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Proposed Mining of the Z20 Uranium Deposit: Phase 1 Biodiversity Impact Assessment

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Biodiversity provides the framework that supports life; without it we won’t survive. Rational custodianship of nature is therefore a non-negotiable obligation on all of humanity.

Project: AWR TR2012-10.1 Proposed Mining of the Z20 Uranium Deposit: Phase 1 Biodiversity Impact Assessment	
Acceptance[1] of report by client: Signature..	
Signed by	
On date	
On behalf of	
Of address	

[1]Acceptance means that AWR and Biodata Consultancy have fulfilled the Terms of Reference for the project to the client's satisfaction.

Proposed Mining of the Z20 Uranium Deposit: Phase 1 Biodiversity Impact AssessmentOctober2012

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Acronyms, abbreviations and shorthand terminology

BIA	Biodiversity Impact Assessment
CBD	Convention for Biological Diversity
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPL	Exploration and Prospecting Licence
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
ML	Mining License
QDS	Quarter Degree Square
ToR	Terms of Reference

Glossary

Assemblage	A general term referring to a collection of species of the same life-form that also occur in the same area. It is less specific than the related term community, which implies that there must be tight relationships, usually competition, among its constituent species.
Chamaephytes	Perennial dwarf or low-growing shrubs that have overwintering buds on persistent shoots at or near ground level.
Endemism/endemic	Referring to species whose natural distribution range is restricted to a certain area. The area can be defined in any one of a number of ways, including politically (e.g. a species may be endemic to Namibia), or biogeographically (e.g. a species that is restricted to the Namib Desert). The latter usually implies a zone that constitutes a specific range of environmental conditions that influence species ability to persist there. Some regions on earth are characterised by a higher level of endemism – i.e. they tend to harbour more species that have restricted ranges of some type.
Phytogeography	A branch of the broader field of biogeography that is specifically concerned with the geographic distribution of plant species. A phytogeographical approach in biodiversity studies is thus one where a lot of emphasis is placed on plant species broader geographic range as a variable that may influence its local presence.
Psammophilous	An organism with an affinity for sand as a habitat.
Red Data List	IUCN Red List of Threatened Species is the world's most comprehensive inventory of the global conservation status of biological species.
Rupicolous	Referring to the habit of animals to live in stony or rocky habitat
Sessile	A non-moving type of organism, such as a plant.
Therophytes	A plant that completes its life cycle in a single season, being dormant as a seed during unfavourable seasons.A technical term for an annual.
Plant community	An alternative synonymous term is phytocoenosis. This term is at the heart of the management concept of a vegetation unit or -type. It refers to a group of plant species that tend to co-occur within a specific geographical area or type of habitat. Their co-occurrence is therefore a distinguishing feature; they can be said to form a community. An extreme form of this concept holds that such a community can be viewed as an organism, to the extent that phytocoenological studies often classify communities in the same way that Linnnaeus classified species, with binomial identity and all. At the very least the term usually implies that there is an ecological mechanism behind the co-occurrence. Traditional community ecology favoured either internal mechanisms such as species interactions that determined relative abundances, or common responses to environmental gradients. Both of these essentially lead to relatively static species compositions. Current thinking places more emphasis on geographical context and so-called neutral dynamics in determining co-occurrence of species (leading to a more fluid species composition) and uses the term community in a much broader and less well-defined sense.

1. INTRODUCTION

In October 2012 Aurecon and SLR commenced a Social and Environmental Impact Assessment for the proposed mining of the Z20 ore body, on behalf of Rössing Uranium Ltd. (RUL). African Wilderness Restoration (AWR) and Biodata Consultancy cc (Biodata) were contracted to conduct the biodiversity impact assessment of the project. The current study is a report on the work done for Phase I of the biodiversity impact assessment, i.e. the proposed infrastructure corridor across the Khan River, linking the Z20 site to the existing Rössing Uranium Mine with a conveyor belt (and diesel line on the conveyor), access road and water and electricity lines.

