ETANGO PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

VEGETATION, VERTEBRATES AND TERRESTRIAL ECOLOGY

Prepared for
A. Speiser Environmental Consultants cc

For
Bannerman Mining Resources Namibia (Pty) Ltd.

By
John Pallett, Environmental Evaluation Associates of Namibia;
Dr Chris Brown, Namibia Nature Foundation Environmental Services;
Coleen Mannheimer.

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List of abbreviations

BSC	biological soil crust
EPL	Exclusive Prospecting Licence
MET	Ministry of Environment and Tourism
NACOMA	Namibian Coastal Management Project (under MET)
NNP	Namib Naukluft Park
NSCNP	Namib – Skeleton Coast National Park
NWCRA	National West Coast Recreation Area

Glossary

Biological soil crust (BSC) – a thin surface 'mat' (up to about 5 mm deep) on desert soils comprising algae, mosses and lichens, as well as fungi and microscopic animals. The most well-known form in the Namib comprises lichens, which are particularly well developed in the fog zone. Less conspicuous crusts occur as a surface mat interwoven with the desert pavement, and as a film of algae and micro-organisms on the undersurface of rocks lying on the soil (fensteralgen).

Cross-section through the upper soil layer to show a biological soil crust from the Namib gravel plains north of Arandis.

Photo of fensteralgen on the underside of translucent rocks on the soil surface.

1. INTRODUCTION AND METHODS

1.1 Terms of Reference and objectives

This Terrestrial Ecology component of the Environmental Impact Assessment of the Etango Project assesses EPL 3345 held by Bannerman Mining Resources Namibia (Pty) Ltd. It understands that the proposed mining area currently comprises "Anomaly A" and adjacent plant immediately to the south of Anomaly A, which will together occupy a footprint of some 3.5 x 1.5 km on mainly Namib gravel plains south of the Swakop River valley in the Namib-Naukluft Park, and located about 47 km north east of Walvis Bay in the Goanikontes area, straddling district road D1991. It is further understood that the Swakop River, and immediately adjacent valley areas to the river will not be mined.

This component includes the inputs of three specialist studies, focused on i) plants, ii) birds and iii) general ecology and vertebrates other than birds. The Terms of Reference for the studies included the following aspects:

- Conduct site visits;
- Identify the taxa that occur or are thought to occur on the site, with emphasis on those that are valuable from an endemicity, conservation priority and/or ecological point of view. In the case of birds, note migratory species;
- Classify the area into broad habitat zones according to vulnerability, ecological and scientific value, and note habitats or sites special to any taxa;
- Assess the ecological requirements and roles of the local species;
- Build up a model of the ecological interactions, the key species in the environment and the key processes that drive the system;
- Gather information on wildlife movements and routes, seasonal aspects and sensitive habitats. Elaborate on key species and key processes in the ecosystem so that consequences of proposed mining actions can be predicted;
- Check whether there are any critical factors from a species or ecological avifaunal perspective likely to jeopardize the Project and that may require further investigation and/or assessment.
- Compile detailed descriptions on expected impacts and suggested mitigatory measures. Involve the client in discussions so that mitigatory actions are built in to the earliest designs and operations of the proposed mine and its associated infrastructures. Impacts were to be considered regarding sensitivity to disturbance from both direct and indirect causes.
- Where necessary, provide input in public meetings about the project.

It is important to note that, although mine design and layout planning has started, the exact location of the various facilities have not yet been fixed. The mine layout plans that were used were based on the mine configuration around Anomaly A only.

The assessment looks at possible impacts on fauna and flora as a result of habitat loss from the proposed mining activities and infrastructure developments. It discusses but does not focus on the impacts that might occur from infrastructure development beyond the immediate project area. Separate assessments will be necessary for the roads and power lines, water supply and other associated developments, at the appropriate times.

1.2 Methods

Preliminary site visits were conducted in March and April 2008. The botanist surveyed the area by means of walked and driven belt transects, concentrating on the deposit areas (in order of priority as indicated by mining staff) and potential sites for establishment of infrastructure, to record the local flora in as much detail as possible, and identify sensitive species and where they are concentrated. Voucher specimens were collected of selected species considered to be of importance, and species in need of identification in the National Herbarium.

The ornithology desk study drew on (a) the National Avifaunal database that holds all available information from the national bird atlas project, road counts, breeding records and all museum specimens, (b) published information in both research publications and reports, and (c) the author's 25 years of experience of working on birds in Namibia.

The assessment of reptiles and mammals was based on their expected occurrence in the general lower Swakop area, using literature, previous knowledge and biodiversity work conducted in the vicinity, viz. collecting surveys done at Rössing (Rössing, 2008) and Valencia (Pallett *et al*, 2008). Evidence of mammal activity – sightings, sounds, dung, burrows and tracks – was noted, and combined with the assessment of habitats and available resources in the area.

A two-day visit took place in July 2008 with Bannerman staff members and the GDR MinProc team to discuss mine outlay aspects and the preliminary findings.

Further field work was undertaken in January, February and March 2009 during and after good rains in the area, when the target areas were more clearly defined and the other reports on biodiversity were available, to more closely inspect the habitats and build up an understanding of the ecological interactions in the area.

The field studies used the B2 Usakos to Swakopmund main road as the northern boundary of focus within EPL 3345, the D1991 through Goanikontes, the Namib-Naukluft Park road to the Moon Landscape, tracks in the Swakop and Khan Rivers and the myriad of small tourist and mining tracks to gain entry to and systematically cover the prospect areas of Rossingburg, Anomaly B, Ombepo, Onkelo, Oshiveli, Anomaly A and Ompo and adjacent areas, including a potential plant area south of Anomaly A. Where necessary, the area was also covered on foot, to view valleys and dead ground not accessible by vehicle. The main objectives of the field study were to (a) ensure that the desktop study of birds previously recorded for the area was comprehensive, (b) carry out detailed assessments at the specific prospect sites, immediately adjacent to these sites and at the site of possible plant development to ensure that general information collected at the quarter degree square level was applicable, and (c) to check for possible breeding sites of Red Data species which would be impacted by mining.

1.3 Single mine impacts and cumulative impacts

This mine development must be seen in the wider context of the 'central Namib uranium rush'. In the last 5 years there has been a sudden boom in uranium prospecting and mine planning in the central Namib. Many proposed mines are going through the process of environmental assessment like this one, focusing on the impacts of their individual projects. However, many impacts are compounded by others from neighbouring developments, so that the net effect of one impact will be greater than is predicted for a single mine in isolation. For example, the impact of one mine's footprint on a range-restricted species might be relatively small, but when assessed in combination with all the other mine footprints, the impact might be significant.

The Etango Project aims to mine one potential ore deposit in EPL 3345, Anomaly A, yet there are 12 other uranium deposits of interest in the EPL. Mining of any of these will add significantly to the impacts that are described for Anomaly A, and could cumulatively compound the assessments made in this report so that mining in the EPL is not recommended. For these reasons, there are statements in this report which recommend a cautious approach in view of the cumulative impacts.

A Strategic Environmental Assessment (SEA) of the central Namib uranium rush is currently underway, and is expected to be concluded in early 2010. While it is understood that this project cannot wait for the SEA to be completed before mine development proceeds, there are some issues where the cumulative impact is significant enough to warrant further studies before this EIA can be considered complete.

1.4 Nomenclature

The Etango Project has had various names associated with it, which may confuse interested parties. These include:

- Goanikontes Uranium Project – the original name of the exploration prospect, named after the farm in the Swakop River which the EPL includes;
- Bannerman prospect – derived from the company driving the operation;
- EPL 3345 – the EPL in which Anomaly A is situated.
- In this report, Anomaly A is the only ore deposit making up the Etango Project. Recent press statements have stated that the Etango Project also includes the Oshiveli and Onkelo ore deposits. This report does not address that change in the status of the Etango Project

This report covers the broad habitats in EPL 3345, and focuses on the impacts of mining only of the Anomaly A ore deposit. Any mining of other ore bodies in the EPL should be the subject of separate environmental assessments.

2. LEGAL AND POLICY REQUIREMENTS

2.1 Applicable principles and legislation

Namibia's Constitution provides for the protection of the environment in Article 95, which says: *"The State is obliged to ensure maintenance of ecosystems, essential ecological processes and biological diversity and utilisation of living natural resources on a sustainable basis for the benefit of Namibians both present and future"***.**

Plant species are protected by various mechanisms in Namibia, including Nature Conservation Ordinance No. 4 of 1975, including amendments, and Forestry Act No. 72 of 1968. Permits are required from the Directorate of Forestry to destroy protected plant species.

The Nature Conservation Ordinance of 1975 declares all species of birds to be "Protected Game" except (a) huntable game birds comprising the following species: Francolins and Quails, Button-Quails, Guineafowl, Ducks and Geese and Namaqua Sandgrouse; and (b) the following birds (which were perceived as potential problem birds): Weavers, Sparrows, Mousebirds, Red-headed Quelea, Bulbuls and the Pied Crow.

The latest draft (January 2008) of the Parks and Wildlife Bill, which will replace the Nature Conservation Ordinance, recognizes three categories of conservation status for Namibia's birds, "Specially Protected", "Protected" and "Commercially Utilisable". The Bill draws from Namibia's Red Data Book (Simmons & Brown in press) to determine the list of Specially Protected Birds. The Red Data Book applies the IUCN (World Conservation Union) criteria to determine conservation status. Sixty bird species (9% of all bird species recorded for Namibia) are listed as Specially Protected, 23 species are listed as Commercially Utilisable and the remainder are classed as Protected.

The Environmental Management Act of 2007 fixes principles for decision-making on issues affecting the environment, but the regulations under the Act have not yet been enacted.

2.2 Namibian commitment to international standards and/or guidelines

Namibia is a signatory to the UN Convention on Biodiversity, committing it to the preservation of species, particularly rare and endemic species, within its boundaries. As a signatory also to the Convention to Combat Desertification it is also bound to prevent excessive land degradation that may threaten livelihoods.

2.3 Legal status of the area

The portion of EPL 3345 north of the Swakop River lies within the National West Coast Recreation Area (NWCRA). South of the river (where mining activities are proposed to begin) lies within the Namib-Naukluft Park (NNP). Both the NWCRA and NNP are about to elevated to National Park status as part of the Namib – Skeleton Coast National Park, which will extend from the Orange to the Kunene River. Additionally, the conservation status will extend into South Africa (Richtersveld National Park) and Angola (Iona National Park), making this a trans-frontier conservation area (Figure 1).

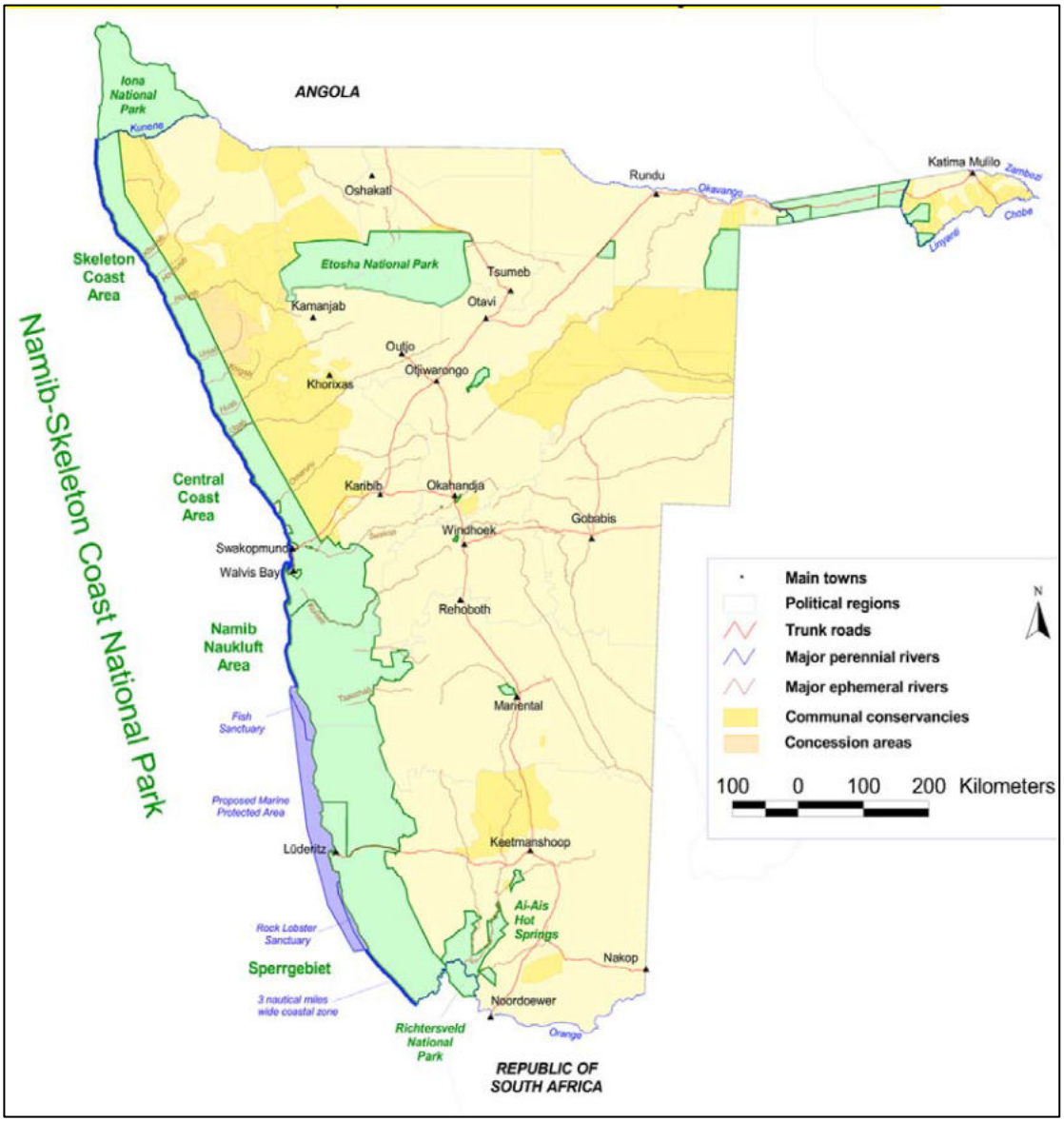


Figure 1: Conservation areas in Namibia, showing the proposed Namib - Skeleton Coast National Park and its linkages with conservation areas in South Africa and Angola. The Etango Project is within the proposed Namib - Skeleton Coast National Park, immediately east of Swakopmund.

3. TOPOGRAPHY AND HABITATS

3.1 General environmental description

The Etango Project is situated in the central Namib Desert, The central Namib lies between the ephemeral Ugab and Kuiseb rivers, and is bounded by the Atlantic Ocean in the west and the escarpment in the east. It falls into the Desert Biome of southern Africa (Rutherford & Westfall 1986) and the Desert Biome of Irish (1994).

The EPL may broadly be divided into four habitat zones (Figure 2), of which two may be further subdivided. Overall it consists largely of sandy gravel plains dissected by ephemeral watercourses and washes that generally trend north-east → south-west. These plains are incised towards the southern reaches of the EPL by the canyon of the westward-flowing ephemeral Swakop River. In the vicinity of the river on both sides the plains (Zone A) tend to gradually change into gravelly, undulating hills dissected by narrow sandy washes (Zone B), finally becoming a broad band of high mountainous ridges forming the canyon, dissected by sandy washes of varying size and accessibility (Zone C), that demarcate the route of the Swakop River (Zone D). Zones B and C drain towards the river.

Many animal taxa are found in more than one habitat, especially larger mammals which move around more widely than small species such as rodents or lizards. The value of describing habitats is that they are clearly distinct components of the total environment, recognizable by humans and by the animals that use them. The habitat approach is therefore used here for two reasons: Firstly, conservation of invertebrate and small vertebrate populations is usually not a case of protecting individuals, but of protecting the habitat which supports them. Secondly, relating the occurrence of habitats found in the project area to the extent of similar habitat in the surroundings helps to assess the distribution and conservation priority of taxa which are known to be confined to particular habitats (see the discussion about *Pedioplanis husabensis*, Section 4.3).

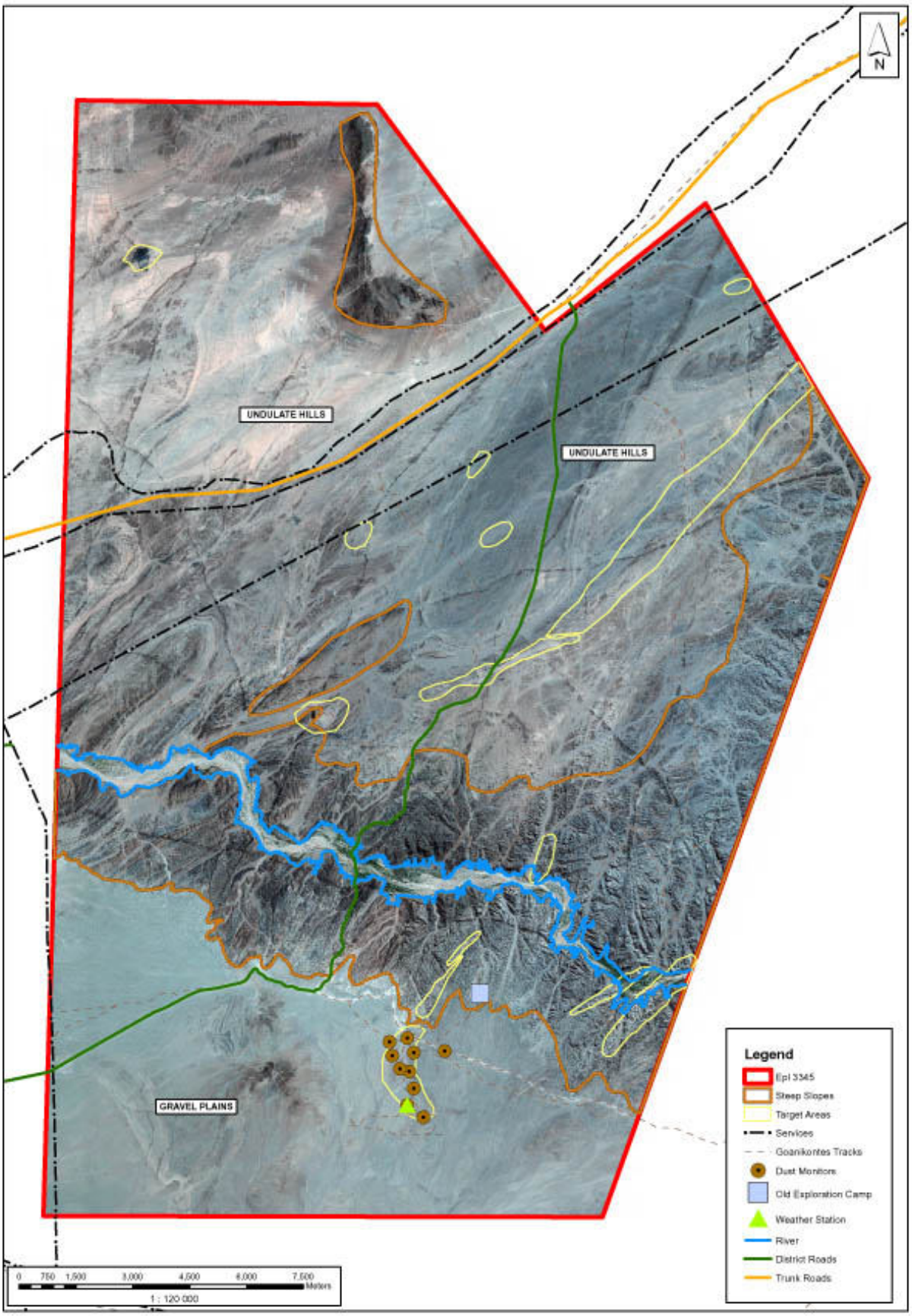


Figure 2: Main habitats within EPL 3345.

