. Khan and Omaruru Rivers included); white oblong indicates the important Erongo Mountains and the yellow oblongs indicate other important rocky areas (e.g. hills, ridges).

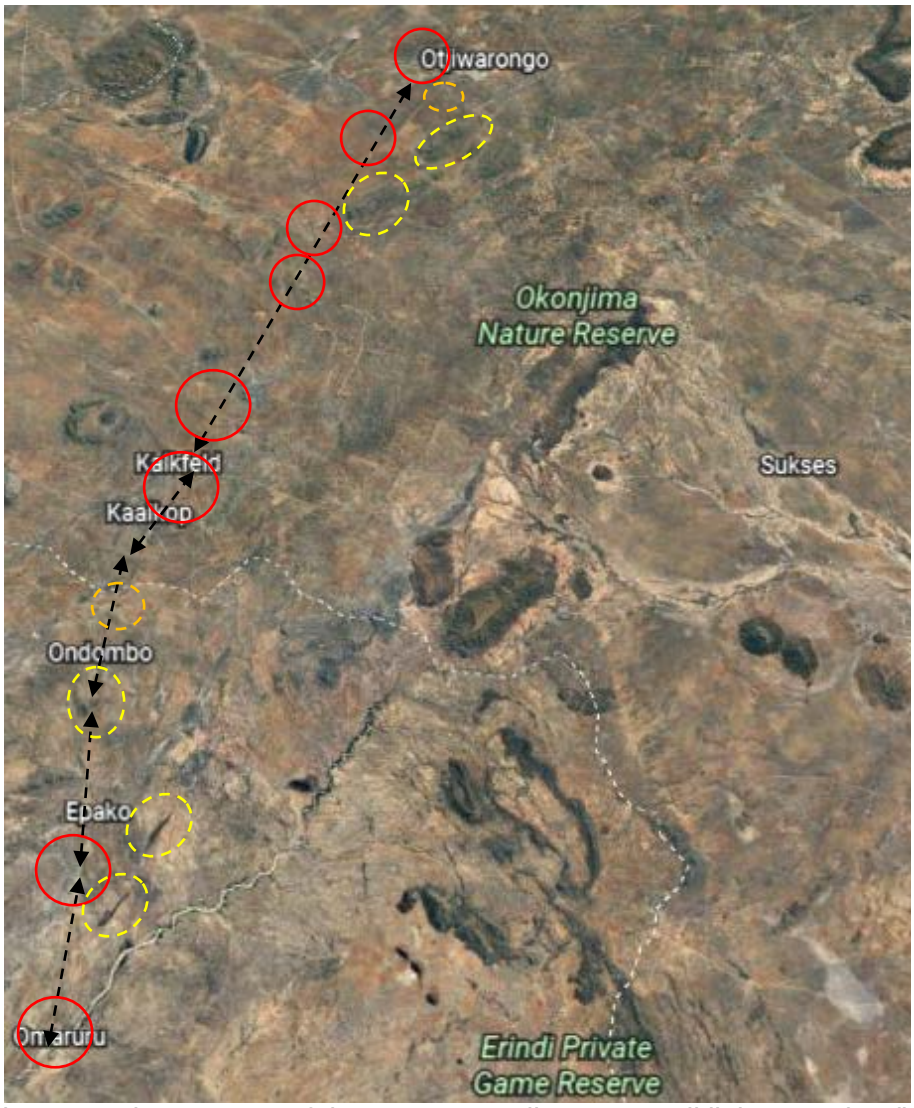

Figure 4. The approximate route of the Omaruru-Otjiwarongo rail link upgrades (black barred arrows). Red circles indicate ephemeral drainage line crossing points (e.g. Omaruru and Omatjene Rivers included); yellow oblongs indicate other important rocky areas (e.g. hills, ridges) and orange circles indicate ground dams.

4 Ecosystem services

Ecosystem services provide benefits that are used by humans and in doing so affect human wellbeing such as livestock, ground/surface/fresh/salt water, fish, soil formation/composition, tourism, recreation, spiritual interactions, etc. According to Harper-Simmonds *et al.* (n.d.) the key ecosystem services in Namibia include:

- Provisioning;
- Regulation and Maintenance; and
- Cultural.