The report comprises both a **biodiversity baseline study** (based on a brief field investigation and a literature study of, *inter alia,* all relevant EIA reports done in the region and within RUL itself) and an **impact assessment** with recommendations for mitigation.

The objective of a biodiversity baseline is to describe the *status quo* of the ecosystem in terms of its structure (diversity metrics) and function (the main processes and functions involved in causing stability, resilience and resistance) and the composition of the major groups of organisms that inhabit the area. As such the baseline study is not limited to the boundaries of the proposed development project; rather it covers an area that is ecologically meaningful, given the ecosystem. A proper impact assessment can only be made if a proper baseline study has been conducted, that provides information on all of the above, but with much emphasis on the functional interactions between taxa and the underlying drivers of patterns and processes. In addition, a baseline study provides the benchmark or reference against which progress in rehabilitation can be measured.

The report layout follows a template provided by Aurecon-SLR at an inception meeting on 15 and 16 October. After the introduction (the current Section), Section 2of the report describes the approach to the study, Section 3 summarises assumptions and limitations and Section 4 summarises the legal and standards context. Section 5 is a description of the affected environment from the perspective of the national, local and site scale. Section 6 describes the alternative development options for the project and Section 7 lists potential impacts. Section 8 summarizes recommended management and monitoring actions required to maximize mitigations and Section 9 provides an overall conclusion. The last section, Section 10, lists all references used and is followed by a set of Appendices that collate lists of species potentially present on site.

2. APPROACH TO STUDY

2.1. Outline of Terms of Reference

The Terms of Reference can be summarised into two main activities:

1. To describe the receiving environment's biodiversity (comprising the vegetation, invertebrates and all vertebrate groups), and
2. To use this information toconduct an impact assessment and provide alternatives and recommendations for management.

The work will be divided into two phases, with Phase 1 addressing the linear infrastructure corridor, and Phase 2 addressing the mining of the Z20 ore body, including the pit and associated waste rock dumps, and changes to the mining plant and development of new Tailings Disposal Facility on Rössing Dome. The current report is for Phase 1.

2.2. Methods

2.2.1. Fieldwork methods

The assessment team made a short orientation visit to Panner Gorge and the Khan River on 15 October 2012. A more extensive individual site inspection was made by J. Irish on 17 October 2012, when 9 hours were spent on site. North of the Khan, spot inspections were made on foot along the proposed road, while the route to be traversed by the conveyor was viewed from two hilltops in the northern parts of Panner Gorge. South of the Khan, the valley along which the access road is proposed to run was traversed on foot from both ends, leaving only about 800 m in the middle unseen. The proposed conveyor route was traversed on foot southwards from where it crosses the large marble ridge south of the Khan, leaving about 3 km of the most rugged portion of the conveyor route across the Khan Valley unseen, except from afar.

The site visits were used to inform our subsequent extrapolations from previous studies and functioned as an accuracy check for the results.

2.2.2. Habitats

For the habitat assessment, the different habitat categorisations, used by the different studies, needed to be standardised to allow comparison. Burke (2005) provided a plant-based biotope classification for the Rössing area north of the Khan River. The Rössing Mine Expansion Study (Aurecon 2011) recognised only three major animal habitats in the area, and they were correlated with Burke's biotopes by Pallett *et al*. (2008). Burke (2009) extended her biotope classification to include the Z20 area as well. The Husab Mine Study (AWR 2010*a*) recognised 13 habitats, of which seven are found in, or near, the Z20 area.

The manner in which these previously published habitats were correlated with the current study is described in Section 5.3.1 below.

2.3. Information Reviewed

2.3.1. General

Sufficient baseline biodiversity information is available in recent studies for the Rössing mine expansion and the Husab Mine and Husab Linear Infrastructure Impact Assessments (AWR 2010a, 2010b; Aurecon 2011). Though centred on opposite sides of the Khan River, these studies extend up to, and include, the Khan, hence they collectively cover the entire current study area. There have been no major increases in biodiversity knowledge of the Central Namib in the less than two years since these studies were completed.