3.2 Zone A – Sandy gravel plains with shallow washes and rocky outcrops

This habitat fills the southern portion of EPL 3345. The land is flat to very gently undulating, and slopes gradually towards the north where it meets the Swakop River. The northernmost part comprises a drop towards the Swakop River, and this is where the district road D1991 has a few lookout spots for the view over the Lunar Landscape.

3.2.1 Sandy gravel plains

The plains are almost bare of plants (Figure 3), with almost all growth being confined to the washes (sub-zone A2). North of the river there were small patches of growth, usually composed of the near-endemic annual grass *Aristida parvula, Enneapogon desvauxii* and *Ophioglossum polyphyllum.* After rains it may be expected that these plains will be covered in grasses, annuals and geophytes that are presently not apparent. Characteristic remains of *Blepharis grossa,* a near-endemic annual herb, were apparent throughout the zone, and many newly-germinated seedlings were present but not identifiable.

Soils are gypsum-rich and have a surface pavement of small stones and grit, underneath which is more fine-grained material mixed with a small proportion of stones.

The soil is not firmly compacted but has sufficient structure that it is easily penetrated by burrowing animals such as ground-living insects, scorpions and lizards. Plant growth is sparse, with scattered low shrubs and grass tussocks, and no trees. Biological soil crusts (BSC) are quite prominent in this habitat, comprising crustose lichens as a conspicuous surface component, and a 'carpet' of microscopic algae and fungi that form a living layer (about 5 mm thick) at the surface. Another manifestation of soil crust organisms is the 'fensteralgen' – a green or black film of algae found on the lower surface of translucent stones such as quartz and feldspar fragments. The BSC organisms and low shrubs are sustained by sporadic fogs which bring regular and small but significant amounts of moisture to the area, precipitating it on the soil surface and on plants (Kimberley et al, 2006).

Figure 3: Most of the perennial vegetation in the plains is confined to the washes.

3.2.2 Drainage lines and washes

Throughout the plains there are shallow ephemeral washes that carry perennial vegetation, as well as several larger drainage lines (e.g. in the vicinity of the Ombuga deposit). These are all characterised by the ubiquitous presence of *Zygophyllum stapfii* (dollar-bush, Figure 4) and *Arthraerua leubnitziae* (Figure 5), both Namib Desert endemics, as well as the near-endemic *Adenolobus pechuelii* subsp. *pechuelii* (Figure 6) and *Hermbstaedtia spathulifolia,* another Namibian endemic. The larger drainage lines carry a more diverse range of perennials, including *Acacia reficiens, Cryptolepis decidua* and *Gomphocarpus filiformis.*

The washes are made conspicuous by the plants they support, which are more numerous, larger and more diverse than on the flat surroundings. This reflects the slightly superior water-concentrating and retaining ability of the washes. The substrate is more sandy and less consolidated, making animal burrowing more difficult. The washes are an important resource for plains-dwelling animals, which find shelter and a concentration of food and moisture in and around the plants (Hachfeld & Jürgens, 2000). For instance, springbok in the area rely largely on the green plant material in washes, and ostrich also fulfill most of their water requirements from wash vegetation. Seed-eating birds such as sandgrouse rely heavily on the products of shrubs in the washes (Lloyd *et al*, 2000). Invertebrates concentrate where there is shade, shelter from wind and food in the green plants or in detritus which collects around them. Scorpions, lizards and other predators feed on the herbivores. Thus animal life on the gravel plains is concentrated in the washes and sustained by the plants in them (Seely & Pallett, 2008). The shallow washes are functional miniature linear oases.

Figure 4: *Zygophyllum stapfii* (dollar bush)

Figure 5: *Arthraerua leubnitziae* (pencil bush)

Figure 6: *Adenolobus pechuelii* subsp.*pechuelii*

3.2.3 Low rocky outcrops and ridges

A number of rocky outcrops of varying composition are scattered throughout the plains. Most were found to harbour virtually no plants, particularly the smaller outcrops. However, in addition to *Z. stapfii* and *A. leubnitziae*, *Aloe asperifolia* and *Hoodia pedicellata* (Figures 7 & 8) both protected species, the former endemic and the latter near-endemic, occur on the larger ridges, particularly on marble and limestone/dolomite substrates (Figure 9).

Figure 7: *Aloe asperifolia*

Figure 8: *Hoodia pedicellata*

Figure 9: Rocky ridges, such as this one in the vicinity of the Ombuga deposit, harbour protected succulent species.

The lichen plains of the Namib are known for their high diversity and are thought to harbour many undiscovered species (Barnard 1998). It was noted that several of the higher-lying rocky ridges on the plains carried a rich lichen population, particularly on the south-western slopes (Figure 10). This emphasises the necessity to conserve high-lying areas such as rocky outcrops.

Figure 10: Lichen diversity on a rocky ridge near the Ombuga deposit.

3.3 Zone B - Gently undulating hills with shallow soil

Shallowly undulating hills (Figure 11) fall between the plains and the mountainous ridges that form the canyon of the Swakop River. They comprise mostly granitic-gneissic bedrock covered with rather shallow coarse soils, with rock debris lying on the surface, partly exposed and embedded in soil. Superficially they appear largely unvegetated, but they are dissected by narrow, sandy-rocky washes that harbour considerable plant life, including endemic and near-endemic species, and are characterised by *Z. stapfii, A. leubnitziae, Asparagus pearsonii, Adenolobus pechuelii, Petalidium variabile, Sesuvium sesuvioides* and *Cryptolepis decidua. Aloe asperifolia* (endemic, protected) occurs in very low numbers on rocky substrates in lateral gullies on these washes (Figure 12). It is the only listed species of formal conservation concern found in this zone. Like on the plains, there are no trees in this habitat.

Figure 11: Gravelly undulating hills north of Anomaly A

Compared to the gravel plains, the coarser nature of the substrate, with a smaller component of fine-grained material and shallower depth to bedrock, make this habitat more difficult for burrowing animals (eg gerbils, some lizards and scorpions) to penetrate. Desert pavement and biological soil crusts are mostly absent, although quartz and feldspar fragments do host fensteralgen. Crustose lichens are mostly absent.

Figure 12: *Aloe asperifolia* in gullies at the southern end of the Oshiveli deposit

Opportunities for animal inhabitants are linked with the sparse vegetation and shelter on the low rock outcrops and rock debris. Species dependent on rocky habitat, such as crevice-seeking lizards and scorpions, are found here in relatively low abundance, and the same goes for species more typical of flat gravel plains.

3.4 Zone C - Deeply incised rocky landscape with steep slopes

The flanks of the Swakop River valley comprise deeply dissected terrain where much bedrock is exposed and rock fragments are abundant on the steep scree slopes. This very rugged terrain is mainly made up by schists and gneisses with intruded and deformed alaskite formations and dolerite dykes that tend to stand out in positive relief (Figure 13).

Figure 13: The Swakop River Canyon is formed by mountainous ridges on either side of the sandy riverbed.

The steep slopes are largely unvegetated. However, the washes that run through them support a diverse vegetation. Endemics and near-endemics found here include *Z. stapfii, A. leubnitziae,*

Petalidium canescens (Figure 14) and *Commiphora oblanceolata* (the Swakopmund commiphora, Figures 15 & 16). The latter
has a disjunct distribution in the Kaokoveld and the central Namib, where it is found only along the Swakop and Khan rivers, usually in small populations of a few, scattered individuals, and on a few rocky outcrops and koppies in the vicinity of the rivers. It was assessed as Near-Threatened in 2002, will be affected by all mining developments near the rivers, and is the plant species of highest conservation concern in the EPL. Thus, although it has not been recently assessed by the National Botanical Research Institute (NBRI), it is recommended that a conservative attitude be assumed, and that that it be assigned a high priority due to its limited habitat potentially being reduced by several large developments in the vicinity of the Khan and Swakop Rivers.

Figure 14: *Petalidium canescens*

Figures 15 & 16: *Commiphora oblanceolata*

There is a small but thriving population of *Welwitschia mirabilis* located along the approach route to the Ombepo ore deposit (vicinity 0488547E, 7494800N). Protection of this population by careful routing of roads and strict track control would be necessary should mining proceed at this ore body (it is not presently planned under the Etango Project).

Animal life in this harsh terrain is nourished by the sparse vegetation and the fact that fog precipitation provides fairly regular and adequate water for their survival, year-round. Small rock overhangs, crevices underneath rocks and fissures and cracks on the surface provide ample shelter for small rock-loving animals.

Relatively large animals occupying this habitat are dependant on the security and shelter afforded by rock overhangs and shallow caves, and the inaccessibility of the terrain. Klipspringer, rock dassie, rock rabbit and rock rat are the mammals that live here on a

permanent basis, feeding on the plants that grow on the slopes and also venturing into the valleys where more vegetation is concentrated. Mountain zebra, kudu and gemsbok utilize rocky areas and valleys as well as adjacent plains. Given this food source, mammal predators such as spotted hyena and leopard are likely but probably rare or vagrant, and raptors (eg black eagle, augur buzzard) fill this role from the air.

At a smaller scale, the rocky habitat provides ideal conditions for animals small enough to penetrate crevices and gaps amongst rocks. These animals benefit from the shelter from heat, wind and predators, and the presence of moisture condensed from fogs (some are known to drink this directly off wet surfaces). Rock-inhabiting snakes (e.g. western keeled snake [*Pythonodipsas carinatus]*) and lizards (e.g. western rock skink [*Trachylepis hoeschi*], Husab sand lizard (*Pedioplanis husabensis*], dwarf plated lizard [*Cordylosaurus subtesselatus*]) are common, while night-searching with an ultra-violet light reveals fairly common rock-living scorpions (e.g. *Uroplectes carinatus, Hadogenes tityrus*). These organisms (also including various centipedes, insects, spiders) are mostly confined to rocky substrates, and preferences for granite (with exfoliating surface slabs) or schists (more blocky) or dolerite (smoother) play a role on the micro-scale.

No natural springs were located during the site visits, and none were reported by the geohydrologist. However, they may still occur in the vicinity. Typically, springs are provided by seepage of groundwater to the surface, and yield water slowly but permanently to support a few trees (usually *Tamarix usneoides* due to the saline conditions, sometimes also *Salvadora persica*). Swakop River water is known to be strongly saline and any springs in the area are likely to be the same. Large mammals such as mountain zebra, kudu and klipspringer rely on such water sources to survive, and are likely to move away if they dry up.

3.5 Zone D - Swakop River and main tributaries

The Swakop River is one of several large, ephemeral western-flowing watercourses in Namibia. Within this EPL are also a number of broad valleys that lead down to the river itself (e.g. north of Ompo, east of Oshiveli and Onkelo).

D.1. Swakop River

This sub-zone consists of a broad, sandy riverbed and alluvial floodplain with a robust riparian vegetation (Figure 17) characterised by woody species such as *Faidherbia albida, Acacia erioloba, Euclea pseudebenus* (all protected species)*, Tamarix usneoides* and S*alvadora persica.*

Figure 17: Riparian vegetation in the Swakop River provides essential resources such as food, shelter and nesting places for many desert organisms

The floodplain supports many other species, including endemics and near-endemics such as *Petalidium canescens, Monechma cleomoides, Zygophyllum stapfii* and *Hermannia amabilis,* and other species, such as *Sueda plumosa.*

Valleys

The large, navigable valleys that drain into the Swakop River are scenically very appealing (Figure 18), and are characterised by *Acacia erioloba, Euphorbia virosa, Petalidium variabile, Codon royenii* and *Zygophyllum stapfii.*

Figure 18: Scenery typical of the Swakop River and the large valleys that drain into it. These represent a potentially valuable, as yet largely untapped, source of tourism revenue for the Namib-Naukluft Park.

The trees and large plants are nourished by the alluvial aquifer and provide an important food resource to larger species of wildlife such as gemsbok and steenbok which feed on the leaves and pods (Kok & Nel, 1996; Jacobson *et al,* 1996). This linear oasis also provides food and shelter for birds and of course many smaller invertebrates and reptiles, which make use of the sheltered and relatively mild conditions in the otherwise harsh surroundings. The sandy river bed has deep unconsolidated soil, with clay and silt layers on the surface and interbedded deeper underground. Since it is periodically flooded and is quite unconsolidated, it is not greatly used as a substrate in which small animals make their burrows.

Since this is the only habitat that supports trees, the trees permanently supply green forage and shelter, and they form a linear connection to relatively wetter areas further inland, animals can enter the desert and survive in otherwise inhospitable terrain (Jacobson *et al,* 1996). Steeenbok, kudu, porcupine, leguaan and platanna frog are examples.

Large mammals such as kudu and gemsbok make use of the river bed most during the driest part of the year, between October and January, when there is fodder from trees and pods and small water sources at springs and gorras which gemsbok dig into the river bed. There are no fixed ‘migration routes’ – the animals move away from and towards the river as they need to and along many different routes (Lenssen, pers. comm. 2008)

4. ASSESSMENT OF PLANTS AND VERTEBRATE ANIMALS OCCURRING IN THE AREA

4.1 Plants

While approximately 17% of the Namibian flora as a whole is thought to consist of endemic species (Barnard 1998), over 30% of plants that occur in the Namibian section of the Desert Biome are believed to be endemic to that area. This is a remarkably high figure, but in the context of this project it is important to note that the areas of highest plant endemicity in the Namib are the Kaokoveld and the southern Namib, both regarded as major centres of endemicity in Namibia (Maggs et al. 1998). Levels of plant endemicity are comparatively lower in the central Namib. This notwithstanding, the proportion of endemic plants recorded in the general area (quarter-degree 2214DB, Appendix 3) is still high, at 18%. The total proportion of endemic and near-endemic species is 31% (Appendix 2). Not all the plants listed in Appendix 3 will necessarily be present in the study area because the list is generated from the database of the National Herbarium, which is based on quarter-degree squares, as well as from observations and collections during this study. Nevertheless it is indicative of the sensitivity of this area and the necessity to minimise the extent of impacts as far as possible.

4.2 Amphibians

Lists of the diversity of amphibians, reptiles and mammals occurring in the project area are shown in Appendix A, together with details of their endemicity and conservation status.

Frogs are a rare phenomenon in this arid area but are not completely absent. One aquatic species (Platanna, *Xenopus laevis*) is tied to the Swakop River, where it lives in pools when the river carries water, and burrows deep underground during dry spells. The other three inhabit ephemera pools and emerge only when the pools are filled by rainwater. They spend most of the year deep within rock crevices or underground in sandy soil.

In terms of conservation status, all four species of frogs are classified as Secure (Griffin, 2003). One is endemic to central western Namibia. Mine development and operations pose no threat to their populations, since they are all distributed widely enough that the mine footprint represents an insignificant proportion of their total range. In combination with other central Namib uranium mines, the cumulative impact is still very low.

4.3 Reptiles

Reptiles are well adapted to desert conditions and species diversity of this group is high in the Namib (Barnard, 1998). Lizards are particularly diverse, with 28 species of geckos, skinks and typical lizards known or expected to occur in this area (Griffin, 2005). This is often surprising to the lay person since many of these animals are secretive or nocturnal, so they easily go unnoticed.

A few common species of lizards are likely to be recognized around the Etango Project area. Day geckos (*Rhoptropus* spp) are commonly seen darting over bare rock slabs and boulders, and *Pedioplanis* sand lizards are also common in areas with many loose rocks on the surface. Slower-moving skinks may be noticed half-emerged from crevices. Barking geckos are conspicuous by their tapping calls given in the evenings and at night. Apart from these few common species, there are many others less likely to be seen unless actively searched for. This assessment did not include a thorough collecting effort to assess the full reptile diversity, as that would involve lengthy fieldwork and museum follow-ups.

An illustrated overview of reptile diversity in the Goanikontes area is presented in Table 1, together with notes on their endemism and conservation status.

Table 1. Illustrated overview of reptile diversity in the Goanikontes project area.

Taxa	**Occurrence and endemism**	**Conservation status**
 Tortoises and terrapins 2 species	Both low probability of occurrence. Both widespread.	Leopard Tortoise Vulnerable
 Geckos 15 species	3 spp endemic to Namib Desert; 3 spp endemic to Central Namib.	all Secure
 Agamas 2 species	Both common and widespread	both Secure
 Chameleons 1 species	Common, endemic to Namib Desert.	Secure
 Skinks 7 species	1 sp endemic to Namibia; 6 spp widespread.	All Secure
 Typical lizards 6 species	1 sp endemic to Namib Desert. 1 undescribed species, *Meroles* sp.nov; Data Deficient; possibly endemic to Central Namib. *Pedioplanis husabensis* Data Deficient, endemic to the lower Swakop-Khan area. 1 sp widespread.	all others Secure
 Plated lizards 1 species	Widespread	Secure
 Worm snakes and blind snakes 3 species	2 spp endemic to Namibia; 1 sp widespread.	all Secure
 Typical snakes 12 species	3 spp endemic to Namibia; 1 sp endemic to Central Namib; 8 spp widespread.	all Secure
 Adders 2 species	1 sp endemic to Namib Desert; 1 sp widespread.	both Secure

Taxa		Occurrence and endemism	Conservation status
	Cobras 2 species	1 sp endemic to Namibia; 1 sp widespread.	both Secure

Mine development and operations will not have a significant impact on the populations of most of the reptile species in the project area. Three species deserve consideration:

Leopard Tortoise occurs marginally here and, while it is classified as Vulnerable (Griffin, 2005), its occurrence is only sporadic and in naturally very low numbers. Nevertheless, tortoises are easily picked up for the pot or to keep as pets, and this is a major reason for their declining populations (Cunningham, 2005). This is a protected species under Namibian legislation, so collecting of any tortoises should be strongly forbidden on and around site, and disciplinary action taken if it is detected.