The proposed Kransberg-Otjiwarongo (Phase 1) rail link upgrades fall within 2 ecosystem zones known as: i) Western Highlands (Kransberg-Omaruru section) and ii) Highland Acacia Savannah (Omaruru-Otjiwarongo section) with the main ecosystem services under each of the above headings viewed as:

i) Western Highlands (Kransberg-Omaruru section):

Provisioning

- Livestock;

- Wild animals;
- Plants for material and energy use;
- Surface water; and
- Ground water.

Regulation and Maintenance
- Soil formation and composition;
- Ground water recharge;
- Mediation of waste and pollution;
- Global and regional climate regulation; and
- Ventilation and transpiration.

Cultural
- Physical interactions; and
- Spiritual, symbolic and intellectual interactions.

The broad drivers of change in the Western Highlands ecosystem zone, with their ecosystem specific pressures (in parenthesis), are viewed as:

- Habitat change (overgrazing);
- Exploitation (abstraction of groundwater, increase in livestock numbers);
- Pollution (no relevant pressures identified);
- Invasive species (no relevant pressures identified);
- Climate change (more extreme climatic conditions such as current drought being experienced); and
- Illegal use (poaching – e.g. black rhino).

Overall, Harper-Simmonds *et al.* (n.d.) expect no major declines in ecosystem services in the Western Highlands zone.

ii) Highland Acacia Savannah (Omaruru-Otjiwarongo section):

Provisioning
- Cultivated crops;
- Livestock;
- Wild animals;
- Plants for material and energy use;
- Surface water; and
- Ground water.

Regulation and Maintenance
- Soil formation and composition;
- Ground water recharge;
- Mediation of waste and pollution;
- Global and regional climate regulation;
- Ventilation and transpiration; and
- Maintaining nursery populations and habitats.

Cultural
- Physical interactions; and
- Spiritual, symbolic and intellectual interactions.

The broad drivers of change in the Highland Acacia Savannah ecosystem zone, with their ecosystem specific pressures (in parenthesis), are viewed as:

- Habitat change (overgrazing and fire control and prevention measures leading to bush encroachment, conversion of freehold farms to resettlement farms);
- Exploitation (abstraction of groundwater, harvesting of game, increase in livestock numbers);
- Pollution (pollution from industry and urban settlement of watercourses – effluent and human waste, air emissions from vehicles and industry);
- Invasive species (cactus and other alien species are common around towns and farmsteads and may spread further into this zone);
- Climate change (potential to increase rate of bush encroachment); and
- Illegal use (no relevant pressures in this zone).

Overall, Harper-Simmonds *et al.* (n.d.) expect that the provisioning services of livestock and groundwater (as a result of habitat change through bush encroachment and the impacts of climate change) and surface water (due to overexploitation primarily as a result of growing demand from Windhoek) all face threats to their continued flow. The regulation and maintenance services relating to soil formation and composition and groundwater recharge are also under increasing pressures from bush encroachment and climate change in ecosystem services in the Highland Acacia Savannah zone.

5 Future climate change scenario

The future climate change scenario that was established to inform the project generally highlights a number of patterns which could, and are currently affecting, the baseline environment described above.

It is projected that there will be an increase in the number of days exhibiting extreme day time temperatures; as well as the number and duration of heat wave events. Furthermore, a greater number of warm nights will increase general discomfort, reduce overnight frost and morning dew.

The rainfall parameters are more complex but there is general agreement that in areas where either increasing or decreasing rainfall volumes are expected, rainfall will be focused into a shorter timeframe. Some areas are exhibiting a shifting in the rainfall onset and cession timing. The rain season is decreasing in length; in the frontal areas of the western and southern areas of the country, winter rainfall is compressed and the dry summer is extended; to the east and north, the convective rainfall is clustered into fewer summer months and the shoulder seasons of autumn and spring exhibit more summer-like temperatures and reduced rainfall. While it is generally expected that there will be a decrease in the number of rainfall days each year, it‘s highly likely that there will be an increase in precipitation intensity and the occurrence of more extreme events when it does rain. This is particularly true in the summer convective rainfall areas. There will also be an increase in dry spell duration between rainfall events.