Apart from specific scientific papers relevant to the study area (e.g. Burke *et al*. 2008), additional reports that were consulted are Burke (2009), Aurecon (2011), Loots (In Press), for background on the biotopes, habitats and specific species distributions.

Finally, the following ancillary information was reviewed:

- Project description documents on compact disk provided by Aurecon/SLR;
- GIS files of proposed road plus pipeline, powerline and RopeCon conveyor; and
- Source documents for the EIA studies listed above, plus additional literature listed under References below.

2.3.2. Vegetation species lists

The plant species list is provided in APPENDIX I. The list was compiled from information from the database of the National Herbarium (SPMNDB) on the quarter-degree square-occurrence of species across Namibia (relevant squares are 2215CA and 2215AC). This list produced 222 species that are likely to occur in habitats relevant to the current study. This is considerably fewer than Burke's (2011) list of 253, but her study covered a much larger area and reported the results of an intensive survey of 21 biotopes. Geographic ranges and conservation status was derived from the Namibian Tree Atlas database (Curtis and Mannheimer, 2005), Nature Conservation and Forestry legislation (as listed below), as well as Red Data lists for Namibia (Loots in Golding, 2002&Loots, 2005). Nomenclature largely follows Germishuizen and Meyer (2003). A list of species of conservation concern was compiled based on the QDS list, and focusing only on those species that occupy habitats along the linear infrastructure route.

2.3.3. Animal species lists

Draft lists of Species of Concern for the current study could be compiled by combining lists from both Rössing Mine Expansion and the Husab Mine Impact Assessments studies. Possible reasons for exclusion from consideration now are:

- The species occurs in a habitat that does not occur or is under-represented in the current study area. Specifically, all former species of concern associated with open gypsum plains habitat were excluded here. Only a very narrow strip of this habitat occurs on or just across the southern border of the study area.

- The species remains formally undescribed. It is almost impossible to assess the impacts on such an undefined taxon or suggest sensible management guidelines. There are recent examples of new taxa threatened by development in Namibia being described within one year, so putative species that remain undescribed indefinitely might not have been distinct to begin with.
- A previously Threatened species is no longer considered to be so. For species with official IUCN evaluations, the current status (as per IUCN Red List of Threatened Species, version 2012.2, verified online on 23 October 2012) was used. For Central Namib endemic invertebrates the unofficial IUCN-equivalent evaluations of Irish (2009) were used. The latter source represents a refinement of the methods originally developed for use in the Rössing Expansion SEIA. They were developed using exact IUCN guidelines, but they have no official status due to reasons beyond our control.

Filtered as above, the original 45 species of potential concern for the combined surrounding were reduced to the 17 species pertinent to the current study area.

3. ASSUMPTIONS AND LIMITATIONS

3.1. Limitations

- For practical reasons, the entire route of each infrastructure element could not be followed. Understanding of the wider area is based on extrapolation from spot investigations of representative habitat and landscape types, against the background of previous work in the area.
- No new collecting was done, and there was only one day of visual observations of macroscopic taxa. Especially for invertebrates and seasonally occurring or nocturnal vertebrates, expected occurrence is therefore mostly based on balance of probability, and not always backed up by real observations.
- Even given the fact that the Rössing area is one of the biologically best known in the Central Namib Desert, much of this knowledge dates from a survey conducted 28 years ago. Large amounts of material collected then have never been studied, and large groups of especially invertebrates remain essentially unknown at species level. The institutional custodian of the material has made no attempt to advance the study of any of the outstanding groups in the past 15 years. Our apparent considerable knowledge of the area's invertebrates therefore actually represents a thin sampling of only those random groups that did receive expert attention at the time. The Environmental Management and Assessment Act of 2007 implicitly assumes the availability of sufficient biodiversity information and reference material for identification, as well as access to it by practitioners. In practice, Namibian biosystematic service institutional capacity does not live up to these ideals. This limitation affects all Namibian environmental impact assessments, not just the current one.