Husab Sand Lizard (*Pedioplanis husabensis*) and the unnamed *Meroles* species have very restricted distributions. *P. husabensis* requires rocky substrate, which occurs continuously over an extent of about 850 km² in the lower Swakop-Khan-Husab area (Rossing, 2008). This is its *expected* total area of occurrence, which still needs to be verified. In comparison, the footprint of the mine is relatively small (less than 1,000 ha.), less than 1% of the expected distribution of the lizard. However there are similar impacts on its population at Rossing, Valencia and other expected uranium mines, so cumulatively the reduction and fragmentation of its habitat may become a significant impact. This species deserves further investigation of its population and extent of occurrence before mine development proceeds.

The situation regarding the new *Meroles* species is even more uncertain. It is known only from one specimen collected immediately inland of Swakopmund (Hebbard, Griffin, pers. comm. 2008). In terms of the precautionary principle, a species whose conservation status is unknown should be regarded as Threatened until adequate information regarding its distribution and abundance becomes available. Clearly, the status of this animal is unclear as its taxonomic status, population status, preferred habitat and extent of occurrence are still unknown. Like for *P. husabensis*, this species deserves further investigation by qualified herpetologists before mine development proceeds.

4.4 Mammals

Large mammals such as springbok and gemsbok are occasionally seen in the area, where they mostly frequent the open plains. They concentrate in areas after rain where grass growth is plentiful, and gemsbok may move to and from the Swakop River to use open water and pods from trees in the river bed. Other large to medium-sized mammals that can be seen in the project area are Hartmann's mountain zebra, klipspringer and rock dassie, which all prefer mountainous terrain. Baboons are resident further upriver and may venture as far west as Goanikontes occasionally, particularly when heavy flows in the river leave abundant pools along the linear oasis.
Mammal predators such as spotted hyena and leopard are likely to be resident in the general area, but are secretive and keep their distance from human activity.

These few species are outnumbered by a variety of other mammals which are largely unnoticed as they are secretive and largely nocturnal, and most of them are small. They include rodents and rodent-like mammals, bats and small carnivores. An illustrated overview of mammal diversity in the Goanikontes area is presented in Table 2, together with notes on their endemism and conservation status.

Table 2. Illustrated overview of mammal diversity in the Goanikontes project area.

Taxa	Occurrence and endemism	Conservation status
 Rodents, hares and dassies 13 species	Namib brush-tailed gerbil endemic to Namib Desert. 1 sp endemic to Namibia. 11 spp widespread.	All Secure
 Shrews and sengis 2 species	Both widespread	Both Secure
 Bats 11 species	Namib long-eared bat endemic to central Namib and adjacent escarpment; 1 sp endemic to Namibia; 9 spp widespread.	All Secure except Namibian Wing-Gland Bat – Data Deficient
 Carnivores 10 species	All widespread	African Wild Cat, Cape Fox and Bat-eared Fox – Vulnerable; others Secure
 Hoofed mammals 6 species	Namibian mountain zebra endemic to the Namib and western escarpment; 5 spp widespread	All Secure

Only three of the listed mammals are noteworthy in terms of endemism. The Namib long-eared bat is known only from a few localities in the Namib and escarpment (Griffin, pers.comm. 2006); and Namib brush-tailed gerbil occurs on gravel plains in the central and northern Namib (Griffin, 1990). Namibian mountain zebra occurs only in mountainous terrain on and to the west of the escarpment, and is considered Secure in Namibia, but Endangered in the international context (Griffin & Coetzee, 2005). None of these species are restricted to a small range of distribution around the project area. None are therefore significantly threatened by the mine development.

Conservation priority species include one bat and three carnivores (Griffin & Coetzee, 2005). The Namibian Wing-gland Bat is only recorded from western Namibia and is very poorly known. In view of its relatively wide distribution to the north and south of the project area, its population is unlikely to be significantly affected by the mine development.

The African Wild Cat is classified as Vulnerable due to its genetic dilution from breeding with domestic cats. Its presence in the area is extremely unlikely but possible in the Swakop River bed where there is vegetation cover. Presence of feral cats might become a problem around the mine during construction and once operational. If they become resident they should be strongly deterred by being captured and killed or removed if seen on site. This is to prevent any interference with African Wild Cats as well as to prevent further impact on the reptile and small mammal populations, which feral cats are known to harm significantly. This issue is not assessed in Section 5 as the presence of African Wild Cats is not very likely, nor is it likely that feral cats will be resident on the mine.

Cape and Bat-eared Foxes are also classified as Vulnerable, as they are potentially threatened by poisoning targeted at jackals. The latter two species both have strong populations in the Namib protected areas and are not further threatened by the mine development.

None of the endemic and conservation priority species are therefore significantly impacted by the mine.

4.5 Birds

Information is provided on the national status of each species recorded for the study area based on Namibia's Red Data Book (Simmons & Brown in press) as well as their status in the immediate project area based on reporting rates. The latter lists birds as Abundant (recorded on >50% of visits to the area), Common (recorded on 20-50% of visits), Uncommon (5-20%) and Rare (<5%).

Because of the hyper-arid character of the area and highly variable rainfall (coefficient of variance of >90%), many bird species found in the project area are highly nomadic, moving from place to place in search of appropriate conditions. This differs from migratory species that undertake fixed annual movements, usually from north of the equator to the southern hemisphere and back. Nomadic species by contrast generally remain within Namibia or adjacent parts of the southern African subregion, but move around widely and in no fixed pattern, to exploit patchy and unpredictable food, water and other ecosystem resources. Thus a number of nomadic species that occur in the area may not be present at certain times of the year or in some years, and their abundance may differ dramatically over time.

4.5.1 Bird diversity of the focal area

A total of 126 bird species was recorded in the avifaunal database for the Goanikontes ¼ degree square (2214Db) into which the project area falls (Table 1). These records were derived from over 60 visits to the area over more than 10 years. They represent about 90% of the total number of species that would be expected in that area. It is mainly the rare species that are not listed. During the field assessment 56 species were recorded, all of which were already in the database for the project area. A relatively high diversity of birds is recorded for this area compared to many other parts of the Namib Desert because of the diversity of habitats, comprising – from an avifaunal perspective - essentially three main forms: (i) flat sandy and gravel plains and gently undulating hills with small drainage lines, (lumping the vegetation zones A and B into one); (ii) deeply incised rocky landscapes (the vegetation zone C), descending down to (iii) the Swakop River and its tributaries (vegetation zone D). This last habitat forms a linear oasis across the Namib, providing a narrow corridor for savanna species to penetrate almost to the coast, e.g. Spurfowl and Guineafowl, Woodpeckers, Barbet, Hornbills – in total some 40 species. It is this habitat that contributes to the relatively high avifaunal diversity of the area. A fourth and highly transient habitat should also be recognized, being that of episodic wetlands following ephemeral river flows and rare rainfall events. This accounts for the rare and uncommon records of ducks and waders in the area.

4.5.2 Migrant species

Fourteen bird species occurring in the EPL are Palaearctic migrants (from Eurasia) and four are intra-African migrants, all visiting Namibia during the summer months. None of the Palaearctic species breed in Namibia. They mostly move around in nomadic fashion in search of good feeding areas, often following rainfall events. All of the intra-African migrants breed in Namibia. In addition, at least three species are partial intra-African migrants, meaning that part of the population is resident and/or nomadic while part migrates. All these species are "Rare" or "Uncommon" in the project area. They have large widespread populations elsewhere and their conservation status will not be significantly impacted by habitat loss as a result of the proposed mining and related infrastructure in the project area.

4.5.3 Endemic species

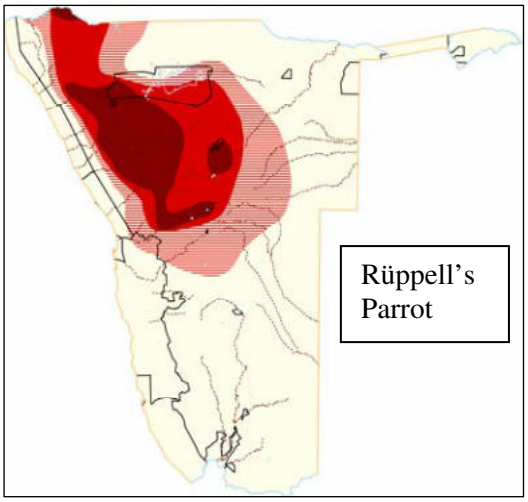
Forty one birds endemic to the southern African subregion were recorded (sA endemics in table). The conservation status of all these species is considered to be "Secure", i.e. not threatened in any way.

Three bird species endemic to Namibia were recorded in the project area (see Table below). One of these, Rüppell's Parrot, is listed as Near Threatened. The conservation status of the other two species is considered to be "Secure", i.e. not threatened in any way.

Species	Status		Habitat	Conservation risk from project
	National	Project site		
Rüppell's Parrot	Near threatened	Rare	Large trees	Low – protect large trees and avoid disturbance in Swakop River and main tributaries
Rüppell's Korhaan	Secure	Abundant	Gravel, sandy & rocky plains & hills	Low – keep footprint on gravel and sandy plains and undulating hills to a minimum
Gray's Lark	Secure	Uncommon	Gravel plains	Very low – keep footprint on gravel plains to a minimum

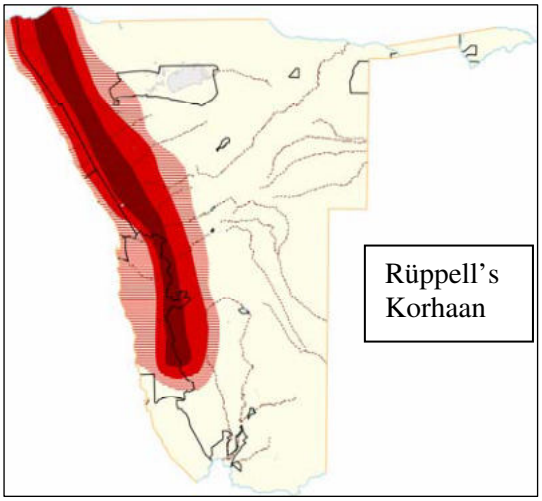
The following species accounts for the three Namibian endemics are taken from Namibia's Red Data Book (Simmons & Brown in press).

4.5.3.1 Rüppell's Parrot



The proposed project site falls on the edge of the range of Rüppell's Parrot where the birds are at low density (see map). Rüppell's Parrot is endemic to Namibia and southern Angola, and occurs predominantly in the escarpment and particularly the ephemeral rivers of n-c Namibia (Simmons 1997). Its range in Namibia covers 140,000 km^2 (Robertson *et al.* 1995). The Namibian population is estimated at 29,500 birds (range 13,000-46,000: Jarvis & Robertson1999). It prefers riverine habitat with large mature, seed-bearing trees. Breeding season is Jan - Jun (Jarvis *et al.* 2001, Simmons 2005) in holes in tall live trees, often in downward facing hollows which makes access difficult for predators.
The illegal trade in wild parrots is perhaps the biggest threat to this species. The illegal trade from Namibia was recently investigated and 600-1,000 birds are probably exported to South Africa or Europe (especially Germany) each year (Selman 1998). Loss of large trees for breeding and feeding is another potential threat. This species is classified as *Near Threatened* because of its restricted range and some evidence of a decline apparent from parrot enthusiasts who state that the large flocks they knew from areas around Windhoek, Okahandja and Outjo no longer occur (Selman 1998).
Mining activities should not take place in the Swakop River and main tributaries, large trees should be protected and mine staff should not be allowed to move beyond the immediate mining and plant area to prevent illegal capture of parrots. If these measures are adopted and applied, there should be no threat posed to this Near Threatened Endemic species by the proposed mining activity.

4.5.3.2 Rüppell's Korhaan

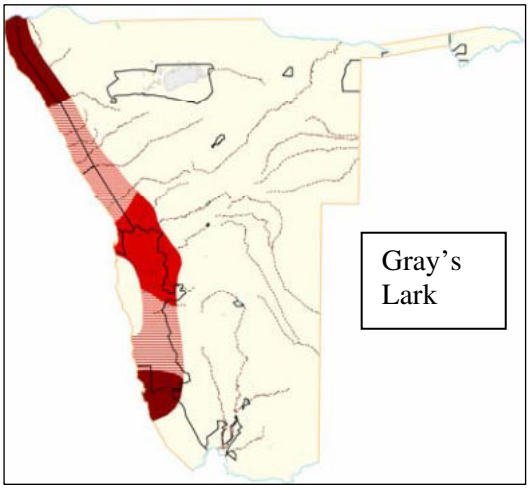


The proposed mining site falls into the core range of this cryptic ground-dwelling species. It is found from the escarpment west to the coast, but avoids unvegetated dunes of the Namib sand sea south of Walvis Bay (Allan 1997). Population size in Namibia is estimated at 99,900 birds and they occupy an area of 201,900 km^2 (Jarvis & Robertson 1999). They occur most commonly in open grassy gravel plains below the escarpment where densities reach 1 bird/1,319 ha. On sandy plains densities are half this at 1 bird/2,667 ha, while birds in valleys and plateaus in montane

habitat occur at low densities of 1 bird/5,934 ha (Viljoen 1983). They are frequently seen in groups of two to four, presumably family units, but up to eight birds have also been observed (Allan 2005). They are sexually dimorphic and presumed monogamous (Osborne 2004). Birds breed in winter with a peak in April - June, but with records of eggs and chicks from every other month bar August (Jarvis *et al.* 2001). They are not threatened in their desert habitat and over one quarter (27%) of their range lies within conservation areas such as the Namib-Naukluft or Skeleton Coast Parks (Jarvis *et al.* 2001).
Mining activities will impact directly on about 550 ha. Other secondary areas of impact are not yet known, but assuming the total area is double this, only one or two family groups of an estimated population of almost 100,000 birds are likely to be displaced. As these birds are highly nomadic in response of rainfall, this impact is considered insignificant. The mine planning should aim to keep its primary and secondary footprints as small as possible.

4.5.3.3 Gray's Lark

This small pale grey lark is endemic to the Namib Desert where it is found in small flocks of up to 30 birds on the pale gravel plains from Kiogab Pan region in the south to Pico do Azevedo in sw Angola (Dean 2000). The area occupied in Namibia is about 46,443 km^2 of which almost half (21,014 km^2) occurs within the protected areas of the Namib-Naukluft Park and the Skeleton Coast Park (Jarvis *et al.* 2001). This species avoids only the Namib Sand Sea with its complete cover of mobile sand dunes. It may be commonest in the areas around Swakopmund, where reporting rates are highest (Dean 1997) but this area has many more observers than areas north or south. Population size and breeding density is unknown but it must number more than 100,000 birds given the extent of its occurrence. Two subspecies are recognised – *A.g. grayi* south of Cape Cross (small and pale sandy brown) and *A.g. hoeschi* in Damaraland which is larger and darker grey-brown (Dean 2005). Both breed opportunistically after rains and recently it has been found to have cooperative helpers at the nest (Boix-Hinzen & Boorman 2003, Demasius 2003). It breeds March-July, laying an average of 2.2 eggs/nest and rearing 1.1 young/nest (Dean 2005). It is not threatened in any way given the proportion of its range in protected areas, and its dry barren habitat requirements.



Mining activities fall within the core range of this species. However, because of the relatively small size of the mining footprint and the highly nomadic nature of this Lark, impacts on the population are likely to be very small to insignificant. The mine planning should aim to keep its primary and secondary footprints as small as possible.

4.5.4 Red Data species

The Red Data listing is an approach based on probabilities of extinction. Depending on the severity of past population declines and population sizes, species are categorized as either:

- **Regionally Extinct:** no individuals or breeding individuals known
- **Critically Endangered:** a species with a 50% chance of going extinct in 5 years
- **Endangered:** a species with a 20% chance of going extinct in 20 years
- **Vulnerable:** a species with a 10% chance of going extinct in 100 years
- **Near-threatened:** a species that does not quite meet the criteria for inclusion into any category but which is likely to enter the Vulnerable category in the near future
- **Secure:** a species that has been assessed against the above criteria and does not qualify because there are presently no conservation concerns

Five Red Data species have been recorded in the project area. One is classed as "Endangered", one as "Vulnerable" and three as "Near Threatened" (see Table below). One is

Rüppell's Parrot (see under Endemic species), confined mainly to the large trees of the Swakop River and tributaries. Another is the Cape Eagle-Owl, confined largely to the deeply incised rocky landscape and cliffs of the Swakop valley. Three are diurnal birds of prey – one vulture and two eagles. The Lappet-faced Vulture is a desert and dry savanna specialist. The Martial Eagle favours open savanna and Namib plains while Verreauxs' (Black) Eagle lives in mountainous and hill areas – thus inhabiting the cliffs and deeply incised landscape of the Swakop River Valley.

As mining activities are proposed mainly for the plains area south of the Swakop Valley, impacts on the Parrot, Owl and Verreaux's Eagle are like to be very low to nil.

National status	Species	Local status (project area)	Habitat	Conservation risk from project
Endangered	Martial Eagle	Rare	Savanna to desert	Low – check for nests (in fork of large trees) and avoid any disturbance in 2 km radius *
Vulnerable	Lappet-faced Vulture	Uncommon	Arid to semi-arid plains	Low – check for nests (top of thorn trees) and avoid any disturbance in 2 km radius *
Near threatened	Rüppell's Parrot	Rare	Areas with large trees, e.g. river courses	Very Low (habitat not in proposed mining area) – protect large trees and avoid disturbance in Swakop River and main tributaries. Ensure no staff go beyond periphery of fenced mining area.
	Cape Eagle-Owl	Uncommon	Rocky outcrops, mountainous areas, cliffs, etc	Very Low (main habitat not in proposed mining area)
	Verreaux's Eagle	Rare	Mountainous, hilly areas with cliffs	Very Low (main habitat not in proposed mining area)

***** During the field assessment, the prospect sites and adjacent areas were thoroughly checked for suitable nesting trees, and all trees were checked for nests. None were found to occur in the area.

The following species accounts for the five Red Data species are taken from Namibia's Red Data Book (Simmons & Brown in press).