Namibia is particularly vulnerable to climate change due to the arid nature of the country and the high dependence on the natural resource base, as well as the limited ability to adapt (MET, 2011). Drought events have the potential to devastate Namibia’s fragile ecosystems and the livelihoods of people who depend thereon. Shifts in the distribution patterns of rainfall, evaporation and temperature are likely to affect the distribution and range of animals and plants. Vertebrate fauna and flora with specific habitat requirements (i.e. range restricted species – e.g. tortoises, amphibians, etc.) and less adaptable to environmental change would be affected most while ecosystems dependent on regular rainfall with low variation – i.e. aquatic – are expected to be adversely affected over time.

6 Recommendations

To show environmental sensitivity and ensure environmental commitment to the proposed Kransberg-Otjiwarongo rail upgrade operations the following general recommendations are made:

Vertebrate fauna

i) Avoid sensitive areas – avoid borrow pit and camp sites and prevent route deviations from negatively affecting the rocky areas, ephemeral drainage lines and ephemeral pan/dam habitats – as indicated in Figures 3 and 4;

ii) Identify vulture and other raptor nesting trees and avoid these areas;

iii) Most bird nesting is associated with rainfall, therefore avoid nest/tree removal during the nesting (breeding) season;

iv) Prevent the killing of perceived dangerous species (e.g. snakes); collection of veld foods (e.g. tortoise); any form of poaching (e.g. setting of snares for birds and ungulates, etc.);

v) Initiate a suitable and appropriate refuse removal policy as littering could result in certain animals becoming accustomed to humans and associated activity and result in typical problem animal scenarios – e.g. baboon, black-backed jackal, crows, etc.; and

vi) Obtain the necessary permits from the Ministry of Environment, Forestry and Tourism prior to the collection, removal and relocation of protected species.

Flora

i) Avoid sensitive areas – avoid borrow pit and camp sites and prevent route deviations from negatively affecting the rocky areas, ephemeral drainage lines and ephemeral pan/dam habitats – as indicated in Figures 3 and 4;

ii) Avoid removing the large protected tree species not directly affected by the proposed development area;

iii) Remove all *Aloe*, *Cyphostemma* and *Lithop* species (should these be encountered) prior to harvesting and relocate elsewhere to similar habitat in the area;

iv) Do not plant invasive alien plant species for ornamental purposes at the construction camp sites as these often escape and become invasive and require more water; and

v) Obtain the necessary permits from the Ministry of Environment, Forestry and Tourism prior to the collection, removal and relocation of protected species.

Ecology

i) Avoid sensitive areas – avoid borrow pit and camp sites and prevent route deviations from negatively affecting the rocky areas, ephemeral drainage lines and ephemeral pan/dam habitats – as indicated in Figures 3 and 4;

ii) Implement erosion control measures where applicable – e.g. at drainage line crossing points, etc.;

iii) Remove all invasive alien species on site – e.g. *Prosopis* spp., etc. – should these occur on site This would not only indicate environmental commitment, but actively contribute to a better overall landscape;

iv) Ensure that adequate fire fighting equipment (e.g. fire beaters; extinguishers, etc.) is available at camp sites and kitchen areas during the construction period to avoid accidental fires;

v) Ensure that all hydrocarbon spills are avoided and/or dealt with adequately and quickly; and

vi) Inform all contractors/workers regarding the above mentioned ecological issues prior to construction activities and monitor for compliance thereof throughout.

All human induced activities (including rail link upgrade activities) change or are destructive to the local fauna, flora and ecology 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 and intensity of the activity – i.e. once initiated, may have a different effect on the fauna and flora as originally predicted. Thus continued monitoring of such impacts during the operational phase(s) is imperative.

The unique habitats have been identified in Section 3.8 and Figures 3 and 4; and although the rail line route is not in a pristine condition and is heavily impacted by current/past small stock farming activities; transmission lines; gravel roads, etc. the borrow pit and camp sites and route deviations potentially could affect unique habitats and/or species and should be treated accordingly. The proposed rail link upgrade activities are not expected to further affect and/or impact negatively on the vertebrate fauna, flora and ecology of the selected route, especially if the sensitive areas are avoided (treated with care) and the recommendations (suggested mitigations) are followed and implemented.

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