4.5.4.1 Martial Eagle

The Namibian population is estimated at less than 350 pairs. It suffers direct persecution through shooting and drowning in farm reservoirs (Steyn 1982, Brown 1991, Anderson *et al.* 1999). In one study of a small breeding population of Martial Eagles in central Namibia, 3 breeding pairs were reduced to 1 breeding pair over a 6-yr period: 4 adults were found shot and another drowned in a farm reservoir. Assuming all nests found in the 840 km^2 study area were used at one time, the population probably numbered 5 breeding pairs and the decline was, at 80%, even steeper than originally recorded. A more surprising threat is that of drowning in sheer-walled reservoirs. In southern Africa Martial Eagles ranked highest of all eagles as victims of drowning: of 65 eagles found dead in reservoirs, 38% were Martial Eagles (Anderson *et al.* 1999). These deaths were especially prevalent in more arid parts, where an estimated 8% of the adult population may succumb to drowning (Anderson *et al.* 1999). This link with aridity suggests that drownings in Namibia may be more prevalent than recorded. Some mortality is associated with collisions with power lines (van Rooyen 1999): 10 birds were reported killed under power lines by Eskom (S African supply company) in the 4 yr period from 1996-1999 (van Rooyen 1999); another 2 collided with the lines in the same period. The numbers killed in Namibia are unknown. A further threat that may have a wider impact on Martial Eagle

populations than the mortalities uncovered in Brown's (1991) farmland studies is a general decline in suitable eagle prey which limits populations (A Jenkins pers comm.). This may be reflected in the larger than predicted territories of >1,000 km^2 uncovered by van Zyl (1992) and the commonly reported result of higher population densities of eagles in areas where natural prey assemblages are intact (Kruger and Hwange NPs : Tarboton & Allan 1984, Hustler & Howells 1990). This may also explain the greater eagle densities in game farms in the Nama-Karoo where large ungulates have been re-introduced compared with small stock farming areas outside (Machange *et al.* MS).

This species is classified as *Endangered* because in central parts of their range they have declined by as much as 80% in little over 5 years through direct persecution (Brown 1991). Given that this occurred in commercial farmlands (Brown 1991) and at least 50% of Namibia's Martial Eagles are estimated to occur on commercial farmland (Boshoff 1997, Mendelsohn *et al.* 2002), it is likely that populations elsewhere have suffered the same declines.

The main impact in the focal area, if birds were found to be breeding there, would be breeding disturbance, possible breeding failures and displacement. The focal mining area and a 2 km radius should be checked for nests (built in the fork of a large tree under the canopy). On the Namib plains such trees are usually found in drainage lines.

4.5.4.2 Lappet-faced Vulture

Its population in Namibia is estimated at about 500 pairs, and it has experienced a decline of at least 10% in the last three generations. As such, it is classed as ***Vulnerable***. The main cause of decline is through poisoning. Mass poisoning incidents have taken place close to the Namib-Naukluft Park (Simmons 1995) as well as in the central and northern areas. An average of 31 vultures are known to have been poisoned and drowned per year in Namibia over the last 7 years, despite continuing and increasing media coverage, farmer awareness forums and poison awareness campaigns via the media, booklets and posters. Together with drowning, shootings and trapping, and unnatural mortalities recorded for other scavenging species on Namibian farmlands (Brown 1991), this mortality rate represents probably the tip of an iceberg of unnatural mortality (Brown 1986, Bridgeford 2001). The species is also listed as *Vulnerable* in South Africa's Red Data Book for the same reasons as detailed here - poisonings, shooting - but also habitat destruction of breeding trees (Anderson 2000) and disturbance during breeding. Globally they are rated as *Vulnerable* because of extinctions in Israel and parts of North Africa, and a declining population throughout southern Africa generally. Namibia holds *c* 50% of the southern African population of the Lappet-faced Vulture, and we thus have a special responsibility in their conservation.

Special attention needs to be paid to causing absolutely no disturbance near nesting sites – including passing vehicular and aircraft traffic and people on foot – within 2 km of any active vulture nest. The focal mining area and a 2 km radius should be checked for nests (built on the top of thorn trees). On the Namib plains such trees are usually found in drainage lines.

4.5.4.3 Rüppell's Parrot

See 4.5.3.1 under Endemic species.

4.5.4.4 Cape Eagle-Owl

This large and apparently scarce nocturnal owl, has three subspecies in Africa. However, just one race (*B.c. capensis*) is confined to southern Africa and is found in a distributional arc similar to the Verreaux's Eagle through Zimbabwe, South Africa and the western parts of Namibia (Mendelsohn & Allan 1997). Its dependence on rocky uplands may explain its absence from essentially flat parts of the central subcontinent. In 1997 there were just three records for Namibia namely (i) a bird at Lorelei on the Orange River in 1956 (Clinning 1980); (ii) a breeding pair near the coast at Lüderitz in 1983 (Walter *et al.* 1986); (iii) an injured bird found on the farm Namibgrens, on the escarpment 140 km sw of Windhoek in 1987 (Brown 1987, Boyer & Bridgeford 1988). Several specialists predicted it would be more widespread than found (Steyn

1982, Walter *et al.* 1986) and may even occur as far north as southern Angola (Kemp & Calburn 1987). Since then numerous records have extended its range from the Swakop River Valley and Brandberg (Mallet-Veale 1996), to the Ugab River in the Namib Desert (Swanepoel 2003) and as far north as 9 km from the Cunene River in the Kaokoveld (W Swanepoel pers obs). Intimate knowledge of habitat preferences were used by Swanepoel to successfully locate owls at the Zebra River in the Tsaris Mountains, on the Brandberg massif, at the Khowarib Schlucht, (Swanepoel 2003) and in the Okakora Mountains near the Cunene River at 17^{o} 13' S (W Swanepoel pers obs). It is probably safe to assume, therefore, that where montane areas are incised by river valleys in arid areas and hyrax or rock rabbits are available, Cape Eagle-Owls are likely to occur in Namibia.

Elsewhere in southern Africa the Cape Eagle Owl prefers relatively mesic rocky habitat so it is unusual that it is found in very arid areas of the Namib Desert. However, most of these are associated with river valleys and the owl shows a preference for rocky or mountainous terrain with cliffs, gorges, canyons and boulder strewn hillsides, especially those consisting of igneous (e.g. granite) or sedimentary rock (e.g. dolomite, limestone: Swanepoel 2003). It appears to have habitat preferences very similar to Verreaux's Eagle and Rock Pigeon and where these and rock hyrax or rabbit are found the bird is likely to occur (W Swanepoel pers obs). The bird hunts mainly (80%) mammals - small and large - in other parts of s Africa (Allan 1995) but its diet in Namibia is poorly known other than records of Red Rock Rabbit, an unidentified rat, Striped Mouse and a Hartlaub's Gull from Lüderitz (Walter *et al.*1986). The one breeding record is from July-August at the coast, towards to the end of the usual breeding period for this species (May-September: Kemp 2005).

Few threats are known for this species because its life-history in Namibia is so poorly known. However its habitat preferences and range suggest that overgrazing by goats in rocky hillsides may be the only threat to its ecology. Low density of people in these areas and the advent of conservancies in many regions suggest this will be a minor threat. Prior to the work of Swanepoel this species would have been categorized as Rare and Peripheral. However, it is clear that substantial populations occur in Namibia and as an endemic subspecies to southern Africa it requires protection and research. It is therefore given *Near-Threatened* status because its population is likely to be small, and probably below 1,000 birds.

This species is at negligible to no threat from the proposed mining activities provided these do not extend into the broken landscape of the Swakop River valley.

4.5.4.5 Verreaux's (Black) Eagle

In southern Africa this species exhibits a U-shaped distribution pattern with a large gap apparent in most of Botswana and ne Namibia. This arises from the lack of prominent highlands in a region dominated by Kalahari sands. Density of breeding pairs varies from 1 pr/10.3 km^2 (one of the highest known for a large eagle) in the Matobo Hills, Zimbabwe, 1 pr/24 km^2 in the Karoo, SA, 1pr/25 km^2 in E Africa, 1 pr/28 km^2 in Ethiopia's Balé Mountains, to 1 pr/ 35 km^2 - 65 km^2 in the Magaliesberg and Drakensberg ranges, RSA (Brown *et al.* 1982, Steyn 1982, Brown 1988a, Allan 1988, Gargett 1990, Davies 1994, Clouet *et al.* 2000). There are no comparable figures for Namibia. However along cliffs around the Waterberg Plateau Park, pairs occur along the 150 km escarpment at a linear density 1pr/25-30 km (Brown & Cooper 1987, Simmons 2002). The global breeding population is unknown but populations for the Cape Province South Africa, have been estimated at between 400 and 2,000 pairs (Davies & Allan 1997). This allows us to estimate a slightly lower population (of *c.*500 – 1,000 prs) for Namibia based on lower reporting rates in the Atlas (Harrison *et al.* 1997) in an area of similar size. Populations fluctuate surprisingly little despite four-fold changes between peaks and troughs in hyrax numbers (Davies & Ferguson 2000, R. Davies in litt); at troughs birds may temporarily disappear or switch to alternate prey. This is only especially marked in drought periods (Gargett *et al.* 1995) and on average occurs once every 20 yr (R. Davies in litt).

Breeding starts in April, with eggs peaking in May and extending through to August; if successful the single nestling fledges several months later in the spring and remains dependent

through the summer months. Availability of prey appears to be the main determinant of timing of breeding and breeding density (Gargett 1990), but winter sheep carrion may advance laying dates in Karoo habitat (Davies 1994). Hyrax population crashes are associated more with breeding failure in eagle pairs than eagle population declines, presumably because eagles can temporarily switch to other prey (R. Davies in litt).

Breeding success recorded for a pair near Windhoek was very high with c/2 each year for 5 years and 1 young reared in 4 of the 5 years (von Ludwiger 2001). Like other raptors they are opportunistic predators preying on medium-sized mammals such as hares, large birds (guineafowl), tortoises and occasionally carrion (Steyn 1982, Gargett 1990, Davies 1994). Prey base varies between the Karoo and Fynbos biomes with hyrax comprising 89% of prey in the Karoo and only 49% in the Fynbos (Boshoff *et al.* 1991). More rabbits, hares and tortoises are taken in the Karoo. Given that Black Eagles inhabit Nama Karoo and escarpment areas in Namibia, hyrax probably form the main diet in Namibia. At times Black Eagles appear capable of regulating hyrax populations by taking a significant proportion of the immatures and adults. The removal of Black Eagles, therefore, significantly increases hyrax populations in the vacuum created, increasing competition for grazing with small livestock, which in turn increases costs to small-stock farmers (Davies & Ferguson 2000). Black Eagles prefer upland areas where rocky terrain is cracked and fissured probably because its hyrax prey can always find refuge in such areas.

For a large bird of prey this species seems to be relatively immune from the depredations of farmers poisons and guns in Namibia, although they were almost eliminated from the Karas mountain range in the 1970-80's due to direct persecution – they have now recovered well. Its montane habitat and low reliance on scavenging thus protect it from such mortality factors. However, this immunity is lost where sheep are farmed in or near montane areas such as the Karoo (Davies 1994). Eagles have disappeared completely only from areas where their hyrax prey has been decimated e.g. Lesotho and communal land in Matobo Hills (Davies & Allan 1997). Use and mis-use of poisons in Namibia is well known and has been responsible for the demise of scavenging species such as Tawny and Martial Eagles (Brown 1991). Thus a large predatory bird such as the Black Eagle is at risk to poisons and direct persecution. Black Eagles also drown in steep-sided farm reservoirs and they feature in the top four most likely raptors to drown: 17 drownings are recorded from arid parts of southern Africa (Anderson *et al.* 1999). Young occasionally disappear from well-known nest sites in Namibia and South Africa some may be due to interference by man (Allan 1988, D Hienrich in litt).

This species is classified as *Near Threatened* because of the threat from the high incidence of poisoning that occurs in Namibia (Brown 1991, Simmons 1995, Bridgeford 2001), and its population size of about 1000 breeding pairs. The reasonable widespread population in areas of low human density, the relative immunity from human-induced mortality in Namibia and a lack of evidence of any decline keep it from being classified as *Vulnerable.* Reservoir drownings can be prevented by farmers covering their water points with nylon mesh, keeping their reservoirs full, providing alternative drinking/bathing facilities, or attaching a log to the side on to which the bird can climb (Anderson *et al.* 1999).

This species is at negligible to no threat from the proposed mining activities provided these do not extend into the broken landscape of the Swakop River valley.

4.5.5 Conclusions and recommendations

The proposed mining site supports a typical avifaunal assemblage of Namib gravel and sandy plains species, adjacent to species of hilly and mountainous areas in the incised Swakop Valley and arid savanna species entering the Namib along the linear corridor provided by the ephemeral Swakop River. Some 126 bird species were recorded in the avifaunal database for the Goanikontes ¼ degree square (2214Db), about 90% of the expected avifaunal diversity that would result from an in-depth long-term study. It is mainly the rare and peripheral species that have not been reported, and these are likely to have little significance for this assessment.

This EPL falls within Namibia's endemic zone, and three endemic bird species occur. The Rüppell's Parrot is "Rare" in the area and confined mainly to the Swakop River. As such, the proposed mining activities will have little or no impact, provided no disturbance of this habitat occurs, and mine staff are not permitted to go outside of the fenced mining area. The distribution of two species – Rüppell's Korhaan and Gray's Lark – are centered on the gravel and sandy plains of the Namib. However, both have populations in the order of 100,000 birds and the proposed mining footprint is small enough to impact only a few individual animals. Also, because of the highly nomadic nature of these species, they will simply be displaced to other areas. As such, the impact of the proposed mining is considered to be very low to insignificant on these endemic species. However, it is nonetheless recommended that the mining footprint be kept as small as possible.

None of the 41 species recorded as endemic to the southern African subregion (typically the "south-west arid" zoogeographic zone) are considered to be at risk from the proposed mining activities. These species all have large ranges in southern Africa and none are considered to be threatened in any way.

Some 18 species are migrants, 14 being Palearctic migrants from Eurasia and four being intra-African migrants (with an additional three being partial migrants). For all of these the impacts from the proposed mining development, in terms of habitat loss, are considered insignificant.

Five species recorded for the project area are listed in Namibia's Red Data Book: Martial Eagle (rare in project area) is listed as Endangered; Lappet-faced Vulture (uncommon) listed as Vulnerable; and Rüppell's Parrot (rare), Cape Eagle-Owl (uncommon) and Verreaux's (Black) Eagle (rare) all listed as Near Threatened. The risk to all these species is rated as low to very low. For the Martial Eagle and Lappet-faced Vulture a detailed field survey was carried out to find all suitable nesting trees in and adjacent to the prospect sites and along access routes and to search these for nests. No nests of these species, current or old were found in the EPL.

Based on the above, the loss of habitat and impacts resulting from the proposed primary mining and processing developments at Anomaly A in EPL3345 pose no significant conservation risks to avifauna populations in the area.

5. ECOLOGICAL PROCESSES AND KEY SPECIES IN THE ENVIRONMENT

5.1 Ecological drivers

'Ecological drivers' is a loose term that refers to the processes and species that are key to the sustained functioning of an ecosystem. For example, ecological drivers for an ungulate-dominated savanna ecosystem would include seasonal rainfall, pasture availability and predator pressure, as well as the dominant herbivore and predator species. The concept is useful for understanding the significance of environmental impacts. If key ecological processes or species are negatively impacted, the integrity and functioning of the ecosystem might be significantly degraded.

5.1.1 Rain, fog, rivers and springs

In keeping with the very low average rainfall (less than 50 mm per year), plant life in the Namib is greatly reduced and grass cover only becomes abundant after summer rains (Hachfeld, 2000). This often falls only in small patches so that grass cover too is usually patchily distributed. The widespread rains across the Namib in early 2009 were very unusual. The short season of greenery, which does not necessarily occur every year, is quickly dried out after rains and thereafter grass material is available only as dry fodder and seeds. Episodic events such as heavy downpours of rain act as the main driver in this ecosystem, as this is when new growth germinates and establishes (Seely, 1978).

Fog precipitation provides smaller and quite regular quantities of water which helps plants to survive, but which is inadequate for their establishment. The fog is therefore also a critical moisture source for the plants, as well as for the microscopic organisms that make up the biological soil crust. This living crust helps to cycle nutrients into the soil and also helps to stabilize the soil against wind erosion, as the surface mat prevents the wind from picking up fine material that is just a few millimeters deeper underground.

Episodic rains also bring floodwaters from further inland in the larger rivers such as the Swakop and Khan. The river beds are the only places where large trees are found in abundance, and these linear oases are recognized as being lifelines across the 100-km wide Namib Desert plain to the coast (Jacobson *et al*, 1995). Flows in the rivers recharge the alluvial aquifers on which the large trees depend. Such flows occur less frequently now than 40 years ago, and reach the sea less frequently, since construction of large dams (von Bach, Swakopoort) and numerous small farm dams in the commercial farming areas upstream. Changes in the riverine vegetation in the lower Kuiseb have been attributed to extraction of water for the coastal region (Jacobson *et al*, 1995), but similar changes have not been recorded in the Swakop. Presumably this is because extraction from alluvial aquifers in the Swakop is insignificant due to the salinity of the water. This situation might change as uranium mines (e.g. Langer Heinrich) now abstract Swakop River water for their operations.

Springs are an added source of water. These are mostly very small, slow seepages which produce very small volumes of water. Nevertheless they are vital for sustaining species such as baboons, klipspringer, gemsbok and zebra, and obviously local birds will utilize the water. Gemsbok and baboons are known to dig 'gorras' or shallow pits in the river beds to reach underground water.

These varied water sources are all of critical importance to the plant and animal life in the central Namib. While rain and fog will not be affected by the mine development, river flows (surface and underground) and continued seepage at springs potentially are.

5.1.2 Food sources

Annual and perennial grasses are quick to react to rain, and falls of greater than about 10mm initiate new growth in perennials and germination of seeds (Seely, 1978). While grass cover is obviously very important, it is the larger plants – perennial shrubs in the shallow washes –

which provide much of the food, moisture and shelter on which most of the animals depend. In the Goanikontes area, these comprise the key species pencil bush (*Arthraerua leubnitzii*) and dollar bush (*Zygophyllum stapfii*), as well as the legume *Adenolobus pechuelii*.

Large animals in the desert must be opportunists. Gemsbok are predominantly grazers, subsisting on grass almost entirely (Smithers, 1990) but they readily browse on pods when these have fallen from trees in the river beds. Springbok and ostriches eat whatever green fodder they can find, and ostriches are always the first large animals to move into an area to eat freshly sprouting grass. Zebra eat only grass, so like gemsbok must make daily movements to water sources to drink. Many desert birds are nomadic, moving in to areas where food (such as grass seeds or insects) is temporarily abundant. This response is seen in larks and finchlarks which irrupt in large numbers then disappear shortly afterwards. Ostriches and bustards also congregate where food is abundant.

Plant matter, after it has dried out and been shed from plants, is distributed by wind as detritus. Wind-blown detritus, comprising fragments of grasses, leaves and stems and other light organic material, tends to catch in and around shrubs and rocky shelters. Precipitation of fog water also occurs on these points so they serve as centres of attraction for small animals seeking food, water and shelter from the wind and sun.

For large animals, the river beds provide necessary fodder in their foliage and pods. Fallen pods from *Acacia, Prosopis* and *Faidherbia* trees are an important resource in sustaining wildlife and livestock populations in the western extremes of the ephemeral rivers (even though *Prosopis* is exotic).

Dried out plant matter, as mentioned above, feeds the herbivores, but an aspect that is often forgotten is the role of these animals in cycling nutrients back into the soil. In a habitat where there is minimal moisture to facilitate decomposition, this is an important function. Dead wood, too, is often thought of as useless, but it is slowly worked down by termites and other insects. It forms an important food source, and should be left intact.

Removal of dead wood (for cooking fuel by construction staff, and recreational braaing by campers and tourists) is therefore strongly discouraged and is actually prohibited by law in protected areas.

5.1.3 Patchy resources and animal movements

Large plains animals, such as gemsbok and springbok, must move from place to place on an irregular basis, depending where rain has fallen and food is available. They also frequent drinking places such as natural springs and artificially provided waterholes, and need to be able to move freely to and from these places without disturbance. Pipelines and fences can effectively prevent them from making these movements if they stretch over a long distance.

5.1.4 Dust suppression

The desert pavement and biological soil crust have the effect of binding the surface of the soil into a mat that is not easily penetrated by wind. Although this is not the purpose of this surface mat, it has the effect of reducing erosion of fine-grained soil material and thereby minimizing dust generation during strong winds. Low levels of airborne dust is a feature of the Namib compared to other deserts, and the desert pavement and biological soil crust play an important part in maintaining it.

5.2 Key processes

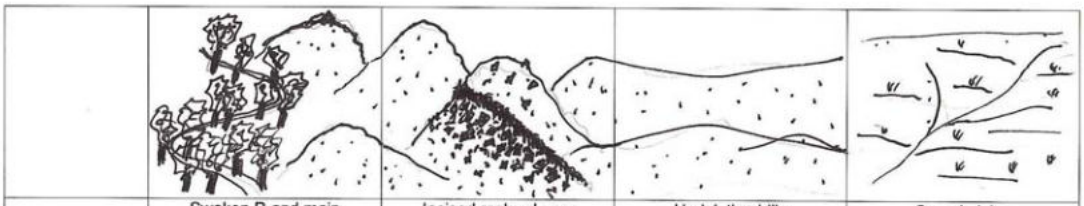
The processes that are important in sustaining the ecosystem can be summarized as (Figure 19):

- Episodic water inputs by sporadic heavy rains and water flows down rivers and washes, recharging alluvial aquifers and sustaining a linear strip of woodland in the larger rivers;
- Regular but small amounts of water provided by fog or sought at springs;

- Episodic abundances of green grass after rain;
- Long-lasting sources of green plant food in shallow washes (shrubs) and in the large rivers and main tributaries (trees);
- Movements of large animals over wide areas so that they can capitalize on patchily distributed resources;
- Wind-blown dispersal of detritus and seeds to distribute the food source and scatter seeds widely for possible germination when conditions permit;
- Cycling of nutrients, albeit at very low rates, by soil crust organisms and through invertebrate activities eg termites and other animals that eat detritus.
- Dust suppression by desert pavement and biological soil crusts.

5.3 Key species

It is difficult to single out which species are 'key' to the central Namib ecosystem. The perennial plants – *Arthraerua leubnitzii, Zygophyllum stapfii, Tamarix usneoides, Prosopis glandulosa, Acacia erioloba* and *Faidherbia albida* are dominant in terms of biomass and ecological role. No particular animal species can be identified as vital to sustaining many of the others, it is their diversity and combined roles which help to sustain the functioning of the ecosystem.



	Swakop R and main tributaries	Incised rocky slopes	Undulating hills	Gravel plains
Food resources	Trees – foliage and pods. Abundant and permanent supply	Sparse, very few trees and shrubs	Sparse, shrubs and grasses	Patchily distributed grass pastures. Perennial shrubs in shallow washes
Water availability	Permanent (saline) groundwater. Episodic surface flows	Episodic rains, very quick runoff. Springs? Regular but low-volume fogs	Episodic rains, little infiltration. Springs? Regular but low-volume fogs	Episodic rains. Regular but low-volume fogs
Key ecological processes	Episodic floods. Groundwater supports linear oasis of trees, springs Animal movements to and from river bed.	Fog precipitation. Springs sustain wildlife Freedom of movement for large animals.	Fog precipitation. Springs sustain wildlife. Wind dispersal of detritus. Freedom of movement for large animals.	Fog precipitation. Wind dispersal of detritus. Freedom of movement for large animals. Nutrient cycling by plants, invertebrates, biological soil crusts

Figure 19: Annotated sketch of ecological processes in the project area

6. PREDICTED IMPACTS OF MINE DEVELOPMENT AND SUGGESTED MITIGATORY ACTIONS

Impacts on vertebrates and on the terrestrial ecology are listed in the Table below. Each impact is then assessed regarding certain criteria to arrive at a final value of significance. If there are possibilities for reducing the impact then the mitigation measures are suggested and the impact after mitigation is given. Research needs arising from the expected impacts are discussed in Section 8.

Summary of impacts on terrestrial ecology

Issue	**Activity**	Project Phase	Health & safety	Bio-physical	Socio-economic	Radiation
1. Mining in a National Park	All construction and mining activities	C, O, D		X	X	
2. Disturbance to fauna	Human presence, mining activities	C, O, D		X		
3. Loss of habitat	Footprint of mine, roads, powerlines, pipelines and accessory works areas	C, O, D		X		
4. Restriction of movement of nomadic species by pipelines and fences	Erection of above-surface pipelines and fences	C, O		X		
5. Increase in poaching	Easier access into wild areas for mine staff, contractors and public, by improved roads into Park and along pipelines and powerlines	C, O, D, P		X		
6. Dust emissions could reduce plant productivity and degrade soil crusts	Many mining activities. Impact likely to be felt in all phases, incl post-closure, if desert pavement and biological soil crusts degraded, making sub-surface fine-grained soil more vulnerable to wind erosion	C, O, D, P		X		
7. Habitat degradation and destruction by vehicle tracks	Prospecting activities (beyond Anomaly A but within EPL), increased recreational access by public	C, O, D, P		X		
8. Decrease in Swakop River surface flows and aquifer integrity, affecting animals and trees	Water abstraction from Swakop River	C, O, D		X		
9. Obstruction of flows in small washes	Mine footprint changes drainage pattern so that downstream flows are restricted			X		
10. Pollution from fuels, oils, hazardous chemicals and litter	Vehicles, mine machinery, processing operations and uranium products use or generate potential pollutants. Human activities generate litter and solid pollution. All contaminants and wastes must be managed.	C, O, D	X	X	X	X
11. Attraction of wildlife to contaminated water sources	Seepages from the ripios heap or other places could create pools of contaminated water which wildlife would be attracted to, but which would be dangerous for them to use	O, D, P		X		
12. Loss of the wilderness sense of place	Combination of mine noise, visual impacts, less wildlife and industrial tone of the mine in a tranquil wilderness setting	C, O, D		X	X	

6.1 Mining in a National Park

6.1.1 Impact description

At present the land falls in the Namib Naukluft Park (NNP). This protected area status is expected to be elevated when it is proclaimed as the Namib - Skeleton Coast National Park later in 2009 (Figure 1). One of the main reasons for proclaiming protected areas is to conserve the country's natural heritage for future generations.

Due to the fact that it falls within a formally protected area, it would be preferable to avoid mining completely. Apart from this moral principle, there are considerations of the threat to conservation-priority plants and animals.

There are endemic and near-endemic plant species found in this EPL, but none of them are of excessively limited occurrence in the national sense (although the endemic are in the global sense). Many of the endemics and near-endemics recorded from the area are annual plants that produce a lot of seed and are reasonably widespread in the central Namib, making them of less concern than the perennial species, which are more dependent on specific habitats and processes, such as ephemeral washes and drainages, being maintained. *Commiphora*s, for instance, are slow-growing and would be unlikely to re-establish in damaged areas except in the extremely long term and even then only if the areas were rehabilitated considerably. There are, however, quite extensive areas of similar habitat outside the deposit areas where these species would continue to grow, providing that these are neither damaged during exploration, construction or mining operations, nor targeted later for further mining activity.

There are also threats to endemic reptiles and invertebrates, which are addressed individually below (Section 6.3.1)

Over and above the conservation-priority plants and animals, one of the main selling points of the NNP is its impressive landscapes and the high value that tourists and locals assign to the sense of place. Any mining proposed in a National Park will have a national impact as the integrity of a national asset is potentially threatened. Land uses that are more compatible with conservation such as eco-tourism also have the potential to be impacted by mining activities.

6.1.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, and the Forestry Act No. 72 of 1968, prohibit interference with and disturbance to wildlife and plants in the Park. Permits are required from the Directorate of Forestry to destroy Protected plant species.

Namibia is a signatory to the UN Convention on Biodiversity, which mandates the country to preserve all species and prevent loss of or threat to any species.

6.1.3 Impact Assessment

Before mitigation is in place

Mining in a National Park	**Rating**	**Justification**
Project phase	C, O, D, P	This impact will be felt throughout the life of the mine, from prospecting through to after closure.
Extent	M	At the mine as well as along roads and infrastructures going to the mine.
Duration	H	For as long as construction, operation and decommissioning activities last, and extending into the post-closure phase because certain parts of the land will be made permanently inhospitable (pit, waste rock dumps).
Frequency	H	Continuous

Intensity	M	Disturbance to animals and destruction and degradation of habitat are illegal in a protected area and conflict with the principles of environmental protection. The environmental functions and processes will continue but in a modified manner. People's use of the area for tourism will also continue, but at a lower level.
Consequence	M	
Probability	H	Definite
Overall rating	**Medium**	The impact will have a negative influence on the biophysical and socio-economic environment. The mitigations that are possible can reduce the severity of the impacts but not remove them altogether.
Status	-	
Degree of confidence	H	Certain

Summary of findings
Development of a mine in a National Park contravenes environmental laws and goes against the principles of environmental protection in Protected Areas. Apart from the legal aspects, the negative impacts of mining in the Park are rated as medium significance on the biophysical and socio-economic environment. Essential mitigations will be able to reduce the severity of the impacts but not remove them altogether.

6.1.4 Mitigation measures

Mining is not a sustainable activity. It usually causes permanent damage, albeit to a limited area. In order to ensure that the area damaged is as limited as possible, impacts such as clearing for roads and other structures on any remaining pristine or less disturbed vegetation outside the limits of the deposit should be minimized to improve the success of later restoration of the habitat. All mitigatory measures recommended in this report should be implemented in the spirit of reducing the negative impacts as much as possible since this is an area where environmental protection should be the first priority. Measures to reduce the negative impacts include:

1. Locating temporary and permanent infrastructure for least impact. It is recommended that areas that are already disturbed or that will definitely be disturbed in the near future be utilised for any temporary camps or construction laydown. If possible, construction teams should live off-site (e.g. in Arandis). Permanent infrastructure, such as the plant, should be planned and placed to obstruct drainage of the plain as little as possible, and to be as unobtrusive as possible.

2. Banning collection of firewood. No collection of firewood should be permitted anywhere in the EPL during any phase of the project.

3. Ongoing restoration. The following are general suggestions.
Disused tracks should be rehabilitated in cooperation with the chief ranger and his staff.
Any exploration trenches where no mining will occur should be filled and contoured. Any levelling or filling of artificially created hills or pits to restore reasonably natural contours will favour re-establishment of the original vegetation, and should be done.
Establishment of a restoration trust fund consisting of a fixed percentage of profits or a given amount per weight of product should be considered.

4. Involvement of local environmental research institutions such as NBRI and Gobabeb
Assessment of populations and losses of populations is an integral part of the Plant Red Data Assessment process. It is suggested that the NBRI be invited to assess the *Commiphora* population occurring in the license area so that any new applications for the area can be assessed in the light of previous population losses.

It is also recommended that the NBRI be invited to undertake a rescue mission for protected species such *as Lithops, Larryleachia, Hoodia* and *Commiphora* at their discretion. If necessary, funding should be made available for travel and S & T expenses for NBRI staff in order to carry out these functions. Should they consider the work necessary but be unable to undertake it themselves due to staffing constraints, the work should be contracted out.

No rescue missions should be undertaken until it is firmly established exactly what areas will be affected, to prevent removal of plants that would not be affected by project activities.

Gobabeb Training and Research Centre should be involved in ecological studies such as population assessments of lizards, optimizing restoration practices, and independently monitoring some of the other impacts discussed below.

5. Monitoring

It is important that an environmental officer, with a reasonable degree of authority, be appointed early on in the project. The role of environmental manager/monitor should not be undertaken by a member of the exploration, construction or mining staff, because these roles are mutually exclusive. An outside person or one dedicated to the environmental role is necessary.

Long-term monitoring of impacts on vegetation will contribute to the knowledge-base for mining developments in the Namib and other arid zones. A plan for establishment and regular monitoring of permanent transects should be developed for each area to be mined prior to mining activities. Monitoring could be carried out by environmental staff on the mine.

Any rescue/relocation projects should also be subject to controlled, long-term monitoring.

6. Penalties

During all phases of the project, but particularly during construction (when many contractors and subcontractors are usually involved), there should be contractually set penalties in place for environmental transgressions. At all times the main contractor should be held responsible for damages, regardless of whether the damage was done by a subcontractor, in order to avoid passing the buck.

Overall impact if mitigation measures are put in place

Mining in a National Park		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Avoid**: - Limit disturbance to the mining footprint. Avoid damage to sections of the NNP that are not in the ML. - During the design phase, avoid damage of sensitive sites (both from a species and habitat conservation perspective and from a sense of place perspective) by placing facilities (temporary and permanent) in areas of least impact. - As far as possible use those areas that have already been disturbed and avoid pristine areas. - In the undesirable event of uranium deposits being mined in sensitive areas, or the mine footprint extending into these areas, consideration should be given to assisting the Park authorities to establish offset areas for biodiversity conservation and for tourism development. **Minimise**: - Minimise the impact of large numbers of people on the National Park by housing people in Swakop during the construction phase and transporting them to site. **Rehabilitate**:

		- It is recommended that progressive rehabilitation and restoration of ecosystems be undertaken and that this commences as early on in the LOM as possible. Rehabilitation efforts should be undertaken in conjunction with Park staff. - Old exploration trenches and old drill sites located within Bannerman's EPL should be rehabilitated. - Once exploration activities have been completed in a section of the EPL, the tracks should be restored. - Rescue and relocation of various species of protected plants should be considered, in collaboration with NBRI. - A restoration fund that is part of the overall rehabilitation fund should be established to fund restoration research, implementation and monitoring at Etango. **Additional studies**: - Long-term monitoring of impacts on vegetation will contribute to the knowledge-base for mining developments in the Namib and other arid zones. A plan for establishment and regular monitoring of permanent transects should be developed for each area to be mined prior to mining activities. Monitoring could be carried out by environmental staff on the mine, and environmental organisations with local knowledge should be involved in an advisory and assistance capacity for monitoring and restoration.
Overall rating with mitigation	**Medium**	

6.2 Disturbance to fauna - animals will move away

6.2.1 Impact description

Large animals such as gemsbok, mountain zebra, Ludwig's bustard, Ruppell's korhaan etc will be scared away from the general area of activity by the noise, dust, sight and smell of people, vehicles, conveyor belts and machinery. Activity on man-made structures such as roads, lay-down areas, waste rock dumps and the heap leach residue dump (ripios) may also drive animals away from the area. The level of activity is also likely to scare animals away from using springs and other local resources (such as fodder in the Swakop River bed) which are important resources that allow them to survive in this arid environment. Certain species such as kudu, ostrich and springbok become quite acquainted to disturbance and move around without concern, while others such as gemsbok, mountain zebra and klipspringer are more wary and tend to keep their distance away from human disturbances, especially if there are other reasons such as night hunting which make them nervous of people, noise and vehicles. Some of the more secretive mammals such as leopard, aardwolf and spotted hyena are also naturally shy and are likely to move away.

The various animals affected by this impact occur in all of the main habitats, so disturbance is likely to affect some species in whichever habitat there is mining-related activity. On the plains (where most of the mine footprint is situated), gemsbok, aardwolf and bustards will move away from the general area. In hills and mountainous habitat (close to the northern end of Anomaly A and the east and west waste dumps), zebra, klipspringer, leopard and hyena will be affected. In the river bed (where only water abstraction from boreholes might occur), all of the above-mentioned animals (except bustards and korhaans)will be shunned as they use this habitat for food, water and shelter. The ecological contributions of these animals are not vital as the ecosystems will continue to function without their presence in this localised area.

Although populations of these animals are naturally low, they are part of the tourist attraction of this part of the Namib which many people visit. Their presence has mainly aesthetic value as it forms part of the sense of place of the area. This is a protected area and visitors hope and expect to see some wildlife. Their absence due to disturbance will therefore have a relatively small ecological impact, but a greater negative impact on the total tourism attraction of the area.

6.2.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, prohibits interference with and disturbance to wildlife in the Park.

6.2.3 Impact Assessment

Before mitigation is in place

Disturbance to fauna – animals move away	**Rating**	**Justification**
Project phase	C, O, D	This impact will be felt throughout the life of the mine, from prospecting (relatively little impact) through to final operations and closure (relatively greater).
Extent	M	Within a few km of the mine as well as along roads and infrastructures going to the mine. Will affect local populations of non-nomadic species, as well as broader populations of nomadic species that will probably stay away from disturbed area.
Duration	H	For as long as construction and mine operation activities last; possibly for longer depending on how much more human activity continues after the area has been made accessible by mining.
Frequency	H	Continuous
Intensity	M	Impact does slightly alter the environmental functions and processes but they will continue with depressed wildlife populations. This is a National Park where these animals should not be subjected to disturbances that chase them away.
Consequence	M	
Probability	H	Definite
Overall rating	**Medium**	The impact will have an influence on the environment, and there is relatively little scope for mitigation.
Status	-	
Degree of confidence	H	Satisfactory amount of information on and sound understanding of the sensitivities of the various animals and of the mining activities that will disturb them. Situations at Rossing and Langer Heinrich mines are comparable.

Summary of findings

Traffic, noise and presence of people will all serve to drive wildlife (predominantly large animals such as gemsbok, zebra, ostrich, bustards) away from the immediate area. None of the mammal and bird species so affected will be significantly threatened from this impact. Its overall rating is medium, since this is a National Park where these animals should not be subjected to disturbances that chase them away. Furthermore, the impact of the Etango Project, as well as possible extension to other deposits in the EPL, together with other neighbouring mines, are likely to cumulatively depress populations of large animals such as gemsbok and mountain zebra, and to cause naturally rare animals such as leopard and hyena to disappear from the area entirely.

The impact is potentially reversible if the amount of human activity reverts to the pre-mining state after mine closure. However, because of the cumulative impact of other neighbouring mines and the likely increase in level of other human activities in the area once mining has started, the impact is likely to become permanent.

6.2.4 Mitigation measures

All unnecessary disturbances to animals should be prevented. The mine planning should aim to keep its primary and secondary footprints as small as possible. Ensure no staff go beyond

periphery of fenced mining area so that disturbance does not spill beyond the boundaries into surrounding areas. In the Swakop River, minimise vehicle movements and human activities in the river and main tributaries. Do not cut or break any trees or branches, as these are sources of food and nesting sites for birds (eg Cape eagle owl) and other animals. Strictly enforce the ban on collecting of firewood.

While these measures must be implemented, most of the disturbance to wildlife is unavoidable and cannot be mitigated, since it arises from the very activities that mining involves. Standard dust suppression and noise suppression methods (as normal occupational procedures to protect mine staff) should be in place to reduce extreme dust and noise emissions.

Overall impact if mitigation measures are put in place

Disturbance to fauna – animals move away		
Project phase	C, O, D	
Overall rating no mitigation	M	Medium impact
Mitigation measures		Limited mitigation potential, as mining activities are inherently noisy and involve large-scale machinery and earth-moving operations. **Avoid:** - Avoid impacts on animals using the Swakop River by ensuring that Bannerman's servitudes (pipelines, powerlines and roads) do not cross through this area. - All deliveries to site must be via the C28 and not via Goanikontes on the D1991. - Actively prevent any collecting of firewood or breaking of any trees (dead or alive). **Minimise:** - Minimise primary and secondary footprint. - Minimise disturbance of wildlife by ensuring that Bannerman's employees and contractors do not go beyond the mine site boundary. - Minimise disturbance form noise by designing the quietest operation possible. If implemented, the noise management measures mentioned in the noise assessment will help to reduce the overall environmental noise. - Standard dust suppression methods (as normal occupational procedures to protect mine staff) should be in place to reduce extreme dust emissions. - Monitor for poaching activities in the vicinity of Etango. **Restore:** - At mine closure ensure that the final land use is returned as close as possible to its pre-mining state, which is relatively pristine desert without barriers to hamper movement of animals.
Overall rating with mitigation	**Medium-Low**	

6.3 Loss of habitat

6.3.1 Impact description

The footprint of the mine will obviously destroy almost all of the plants, invertebrates and small vertebrate animals that live there. In view of the wider habitat surrounding the footprint, this is not a significant impact for most of the plants and vertebrates. However, it is significant for those species that have a restricted distribution, as the population might be reduced by a significant extent, or together with the cumulative impact from other mines, add to a significant impact.

Two species of lizards are known to occur here which fit this category. One, *Pedioplanis husabensi*s, is known to occur in rocky habitat in the lower Swakop – Khan valley area,

although the limits of its distribution are not clear. No research on this species has been carried out since it was first described about 20 years ago. The second species is new to science and has not yet been named. It is thought to occur only in the lower Swakop – Khan area, but habitat preference, distribution limits, population size are all unknown. Present plans show the Anomaly A footprint on the gravel plains habitat only, so *Pedioplanis husabensis* is unlikely to be immediately impacted. The impact on the second species cannot be clarified until its status and habitat preference are better known.

No birds or mammals are significantly impacted by the footprint of the mine itself, so long as the mine footprint stays out of the incised rocky slopes of the Swakop River (Habitat zones C and D). However, large areas of the Namib are being fragmented into smaller pieces by infrastructures such as roads, pipelines and powerlines, which cumulatively are reducing habitat for species that require large undisturbed areas to feed and breed, such as vultures and bustards. The impact of the Etango Project individually in this regard is probably insignificant, but cumulatively is becoming a factor of concern.

The impact of the mine footprint is probably irreversible as it will be impossible to restore parts of the operations (pit, waste rock dumps, ripios heaps) to their pre-mining condition after closure. The permanent loss of habitat equates to permanent loss of *x*% of the lizard populations, but the value of *x* is still unknown due to poor knowledge of the distributions and habitat preferences of the two lizards.

In terms of habitats most threatened by the footprint, the rocky and mountainous areas are richest with regard to plant species of conservation concern, and are rated medium sensitivity. This habitat also supports *Pedioplanis husabensis* which deserves conservation attention, and possibly the other undescribed lizard discussed above. Mine development in this habitat should be minimised. At present, the ore deposit being focused on, Anomaly A, is outside of this habitat zone, and all mine plant development is to be situated on the gravel plains. However, waste rock dumps might extend into this habitat, especially since the greater relief allows these dumps to be partly hidden. Furthermore, other known ore deposits in the EPL – Oshiveli, Onkelo, Ompo, Ombepo and part of Anomaly B – are in steep rocky habitat, so any future expansion of mining to these deposits, and waste rock dumps situated close to them, will cause loss of the steep rocky habitat. Cumulatively, the loss and fragmentation of habitat from the other possible mining areas in the EPL and neighbouring mines could be a significant threat to the survival of these species.

Distributions of plants and vertebrates found on the sandy gravel plains are more widespread. Species that occur on the rocky outcrops on the plains, such as *Aloe asperifolia* and *Hoodia pedicellata* are less common, with a far more limited habitat. *Aloe namibensis, Lithops ruschiorum* and *Larryleachia marlothii* may potentially also be of concern on rocky ridges, as they are known to occur in the area and they are protected species that are also valuable collectors items. Wherever possible mining activities should be kept away from the larger rocky ridges carrying species of conservation concern. This recommendation has been taken up so that a mine exclusion zone has already been placed around the lone outcrop southwest of Anomaly A. Additionally, controlled rescue and relocation of protected species could be considered.

Several of the higher-lying rocky ridges on the plains carry a rich lichen population, particularly on the south-western slopes. This emphasises the necessity to conserve high-lying areas such as rocky outcrops where possible.

6.3.2 Legal requirements

Namibia is a signatory to the UN Convention on Biodiversity, which mandates the country to preserve all species and prevent loss of or threat to any species.

Nature Conservation Ordinance No. 4 of 1975, including amendments, and the Forestry Act No. 72 of 1968, prohibit interference with and disturbance to wildlife and plants in the Park. Permits are required from the Directorate of Forestry to destroy Protected plant species.

6.3.3 Impact Assessment

Before mitigation in place

Loss of habitat	**Rating**	**Justification**
Project phase	C, O, D, P	
Extent	M	Within entire footprint of mine and accessory work areas.
Duration	H	For as long as construction and mine operation activities last; and permanently after that since some areas will be severely changed (eg by the pit, waste rock dumps, ripios heaps).
Frequency	L	
Intensity	M	Loss of species (particularly 2 lizard species, possibly permanently through cumulative impact) will slightly alter the environmental functions and processes, but they will continue in a modified manner.
Consequence	M	Medium impact
Probability	H	Direct loss of habitat due to the mine footprint is certain, but the significance of the impact depends on which habitats the mine is built on. Permanent loss of species (extinction) is unlikely if footprint is selected to avoid sensitive habitats. Probability of a significant impact is high if cumulative loss of steep rocky habitat (from other deposits and mines) is great.
Overall rating	**Medium**	The impact is Medium because of the potential threat to lizard populations whose range and /or habitat preference are not well known.
Status	-	
Degree of confidence	M	Very limited information available on the lizard endemic species themselves, and on what effects the mine might have on their populations. Also, uncertainty about the cumulative impact due to other neighbouring mines.

Summary of findings
The footprint of the mine is relatively small and insignificant in relation to species which have a wide Namib or greater distribution. However the footprint could have serious impacts for range-restricted species. Although *P. husabensis* will probably not be affected by the present layout of the mine (based on Anomaly A only), the other new species could be seriously impacted by mine developments. Cumulatively, the loss and fragmentation of habitat from the other possible mining areas in the EPL and neighbouring mines could be a significant threat to the survival of one or both species.

6.3.4 Mitigation measures

Planning of where to situate various mine components should take the sensitivity of different habitats into account. It is recommended that no mining development be allowed within 1 km of the Swakop River channel and in the large valleys that flow into it (Habitat Zone D). Where possible, it is advised to avoid the steep rocky habitat (Habitat Zone C) and rocky outcrops on the gravel plains (a subdivision of Habitat Zone A). These recommendations, made in the Scoping Phase, have been included in preliminary mine design plans.

Once the situation of the mine footprint is decided, rescue and relocation of certain plants (aloes, *Hoodia*, *Commiphora oblanceolata,* possibly others) should be carried out so that species of conservation priority or with protected status are preserved. Some of the plants occur in low numbers and this should be done in collaboration with the National Botanical

Research Unit and its National Botanic Garden, and possibly a commercial nursery. Rescue and relocation is not recommended for small vertebrates as it is impractical and ineffective.

Further mitigation of the footprint is not possible for the duration of the mine's existence. After closure, restoration of the mined area will go some way to restoring the habitat, but certain features will be un-restorable eg the pit and waste rock dumps. Once established there is therefore limited mitigation potential, which therefore places the emphasis on siting mine infrastructure and facilities in locations that will create the least environmental damage. There should also be strict measures to limit the spatial extent of the footprint, so that unplanned damage to the environmental does not spill over the limits of the intended footprint.

Overall impact if mitigation measures are put in place

Loss of habitat		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Avoid:** - To minimise impacts on known range-restricted species and on sensitive ecology, avoid 1) the Swakop River and a 1 km wide zone on either side of the main channel; 2) the steep rocky habitat, and 3) rocky outcrops on the gravel plains. **Mitigate:** - Minimise the primary and secondary footprint. - Fence / demarcating the boundary of the proposed footprint during the construction phase to ensure that unnecessary damage does not take place. - Prior to stripping and clearing, rescue and relocate selected plants (such as aloes, *Hoodia and, Commiphora oblanceolata.* This must be done in conjunction with the NBRI. - Prior to disturbance of an area, where trees are found the area should be checked to ensure that martial Eagle and Lappet faced vultures are not breeding there. If a nest is found construction must be halted until specialists have been consulted. - Rescue and relocation is not recommended for small vertebrates as it is impractical and ineffective. - Develop a restoration plan in conjunction with a restoration ecologist and important stakeholders such as MET. - Undertake progressive restoration starting in the operation phase. Apply adaptive management to improve restoration approaches. **Restoration:** - Restore the disturbance footprint to the pre-defined end land use and in accordance with the restoration plan. - Monitor effectiveness of restoration efforts and modify approaches where applicable **Additional research:** - The precautionary principle dictates that no species should be threatened due to ignorance of its status. Additional research of the Husab sand lizard and the unidentified species should be undertaken to better understand their distributions and habitat preferences. - Additional research should be undertaken to establish the extent of the Commiphora populations occurring in EPL3345 so that if mining extends into other parts of the EPL, or if new mining applications are made in the region, that the impact can be assessed in the light of previous population losses. - The restoration potential of many desert habitats is unknown but is expected to be low. Research into ways to restore desert pavement and biological soil crusts is recommended as they are an integral component of the gravel plains, where most of the habitat loss is expected.

Overall rating with mitigation	**Medium**	The impact on plants after mitigation is Low. Limited scope to mitigate the potential impact on small vertebrates, even with tight control of the total footprint. Following the precautionary principle, the rating of the impact remains Medium.

The precautionary principle dictates that no species should be threatened due to ignorance of its status. Research will require properly assessing the population and conservation statuses of the two lizard species possibly significantly affected by the footprint. It they are found to be more widespread, the impact of habitat loss could be lower.

6.4 Restriction of movements of nomadic species by above-surface pipelines and fences

6.4.1 Impact description

Large terrestrial animals such as gemsbok, springbok and ostrich move widely to make best use of patchily distributed resources. Individuals may be unable to cross man made barriers such as water pipelines even if it looks 'logical' to people that they can. Gemsbok tend to go underneath a raised pipeline or fence if they can; springbok may jump over if the height is lower than +- 1m but tend to not go over solid pipelines (as opposed to fences which are see-through); ostrich are held back by even lower pipelines and fences. Should large structures such as waste rock dumps also block of a traditional movement corridor this can also cause problems as the animal have to divert and find a new route. As long as the diversion is not too long this is not necessarily problematic but a series of diversions could prevent animals e.g. from accessing valuable water or grazing resources.

6.4.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, prohibits interference with and disturbance to wildlife in the Park.

6.4.3 Impact Assessment

Before mitigation in place

Restriction of movements of nomadic animals	**Rating**	**Justification**
Project phase	C, O, D, P	Features such as fences and pipelines will only last as long as the mine. Others such as waste rock dumps will be permanent.
Extent	M	Along infrastructures going to the mine. At present the location of waste rock dumps and the plant is unlikely to be problematic as they are on the plains with space around them.
Duration	H	For as long as construction and mine operation activities last, and permanently for certain features.
Frequency	H	Continuous
Intensity	M	Obstacles will alter the movements of animals and possibly play a part in depressing the overall populations of animals such as ostrich and gemsbok.
Consequence	M	Medium impact
Probability	M	Definite if long distance above-surface pipelines or fences (> 5km) are constructed
Overall rating	M	**Medium impact**
Status	-	
Degree of confidence	H	There is sound understanding of the importance of allowing movements of animals that rely on patchily distributed resources. However precise movement corridors in the vicinity of Etango have not been identified.

Summary of findings
Fences and above-surface pipelines have the potential to restrict animal movements. This impact is of medium significance – at worst it will exacerbate the other disturbances to wildlife that will jointly depress wildlife populations in the area.

Theoretically, once barriers to movement are taken down after mine closure, animals will be able to move around again. However, if the barriers have been in place for a long time (>20 years), the populations 'forget' where the resources are found and the routes to and from them. The impact is then permanent.

6.4.4 Mitigation measures

Obviously the active mine, plant and office area needs to be fenced to prevent stray animals from entering and putting themselves and people at risk, during construction and operation phases. Any other fencing should be avoided. At closure, fences and pipelines should be removed.

Long (>2 km) lengths of fencing should not be erected along linear features such as roads or pipelines. Pipelines lying above surface should have 10 m wide earth ramps going over them every 1 km, or should be buried at that frequency, to allow large animals to cross them. Animal crossings should be constructed in a way that vehicles are prevented from using them.

Overall impact if mitigation measures are put in place

Restriction of movements of nomadic animals		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Avoid:** - Permanent structures such as the waste rock dumps and LRSF should not be built in the path of well established movement corridors. This should be taken into account during the design phase. Major washes are often popular movement corridors and as far as possible development should be avoided in these habitats. **Minimise:** - Fence those areas of the mine and plant where animals must be prevented from entering (e.g. plant, office area, water dams). - Pipelines that are laid above ground should have 10m wide earth ramps built over them every 1km or should have sections buried, thus creating crossing points for nomadic animals. Animal crossings should be constructed in a way that vehicles are prevented from using them. - At closure remove all fences, pipelines and other obstructions.
Overall rating with mitigation	L	**Low impact**

6.5 Increase in poaching and illegal collecting of rare plants

6.5.1 Impact description

The concentration of people on the mine footprint area and moving around in the vicinity opens up possibilities for people to lay snares and poach animals by various means. Picking up certain animals such as tortoises or chameleons requires no trapping at all. Construction staff may be tempted to poach animals for the pot. Ruppell's parrot breeding in trees in the Swakop River bed might be illegally captured for the parrot trade.

There will be easier access into the Park for mine staff, contractors and public, by improved roads and along pipelines and powerlines. Overall level of human activity along the roads to the mine will increase. Increased traffic and numbers of people mean increased opportunities

for poaching and greater need for law enforcement to prevent it. Illegal collection of rare succulents is included in this section, as easier access will exacerbate this problem, directed most particularly at *Lithops*, *Hoodia* and some aloes. Law enforcement in the Park is inadequate at the moment, and is unlikely to improve through MET alone. Under the new Management and Development Plan for the Park, MET-NACOMA intends to implement an Honorary Warden system that will strengthen law enforcement through public involvement in Park management.

On the other hand, it is possible that the increased number of people around the site and their night-time presence in the area will deter illegal hunters who have, in the past, been able to poach freely. Time will tell. For the purpose of managing this impact, we assume the worst case scenario here, and make recommendations to minimise the possibilities for poaching.

6.5.2 Legal requirements

Park regulations specify no-one is allowed to drive in the Park after dark except on main (non-permit) roads. Also any killing or removing animals is prohibited under Park regulations.

6.5.3 Impact Assessment

Before mitigation in place

Increase in poaching	**Rating**	**Justification**
Project phase	C, O, D, P	
Extent	M	Within about 10 km of the project area and along the routes between the project area and urban centres.
Duration	H	For as long as construction, operation and closure activities last. Will probably continue after closure as roads into the Park will then be improved and the vigilance function undertaken by the mine will have left.
Frequency	L	Sporadic events
Intensity	M	Poaching will alter the environmental functions and processes, but they will continue in a modified manner.
Consequence	M	Medium impact
Probability	M	This impact is likely to materialise.
Overall rating	M	**Medium impact**
Status	-	
Degree of confidence	H	The impacts of poaching – depressed wildlife populations – are certain. However, the level of poaching that is experienced will depend on the effectiveness of activities taken to combat it.

Summary of findings

Illegal hunting and poaching happens at present, and may or may not increase with greater human activity associated with this mine and others, and the generally easier access that the mines provide. This impact has medium significance.

Once people are no longer active in the area, levels of poaching might decline, allowing wildlife populations to recover. However, the increased access to the area that the mine will bring will probably not be reversed, so opportunities for poaching will probably increase in the long term.

6.5.4 Mitigation measures

This impact can be minimised by good management. Ensure tight control of movements and activities on and around site, especially into the Swakop River bed. Maintain vigilance for suspicious night activities or shots along access roads and surrounding tracks. MET and the NACOMA project are presently setting up an Honorary Warden system to strengthen law enforcement activities through public involvement. The mine should actively contribute to this approach. Discipline transgressors strictly to deter others.

Overall impact if mitigation measures are put in place

Increased poaching		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Avoid:** - Avoid having a construction camp on site. Transport people to and from Swakopmund and Walvis Bay. **Mitigate:** - If a decision is made to have a construction camp on site, then the camp must be fenced in and recreational facilities provided. Security must be vigilant and monitor for poaching and illegal collection of plants and animals. - Collection of firewood should be prohibited anywhere in the EPL during any phase of the project. - Ensure tight control of movements and activities on and around site. - Maintain vigilance for suspicious night activities or shots along access roads and surrounding tracks. - Work with MET and NACOMA to strengthen law enforcement activities through the Honorary Warden system. - Discipline transgressors in accordance with the Law and company policy.
Overall rating with mitigation	**Low**	Low impact if effectively mitigated

6.6 Dust emissions could reduce plant productivity and degrade soil crusts

6.6.1 Impact description

Dust will be kicked up by earth-moving operations, crushing and screening, blasting and other mine-related activities. Also, the increased network of vehicle tracks in the vicinity, especially during prospecting and mine construction phases, will increase dust levels around site.

Dust settles on the ground surface and on plants, reducing the exposure of biological soil crusts (BSCs) and photosynthesizing leaves to light. This smothering can reduce the functioning of the crusts and plants, and even kill them if extreme. Damage to BSCs and the desert pavement can exacerbate dust generation by strong winds which are able to erode exposed surfaces. Cumulative fall-out of dust in climates which lack rain to wash it away is suspected to depress invertebrate populations, as it clogs up crevices and interstices in which they shelter (Henschel, pers. comm. 2007).

Dust generation from vehicle tracks is a less serious problem, and with strict track discipline in the EPL can be effectively mitigated. However off-road driving by the public is a recognised problem in the Park, and could become worse as access roads into the Park improve for this and other mines. This is addressed under 6.7 – vehicle tracks.

Without dust suppression measures, the potential impact of dust blanketing is locally significant. However, dust suppression measures are standard features of mining operations and, so long as these are in place, the problem can be effectively minimised. The problem is likely to be most significant during construction, before full dust suppression measures are in place.

6.6.2 Legal requirements

Occupational health concerns demand dust suppression measures.

6.6.3 Impact Assessment

Before mitigation in place

Degradation in plant and biological soil crust productivity from dust emissions	**Rating**	**Justification**
Project phase	C, O, D, P	
Extent	M	Within about 5 km of the project area
Duration	H	For as long as construction, operation and closure activities last. Will possibly continue after closure if restoration of disturbed desert pavements and BSCs has not had time to reach completion, allowing wind erosion on exposed surfaces.
Frequency	H	Continuous
Intensity	M	Smothering by dust downwind of dust-generating activities will alter the environmental functions and processes, but they will continue in a modified manner.
Consequence	M	Medium impact
Probability	H	This impact will definitely materialise, but can be effectively mitigated
Overall rating	**Medium**	The impact has a medium rating as its influence on the local environment is not severe and can quite easily be controlled.
Status	-	
Degree of confidence	H	Dust generation is certain, and smothering by dust will certainly kill plants and BSCs in a localised area. However, the problem rarely reaches this level of severity because mitigation is practical and effective.

Summary of findings
Dust emissions from earth-moving, vehicles and blasting will have a medium impact on the surroundings, by blanketing plants and biological soil crusts which reduces their photosynthesising rate and can kill plants if it is severe. Dust suppression measures are recommended to reduce the impact, and are a standard feature of environmentally conscious mining.

6.6.4 Mitigation measures

Thorough dust suppression measures should be implemented on site. Monitoring of dust levels around site and off-site should be done, and dust suppression activities adjusted as necessary in response to the findings.

Overall impact if mitigation measures are put in place

Degradation in plant and biological soil crust productivity from dust emissions		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Mitigate:** - Effective dust suppression measures must be implemented on site at all dust-creating activities. . - As far as possible use dust retardants (e.g. tar, salt roads or dust-a-side type product) on all access roads. Water is not an effective dust suppressant for access and haul roads and is considered a waste of a valuable and scarce resource. - Strictly control track discipline to prevent unnecessary damage to desert pavement and biological soil crusts. **Monitor:**

		- Monitoring of dust levels around site and off-site should be done, and dust suppression activities adjusted as necessary in response to the findings.
Overall rating with mitigation	**Low**	Low impact if effectively mitigated

Effective mitigation of this impact can reduce its overall rating to low.

6.7 Habitat degradation and destruction by vehicle tracks

6.7.1 Impact description

Vehicle tracks damage the soil surface by breaking the desert pavement and biological soil crust, creating ruts and exposing the softer, fine-grained gypsum-rich subsoil to wind erosion. Apart from the aesthetic impact of tracks over desert surfaces, the tracks also destroy plants, surface lichens and BSCs, exacerbate dust generation by winds, compact the soil making it more difficult for seeds and burrowing animals to penetrate, and crush underground burrows. Cumulatively, many tracks and repeated tracks over an area can significantly degrade the surface and soil micro-environment.

This impact has the greatest visual and ecological impact on gravel plains where ruts and scars caused by vehicles on the soft gypsum-rich soil may last for decades. Vehicle damage is less where the soil is very shallow and hard, as it is on the undulating plains and rocky slopes, but in these habitats the visual impact is often greater since tracks on high relief are more conspicuous. Vehicle tracks in river beds can do more direct damage to small bushes and shrubs, but their ecological damage to the sandy substrate is less.

Prospecting activities in other parts of the EPL can be expected to continue. While exploration and prospecting activities have been subjected to a separate EIA, they are addressed here again as they will cumulatively add to the level of human activity in the area once the mine is operational. Tracks made during exploration and drilling programmes inflict the damage described above. It is expected that unnecessary off-road driving by mine and contractor staff will be tightly controlled, and that tracks will be rehabilitated once their use is finished. Nevertheless, a certain amount of damage is unavoidable.

Of greater concern is recreational off-road driving by members of the public, which follows and exacerbates mine-related desert driving. People often follow a track which leaves the main road, and the level of off-road driving in pristine areas is increased where improved roads into wild areas make access easier. Overall, illegal off-road driving in the Park constitutes a major problem, and it is exacerbated by the improved access which the mines are creating.

6.7.2 Legal requirements

Off-road driving in the Park is illegal, but is allowed for exploration and prospecting under conditions stipulated under each project's EIA and environmental clearance.

6.7.3 Impact assessment

Before mitigation in place

Habitat degradation and destruction by vehicle tracks	**Rating**	**Justification**
Project phase	C, O, D	
Extent	M	Within the EPL and along infrastructures going to the mine
Duration	H	For as long as mining and closure activities last. Will possibly continue after closure due to improved access into Park area for this and other mines.
Frequency	H	Continuous
Intensity	M	Depends on the level of illegal off-road driving. At worst, it will alter the environmental functions and processes, but they will continue in a modified manner.
Consequence	M	Medium impact
Probability	M	This impact will probably materialise.
Overall rating	**Medium**	The impact of off-road driving is mainly aesthetic, and environmental functions and processes are only moderately degraded by vehicle tracks.
Status	-	
Degree of confidence	H	Judging by the amount of off-road driving that occurs in the Park, this area is unlikely to be any different.

6.7.4 Mitigation measures

Mitigation of this impact is possible and highly necessary. Tracks to be used should be clearly demarcated, and track discipline should be strictly controlled in all mine-related vehicles. Transgressors should be penalised to set an example that the mine takes the issue seriously. Tracks made in areas that prove unsuitable for mining
should be rehabilitated in cooperation with Namib-Naukluft Park staff. Rehabilitation of tracks should only be done on tracks that are no longer needed. This is to prevent new tracks being made alongside rehabilitated ones, since mine staff may feel that once a track has been rehabilitated it should not be disturbed by being driven over again.

Rehabilitation is presently done by raking all vehicle-disturbed surfaces once driving in an area is no longer required. This shows commitment to the principle of restoration, but questions have been raised about its effectiveness. The issue is whether raking on certain substrates actually damages the desert pavement and biological soil crust more widely than vehicle tracks, thus possibly exacerbating dust creation by wind erosion and retarding the recovery process.

The main problem with regard to vehicle tracks comes from illegal off-road driving by members of the public, who have easier access into wild areas due to better roads made by the mines. Improved law enforcement is required to limit this widespread illegal activity, yet MET is under-capacitated for this function. The mine should actively collaborate with MET and NACOMA to re-establish the Honorary Warden system to strengthen law enforcement activities.

Overall impact if mitigation measures are put in place

Habitat degradation and destruction from vehicle tracks		
Project phase	C, O, D	
Overall rating no mitigation	M	Medium impact
Mitigation measures		**Minimise:** - Ensure that new tracks are laid out so as to minimise damage to plants and desert pavement. - Tracks must be clearly demarcated and if necessary turning circles provided. **Mitigate**: - On the Etango site and the greater EPL, track discipline should be strictly enforced - Collaborate with MET and NACOMA to re-establish the Honorary Warden system to strengthen law enforcement activities. **Restoration:** - All tracks to be rehabilitated as soon as they are no longer needed. Bannerman already has a rehabilitation procedure in place as part of is exploration programme. This should be applied on the Etango site as well. **Monitor:** - Monitor rehabilitated sites to establish if ecosystem functioning is being restored over time. If not adapt rehabilitation approach to improve effectiveness. - Monitor illegal off road driving by staff and the public in the vicinity of the mine. Actively collaborate with MET to re-establish the Honorary Warden system to strengthen law enforcement activities in the Park.
Overall rating with mitigation	**Low**	This can be reduced to a **Low impact** if mitigation is effective. Controlling illegal off-road driving by the public has proven to be a near-impossible task for MET, therefore great emphasis is placed on strengthening law enforcement capabilities in the Park and the mine actively contributing to this role.

6.8 Degradation of the Swakop River linear oasis due to water abstraction or unintended dewatering

6.8.1 Impact description

Water abstraction from the Swakop River might be done, most likely to supplement water supplies during construction but possibly also during the operational phase. Although Swakop water is very saline, it is used for dust suppression at Langer Heinrich and can have other uses where quality is not an important criterion. Additionally, there might be dewatering in the aquifer when the pit reaches its greatest depth since this will be below the level of the river bed.

The alluvial aquifer supports large trees and the linear oasis, which are an important component of the ecology of the area. Decrease in surface flows and extent of residual pools might occur as flood volumes decrease due to a lowered water table. Even if abstraction is not excessive, there is the possibility that surface pools will not last as long, thus depriving local wildlife of this resource. Also, the productivity of trees, in terms of their leaf and pod production, might also decline. Once abstraction stops, recovery of trees will occur so long as they have not died in the process. Dewatering in the aquifer by water draining into the pit could have a significant impact on the local and downstream riverine vegetation.

The Swakop River bed and side tributaries, together with steep incised valley walls, are important linear oases which support birds (including the Near-Threatened Ruppell's Parrot, Cape Eagle Owl and Verreauxs' Eagle) and large mammals (including secretive and rare carnivores such as leopard and spotted hyena). The diverse and structured riparian vegetation of the western ephemeral watercourses in Namibia make them a priceless biological resource

supporting biological productivity at every level in this extremely arid zone. It is recommended that mining not be permitted within at least 1 kilometre from the main river channel, and in the large valleys that flow into it, in order to maintain this ecologically important ecosystem. The area north and north-east of the Swakop River in the vicinity of the Ompo deposit is also of particular concern. From the river northwards to approximately 7495362N (near the turnoff presently being used to approach the Ombepo deposit) should preferably be conserved.

Furthermore, the Swakop canyon *per se* is a valuable asset, as yet underutilised, to the Park. It is structurally scenic, and contributes hugely to the character and scenic value of the river, and thus to future tourism in the Namib-Naukluft National Park.

The hydrology report addresses the possible impact on small-scale farmers further downstream in the Swakop River bed.

This impact is likely to be complicated by other uses and users of Swakop water, so that the cumulative impact will be of much greater ecological impact than the impact of abstraction from any one mine.

6.8.2 Legal requirements

DWA abstraction permit and conditions associated with it (to do with monitoring and impacts on vegetation).

Interference with the ephemeral Swakop River linear oasis would violate Article 95 of the Namibian Constitution, which states that *"The State is obliged to ensure maintenance of … essential ecological processes …"*

6.8.3 Impact Assessment

Before mitigation in place

Degradation of Swakop River vegetation due to water abstraction or unintended dewatering	**Rating**	**Justification**
Project phase	C, O, D, P	
Extent	M – H	Impact could extend a distance downstream, depending on the level of abstraction from the alluvial aquifer.
Duration	H	For as long as the mine uses Swakop water, which ideally should only be for the first few years until reticulation of desalinated water is established. Over-abstraction might occur but the monitoring (see Mitigation) should detect if this is happening, and then the abstraction regime must be relaxed to allow recovery of the aquifer. Possible dewatering of the aquifer into the pit is a permanent risk once the pit is deeper than the river level.
Frequency	H	Continuous
Intensity	H	Over-abstraction could alter the environmental functions and processes so that they are significantly altered eg downstream farmers deprived of water, riverine woodland severely degraded.
Consequence	High	High impact
Probability	L – M	The likelihood that this impact will be severe is low if mandatory groundwater depth and vegetation condition monitoring is done properly. However, as noted above, there might be impacts on wildlife (springs disappear) which occur without any other indications of degradation of the aquifer.
Overall rating	**High**	This impact is potentially high if the aquifer is significantly affected by abstraction or unintended dewatering. The risk is made greater

		by the possible cumulative influence of other mines.
Status	-	
Degree of confidence	H	There is sound understanding of the effects of falling water tables on riverine vegetation of Namibia's westward flowing rivers, and on the crucial role that the rivers fulfil as linear oases.

Summary of findings
The effects of groundwater abstraction on downstream users and riverine vegetation are well known. With reference to wildlife, the impact will add to the other pressures that animals experience – on top of being disturbed by human activities, their food supply (pods and foliage) and shelter might deteriorate, and shallow water sources might be more difficult to access. The significance of this impact is High considering the vital role that the linear oasis plays in sustaining wildlife, and the cumulative impact of many mines wanting to use Swakop water.

6.8.4 Mitigation measures
If water abstraction from the Swakop River is desired, permitting procedures should be followed through the Department of Water Affairs. The conditions for abstraction usually include monitoring of the riverine vegetation (as done by Rossing and Valencia). If any negative impacts are detected, the abstraction regime should be immediately reviewed.

Thorough modelling of the aquifer and its vulnerability to dewatering into the pit is necessary so that this unintended and highly significant impact is avoided. If dewatering is likely then the deepest levels of ore might need to be sacrificed so that the linear oasis function of the river is not compromised.

Overall impact if mitigation measures are put in place

Degradation of Swakop River vegetation due to abstraction of groundwater or unintended dewatering		
Project phase	C, O, D, P	
Overall rating no mitigation	H	High impact
Mitigation measures		Monitor strictly the groundwater depth and condition of riverine trees to detect any early signs of degradation of the alluvial aquifer. Review the abstraction regime immediately if any negative impacts start to show.
Overall rating with mitigation	H	The impacts caused by excessive abstraction can be reduced to **Low** if monitoring is effectively carried out and it is followed up by appropriate changes to the abstraction regime. However the risk of unintended dewatering remains highly significant and the overall rating remains **High.**

6.9 Obstruction of flows in shallow washes and changes to the drainage pattern

6.9.1 Impact description

Shallow ephemeral washes on the plains support various plants (e.g. *Zygophyllum stapfii, Arthraerua leubnitziae, Hermbstaedtia spathulifolia* and *Adenolobus pechuelii*) which have been shown to support much of the life on the plains. Wherever possible these drainage lines and washes should be conserved so as to restrict possible losses of downsteam populations of endemics and near-endemics that lie outside the EPL. Although common and appearing to readily recolonise disturbed areas, plants in the washes could be impacted by a number of large developments, and the cumulative losses may yet prove to be of concern. Loss of populations of plants and deterioration of ecosystem functioning outside the mining area due to impeded drainage would be highly undesirable.

6.9.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, prohibits interference with and disturbance to flora in the Park.

6.9.3 Impact Assessment

Before mitigation in place

Obstruction of flows and changes to the drainage pattern	**Rating**	**Justification**
Project phase	C, O, D, P	
Extent	M	Impact could extend a distance downstream, depending on how severely flows are restricted.
Duration	H	The impact could be permanent if the drainage patterns are permanently changed.
Frequency	H	Continuous
Intensity	M	Deterioration of flows in the ephemeral washes could affect environmental functions and processes but the impact is likely to be moderate.
Consequence	Medium	Medium impact
Probability	M	This impact may materialise
Overall rating	**Medium**	This impact is potentially of medium significance since its extent is quite limited and the washes do not make critical inputs to large downstream flows.
Status	-	
Degree of confidence	H	There importance of the washes in sustaining life on the gravel plains is well understood.

Summary of findings

The mine footprint could potentially change the local drainage pattern so that downstream flows in the shallow washes are restricted. This would affect plant and animal life in the washes downstream. The impact, if it occurred, would be of medium significance.

6.9.4 Mitigation measures

Mine layout should be such that original gradients are not strongly altered and that channels for sporadic flows, even if they are shallow and wide, should be kept open and unrestricted.

Overall impact if mitigation measures are put in place

Obstruction of flows and changes to the drainage pattern		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium
Mitigation measures		**Avoid:** - During the design phase, care should be taken to avoid placing infrastructure in or across washes. As far as possible washes should be kept open and unrestricted to allow sporadic water flow to move through the environment. **Minimise:** - Where it is impossible to avoid washes, storm water diversions should be designed that allow clean storm water to flow past the infrastructure and feed downstream communities. - Care should be taken not to alter the gradient significantly as this will alter stream flow characteristics and could cause water erosion.
Overall rating with mitigation	**Low**	Proper mitigation can reduce the impact to Low.

6.10 Pollution from fuels, oils, hazardous chemicals, radioactive substances, office and domestic waste

6.10.1 Impact description

Vehicles and mine machinery use fuel, oils and greases. Acid leaching and other possible chemical processes use acids and chemicals such as ammonia which are hazardous to health. Uranium is a heavy metal which is potentially hazardous to health apart from its radioactive properties. All of these processes and products have the potential to seriously pollute air, soil and water sources, constituting a threat to human health (which are subject to occupational health regulations) as well as to animals and plants with which they come into contact.

Activities of people during construction and operation generate wastes related to work (such as scrap metals, plastics, effluents) and related to office and domestic activities (such as food wastes, litter, plastics) and human wastes (sewerage). All of these products can also degrade or pollute the surrounding environment if not properly managed.

The prevention and mitigation measures for the various kinds of pollutants are not considered here, since we assume that appropriate mechanisms will be put in place to manage these risks. Of relevance here is the potential to impact on wildlife and ecological processes:
Litter – unsightly, scrap metals and plastics can injure and kill animals;
Poisonous gases – potentially more harmful to people since they will be in the working areas of the plant, not where wild animals are present;
Contamination of water sources by hazardous substances or radioactivity– the greatest threat.

6.10.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, prohibits harmful pollution and littering in the Park.

6.10.3 Impact Assessment

Before mitigation in place

Pollution from fuels, oils, hazardous chemicals, radioactive substances office and domestic waste	**Rating**	**Justification**
Project phase	C, O, D, P	The impact could be permanent if contamination from spillages or waste dumps persist after closure. The main impact of solid pollution will be during construction, operation and closure.
Extent	M	Impact will be on site as well as extending into the surroundings from wind (litter, smoke and gases) and water contamination.
Duration	H	At worst, impact of radioactivity contamination on plants and animals could last for 10 years or longer
Frequency	L	Occurrence of serious incidents is likely to be low.
Intensity	M	Litter and solid wastes could affect environmental functions and processes but the impact is likely to be moderate. Potential radioactive contamination of underground water sources could affect local plant and animal populations
Consequence	M	Solid wastes are relatively easily manageable so long as there is commitment to do so. Contamination of pollutants, particularly radioactive substances, into groundwater would affect local and possibly downstream plants and animals.
Probability	L-M	The presence of pollutants is certain. The degree of risk to the environment depends on management measures to prevent

		pollution incidents, to monitor the surrounding environment for levels of indicator pollutants, and to react timeously in the event of a contamination incident.
Overall rating	**Medium**	The worst case scenario from pollution is of Medium significance for plant and animal populations
Status	-	
Degree of confidence	L	Understanding of the risks from the pollutants on the mine, and the likelihood of an accident, is poor. This assessment takes a precautionary approach based on the worst case scenario.

Summary of findings
Potential pollution from gaseous, liquid and solid pollutants is a well recognised threat from any mining operation and requires due attention. While occupational health and sanitation considerations should address threats from pollution that put people at risk, the impact on wildlife and ecological processes must also be addressed. These include:
Litter – unsightly, scrap metals and plastics can injure and kill animals;
Contamination of water sources by hazardous substances or radioactivity– the greatest threat.

6.10.4 Mitigation measures

There should be a strong anti-litter and clean surroundings policy within all working and accommodation areas of the mine, for any and all mine-related activities. This is an important component of standard safety precautions which the mine will presumably be promoting. Management needs to ensure that it extends to the temporary living facilities where construction and decommissioning staff will be housed. An important factor in the Namib is that plastic and paper litter can be carried far beyond the mine footprint from winds. Wire mesh fencing should be erected around all working and living areas to catch this wind-blown material, and the fences should regularly be inspected for any such litter.

Hydrological specialists should advise on how best to prevent any unintended leakage of contaminated waters into groundwater reserves, and on the detection and monitoring systems put in place that would trigger a response so that groundwater resources are not jeopardised. The systems should be put in place so that contamination is prevented now and during the operational phase, as well as far into the future for as long as the risk remains.

Radiation risks will presumably be well addressed in the operational procedures and safety mechanisms of the mine. Nevertheless, the chance of an accident depends on human error, which is always a possibility.

Overall impact if mitigation measures are put in place

Pollution from fuels, oils, hazardous chemicals, radioactive substances, office and domestic waste		
Project phase	C, O, D, P	
Overall rating no mitigation	M	Medium
Mitigation measures		**Mitigate:** - Implement a strong anti-litter and clean surroundings policy. Wire mesh perimeter fencing should be erected around working and living areas to prevent spread of wind-blown litter. - All domestic waste to be disposed of in waste bins that have lids and are stored behind a fence so as to prevent scavenging - All domestic waste bins to have lids so as to reduce the likelihood of windborne litter. - Regularly inspect and clean up site, access roads and general environment in proximity to the mine of litter. - Spillage management procedures need to be developed for all reagents used on site. Managing spillages along the access route must be included in these procedures. Geohydrological expertise should advise on

		appropriate detection and avoidance mechanisms for contamination of groundwater reserves. - Spills to be cleaned immediately and contaminated soils and water must be remediated or treated. - Radiation safety procedures to be strictly enforced. - All waste to be disposal of in appropriate waste disposal facilities (e.g. specific facilities designed for hazardous wastes). - Geohydrological expertise should advise on appropriate detection and avoidance mechanisms for contamination of groundwater reserves, particularly in the Swakop River alluvial aquifer.
Overall rating with mitigation	**Medium**	Mitigation measures are essential and can help to significantly reduce the likelihood of an accident. However, even with thorough housekeeping and safety awareness, the impact of a contamination accident on local plants and animals could still be serious.

6.11 Attraction of wildlife to contaminated water sources

6.11.1 Impact description

Leakages and spillages of water are likely to occur at various places on the mine, and there might be instances where these contain pollutants which are hazardous to animal health. Animals seek out places where there is water and will find their way to them. Drinking contaminated water might make them ill or sickly, making them more vulnerable to predation. Possibly, Red Data species such as Lappet-faced Vultures or Cape Eagle Owls could be killed. This impact will exacerbate other disturbances to local animals so that populations are depressed.

A secondary impact of water seepages is that vegetation may be locally more available and greener so that herds of animals (eg kudu) move closer to the mine and pose a safety risk by increasing the chance of vehicle accidents.

6.11.2 Legal requirements

Nature Conservation Ordinance No. 4 of 1975, including amendments, prohibits disturbance to wildlife in protected areas.

6.11.3 Impact Assessment

Before mitigation in place

Attraction of wildlife to contaminated water sources	**Rating**	**Justification**
Project phase	O	This impact is most likely during the operational phase.
Extent	L	Impact will mostly be limited to the boundaries of the development site.
Duration	H	If seepages occur they are likely to last for a long time.
Frequency	H	Continuous
Intensity	L	Environmental functions and processes will continue but wildlife populations will be depressed.
Consequence	Low	Low impact
Probability	M	This impact may materialise
Overall rating	**Low**	This impact has low significance since small numbers of animals are likely to be affected. This impact simply exacerbates other disturbances to local wildlife populations.
Status	-	
Degree of confidence	M	This impact has been found to occur at Rössing mine, so it can confidently be predicted that it will also occur at Etango. The

		actual extent to which it causes death of local wildlife is not certain.

Summary of findings
Unintentional creation of water points from seepages may lure animals to drink possibly polluted or contaminated water, and make them ill and more vulnerable to predation. It may also create an attraction for animals so that their presence poses a safety hazard. The significance of this impact is low.

6.10.4 Mitigation measures

Places where water accumulates should be fenced off to prevent animals using such water points, particularly birds that may be attracted. All leakages and seepages should be investigated and repaired as soon as possible to prevent unnecessary wastage of water and the creation of this problem.

Overall impact if mitigation measures are put in place

Attraction of wildlife to contaminated water sources		
Project phase	O	
Overall rating no mitigation	L	Low
Mitigation measures		**Mitigate:** - Fence off all effluent ponds, using a fine wire mesh, to ensure that both large and small animals cannot gain access. - Mend pipeline leaks and clean up spills immediately. **Monitor**: - Monitor for bird fatalities and if necessary install bird deterrents. - Establish leakage detection systems for all pipelines, tailings and ripios facilities.
Overall rating with mitigation	**Low – zero**	The mitigatory measures will help to reduce causing death or harm to local animals.

7. RECOMMENDED FURTHER MITIGATORY ACTIONS TO MINIMISE NEGATIVE IMPACTS

1. In the undesirable event of uranium deposits being mined in the Park or the mine footprint extending into sensitive areas, consideration should be given to assisting the Park authorities to establish offset areas for biodiversity conservation and for tourism development.

2. Arrangements for staff, contractors and visitors at site should clearly emphasize that this is a National Park and legislation applicable to it will be enforced. This refers particularly to prohibitions on poaching, collecting of any plant and animal material, and collecting of firewood.

3. The mine should volunteer a few (5-6) Honorary Wardens from its own staff and liaise with MET to enforce Park regulations amongst non-staff i.e. tourists. This will help to control off-road driving and disturbances to fauna by the public in the vicinity of the project area.

4. The scenic integrity in much of the Namib-Naukluft National Park will be permanently destroyed by mining activities and the provision of services such as water and electricity to the mine/s and plant/s. Furthermore, the Swakop River Canyon is an area of exceptional beauty, easily on a par with the Fish River Canyon, and it holds considerable potential for further development as a tourist destination, particularly for long-distance hiking. Consideration should be given to assisting the Park authorities to establish hiking and camping facilities in the river to compensate for damage and activities that will limit use of the area for tourism in future.

8. RECOMMENDATIONS FOR FURTHER STUDIES

8.1 Herpetological research on *Pedioplanis, Meroles* lizards and geckos

The status of lizards, particularly sand lizards in the *Pedioplanis* and *Meroles* genera, and geckos in the *Pachydactylus* genus, is very poorly known. Collecting surveys to establish distribution ranges and population status, in combination with taxonomic work to decipher the status of taxa that are actually involved, need to be undertaken to clarify the conservation priority of these animals.

A survey in early summer, when the animals are active, is recommended. Collecting would need to be done at sites in the lower Swakop and Khan valleys, as well as in surrounding habitats and areas further afield, to gather comparative material. Follow-up taxonomic work would be required, involving sending specimens to specialists in RSA and overseas. The latter component is usually the most time consuming part, as taxonomic work is slow and can only be undertaken when there is enough sample material from a wide distribution to pronounce on the status of the taxa.

The research is needed to answer questions about the vulnerability of various animals from the Etango Project. It is likely that other uranium deposits in the EPL will be targeted once Etango is operational, which are more in rocky habitat harbouring *Pedioplanis husabensis* lizards. Any expansion of the mine is likely to increase the threat against this and other rock-loving species, hence the need to get clarity on their status as soon as possible.

8.2 Restoration research

Restoration in this arid, fog-driven desert will require targeted research to make it optimally effective. For instance, the standard recipe for rehabilitating vehicle tracks is raking, but it is possible that this method, on certain substrates, causes more damage to the desert pavement and biological soil crusts. Targeted, in-situ research projects can help to find the best solutions for effective restoration. Studies could be elaborated with the help of researchers at Gobabeb, using comparative data from there and in situ studies in the Goanikontes area.

8.3 Botanical collecting

As a form of support to biodiversity research in Namibia, the mine could consider assisting local research institutes with non-mine related work. For instance, some plants such as *Adenolobus pechuelii* flower prolifically after good rains, so possibly the National Plant Genetic Resources Centre (NPGRC) could be invited to do seed collection when this occurs and is noticed by on-site staff. Collection of seeds from certain plants is complicated by the fact that seed maturation is sporadic and occurs over an extended period of time. Alternatively, environmental staff on the mine could be trained to undertake seed collection on their behalf.

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APPENDIX A

Database of expected reptile, amphibian and mammal diversity for the Goanikontes area, with habitat preference and conservation status

Habitat preference: M = Mountainous rocky terrain
H = Undulating hills
G = Gravel plains
R = River bed
R = Aquatic.

Endemicity: LS = Endemic to lower Swakop+Khan River area
CN = Endemic to Central Namib
ND = Endemic to wider Namib Desert (Orange - Kunene)
NA = Endemic to political Namibia
Cell empty = Widespread (not endemic to Namibia)

Conservation status: CE = Critically Endangered
EN = Endangered
VU = Vulnerable
NT = Near-Threatened
DD = Data deficient
S = Secure
NE = not evaluated

REPTILES AND AMPHIBIANS

Common name	**Genus, species**	**Habitat**				**Ende-mism**	**Cons Status**
		M	**H**	**G**	**R**		
TORTOISES AND TERRAPINS							
Leopard Tortoise	*Geochelone pardalis*				R		VU
Helmeted Terrapin	*Pelomedusa subrufa*				R		S
SCALED REPTILES							
Geckos							
Southwest African Flat Gecko	*Afroedura africana*	M	H			NA	S
Coastal Namib Day Gecko	*Rhoptropus afer*	M	H	G		ND	S
Bradfield's Namib Day Gecko	*Rhoptropus bradfieldi*	M	H	G		CN	S
Barnard's Namib Day Gecko	*Rhoptropus barnardi*	M	H	G		NA	S
Giant Ground Gecko	*Chondrodactylus angulifer namibensis*			G		ND	S
Palmato Gecko	*Palmatogecko*				R	ND	S

Common name	Genus, species	Habitat				Ende-mism	Cons Status
		M	**H**	**G**	**R**		
	rangei						
Velvety Gecko	*Pachydactylus bicolor*	M	H	G		NA	S
Namib Ghost Gecko	*Pachydactylus kochii*			G		CN	S
Namibian Rough Scaled Gecko	*Pachydactylus rugosus*			G		NA	S
Namib Variable Gecko	*Pachydactylus scherzi*			G	R		S
Button-scale Gecko	*Pachydactylus turneri*	M	H	G	R		S
Weber's Gecko	*Pachydactylus weberi werneri*	M	H	G		NA	S
Banded Barking Gecko	*Ptenopus carpi*			G		CN	S
Barking Gecko	*Ptenopus garrulus*			G	R		S
Festive Gecko	*Narudasia festiva*	M				NA	S
Agamas							
Namibian Rock Agama	*Agama planiceps*	M					S
Western Rock Agama	*Agama anchietae*	M					S
Chameleons							
Namaqua Chameleon	*Chameleo namaquensis*	M	H	G	R	ND	S
Skinks							
Wedge-snouted Skink	*Trachylepis acutilabris*			G	R		S
Western Rock Skink	*Trachylepis hoeschi*	M	H				S
Western Three-lined Skink	*Trachylepis occidentalis*	M	H		R		S
Namibian Tree Skink	*Trachylepis spilogaster*				R		S
Western Variegated Skink	*Trachylepis variegata*	M	H	G			S
Koppie Skink	*Trachylepis sulcata*	M	H	G			S
Namibian Dwarf Burrowing Skink	*Scelotes capensis*	M	H	G		NA	S
TYPICAL LIZARDS							
Spotted Sand Lizard	*Meroles suborbitalis*			G			S
New species 1	*Meroles sp. nov.*					CN	NE
Short-headed Sand Lizard	*Pedioplanis breviceps*			G		ND	S
Husab Sand	*Pedioplanis*	M	H			LS	DD

Common name	Genus, species	Habitat				Ende-mism	Cons Status
		M	**H**	**G**	**R**		
Lizard	*husabensis*						
Namaqua Sand Lizard	*Pedioplanis namaquensis*			G	R		S
Western Sand Lizard	*Pedioplanis undata*			G	R		S
PLATED LIZARDS							
Dwarf Plated Lizard	*Cordylosaurus subtesselatus*	M		G			S
SNAKES							
WORM SNAKES							
Damara Worm Snake	*Leptotyphlops labialis*			G	R	NA	S
Namibian Worm Snake	*Leptotyphlops occidentalis*			G	R	NA	S
Blind snakes							
Delalande's Blind Snake	*Rhinotyphlops lalandei*			G	R		S
Typical snakes							
Brown House Snake	*Lamprophis fuliginosus*			G	R		S
Namib Sand Snake	*Psammophis namibensis*			G	R		S
Western Whip Snake	*Psammophis trigrammus*			G	R	NA	S
Karoo Whip Snake	*Psammophis notostictus*			G	R		S
Leopard Whip Snake	*Psammophis leopardinus*			G	R	NA	S
Rhombic Egg-eater	*Dasypeltis scabra*				R		S
Namaqua Tiger Snake	*Telescopus beetzii*	M	H	G	R		S
Southern Tiger Snake	*Telescopus semiannulatus*	M	H	G	R		S
Damara Tiger Snake	*Telescopus sp. nov.*	M	H			CN	S
Western Keeled Snake	*Pythonodipsas carinatus*	M				NA	S
Mole Snake	*Pseudaspis cana*			G	R		S
Dwarf Beaked Snake	*Dipsina multimaculata*			G	R		S
Adders							
Horned Adder	*Bitis caudalis*		H	G	R	ND	S
Puff Adder	*Bitis arietans*			G	R		S
Cobras							
Zebra Snake	*Naja nigricincta*	M	H	G	R	NA	S
Cape Cobra	*Naja nivea*	M	H		R		S

Common name	Genus, species	Habitat				Ende-mism	Cons Status
		M	H	G	R		
AMPHIBIANS							
Frogs							
Damara Dwarf Toad	*Bufo hoeschi*				R	CN	S
Platanna	*Xenopus laevis*				R		S
Marbled Rubber frog	*Phrynomantis annectens*				R	NA	S
Tremolo Sand Frog	*Tomopterna cryptotis*				R		S

MAMMALS

Common name	Genus, species	M	H	G	R	Ende-mism	Cons. status
INSECTIVORES							
Shrews							
Reddish-grey Musk Shrew	*Crocidura cyanea*				R		S
ELEPHANT SHREWS (SENGIS)							
Round-eared Sengi	*Macroscelides proboscideus*	M	H	G	R		S
BATS							
Straw-coloured Fruit Bat	*Eidolon helvum*				R		S
Egyptian Slit-faced Bat	*Nycteris thebaica*				R		S
Darling's Horseshoe Bat	*Rhinolophus darlingi*	M	H	G			S
Dent's Horseshoe Bat	*Rhinolophus denti*	M	H	G			S
Sundevall's Leaf-nosed Bat	*Hipposideros caffer*	M	H	G			S
Flat-headed Free-tailed Bat	*Sauromys petrophilus*	M	H	G			S
Namibian Wing-gland Bat	*Cistugo seabrai*	M	H	G		NA	DD
Long-tailed Serotine	*Eptesicus hottentotus*	M	H	G			S
Namib Long-eared Bat	*Laephotis namibensis*	M	H	G		ND	S
Yellow House Bat	*Scotophilus dinganii*	M	H	G	R		S
Southern Long-fingered Bat	*Miniopterus natalensis*	M	H	G			S
RODENTS							
Namibian Pygmy Rock Mouse	*Petromyscus collinus*	M	H	G		NA	S
Pygmy Gerbil	*Gerbillurus paeba*			G	R		S
Namib Brush-tailed Gerbil	*Gerbillurus setzeri*			G		ND	S

Common name	Genus, species	M	H	G	R	Ende-mism	Cons. status
Short-tailed Gerbil	*Desmodillus auricularis*			G			S
Large-eared Mouse	*Malacothrix typica*				R		S
Three-striped Mouse	*Rhabdomys pumilio*				R		S
Tree Rat	*Thallomys paedulcus*				R		S
Namaqua Rock Rat	*Aethomys namaquensis*	M	H	G			S
Western Rock Dormouse	*Graphiurus rupicola*	M	H	G			S
Porcupine	*Hystrix afrcaeaustralis*			G	R		S
Dassie rat	*Petromus typicus*	M	H	G			S
HARES							
Cape Hare	*Lepus capensis*		H	G	R		S
DASSIES							
Rock Dassie	*Procavia capensis*	M		G			S
CARNIVORES							
Leopard	*Panthera pardus*	M	H				S
African Wild Cat	*Felis lybica*				R		VU
Southern Small-spotted Genet	*Genetta felina*				R		S
Suricate	*Suricata suricatta*			G			S
Spotted Hyena	*Crocuta crocuta*	M	H	G	R		S
Aardwolf	*Proteles cristatus*			G			S
Cape Fox	*Vulpes chama*	M	H	G	R		VU
Bat-eared Fox	*Otocyon megalotis*			G			VU
Black-backed Jackal	*Canis mesomelas*	M	H	G	R		S
Striped Polecat	*Ictonyx striatus*			G			S
HOOFED MAMMALS							
Springbok	*Antidorcas marsupialis*		H	G	R		S
Steenbok	*Raphicerus campestris*				R		S
Gemsbok	*Oryx gazella*		H	G	R		S
Klipspringer	*Oreotragus oreotragus*	M	H	G			S
Greater Kudu	*Tragelaphus strepsiceros*	M	H	G	R		S
Namibian Mountain Zebra	*Equus zebra*	M	H	G		ND	S
PRIMATES							
Chacma Baboon	*Papio ursinus*	M	H		R		S