3.2. Assumptions

- Habitat homogeneity and taxon habitat specificity in the study area is such that extrapolation from existing datasets will give useful results.
- The many poorly known groups of invertebrates will show the same trends exhibited by the few better known ones.

4. LEGISLATIVE CONTEXT

4.1. Acts and policies relevant to the management of impacts on biodiversity

Table 1.List of relevant acts and policies.

	Act, policy or convention	Aims and requirements
1	The Constitution of the Republic of Namibia	Any activities must comply with Section 95(l), which provides for “the maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis ...”
2	The Public Health Act 36 of 1919	Prohibits users of land to cause nuisances that may be injurious or dangerous to health. The definition of 'nuisance' includes the emission of environmental pollutants.
3	Draft Pollution Control and Waste Management Bill of 1999	Provides for the control and management of several types of pollution, inter alia to reduce their effects on species; until the bill is enacted, the draft bill serves as guideline for the design of future compliance
4	The Parks and Wildlife Management Bill of 2001	This act governs the declaration and management of national protected areas, of which the Namib-Naukluft National Park forms a part
5	Environmental Management and Assessment Act of 2007	This act provides a set of principles for environmental management, and lists those activities that require an EIA process (this includes all types of mining and exploration activities). The implementation guidelines are given in the associated Regulations of 2012.
6	Minerals (Prospecting and Mining) Act 33 of 1992	Provides for EIAs in mining activities, and includes requirements for rehabilitation of prospecting and mining areas and for minimising or preventing pollution
7	Nature Conservation Ordinance 4 of 1975, as amended in 1996	Provides for the declaration of protected areas and for the specific protection of scheduled species where they occur
8	Inland Fisheries Resources Act 1 of 2003	Provides for the protection of aquatic ecosystems and applies to any freshwater body that is not situated on private property. 'Fish' is defined to include freshwater crustaceans. Section 20 prohibits the erection or installation of any structure in a river or stream in the absence of consultation with the Minister
9	Forest Act 12 of 2001, as amended in 2005	Aims to conserve soil and water resources, maintain biological diversity and to use forest produce in a way which is compatible with the forest's primary role as the protector and enhancer of the natural environment

	Act, policy or convention	Aims and requirements
10	Convention on Biological Diversity	Aims to pursue the conservation of biological diversity and the sustainable use of its components. Participating countries are expected to introduce appropriate procedures requiring environmental impact assessment of projects that are likely to have significant adverse effects on biological diversity, with a view to avoiding or minimizing such effects. Also explicitly provides an opportunity for a more positive approach to be taken in impact assessments, to identify opportunities for enhancing biodiversity.
11	The Convention on International Trade in Endangered Species (CITES) of 1973	Regulates trade in endangered species, through listing in appendices: • Appendix I includes species threatened with global extinction, and trade in these is subject to particularly strict regulations. It is only authorized under exceptional circumstances. • Appendix II includes species that are not necessarily now threatened with extinction, but may become so unless trade in them is strictly regulated to avoid utilization incompatible with their survival. It also includes any other species for which trade needs to regulated in order to effectively control trade in strict Appendix II species. • Appendix III includes species where trade regulation to prevent exploitation is mainly needed on the individual country or regional level. Namibia currently has no CITES Appendix III species.
12	Convention to Combat Desertification	Aims to prevent excessive land degradation that may threaten livelihoods.

4.2. Guiding principles and standard concepts

There are no official standards for acceptable species loss or habitat loss levels in Namibia, and we need to follow general best practice guidelines instead.

At species level, the upper threshold of acceptable change would be any negative change to a species' status that would increase its risk of extinction. This needs to be considered on a species by species basis. A widespread adaptable species with *Least Concern* status would be able to absorb change with little effect, but a range-restricted species that already has *Critically Endangered* status, would not. Acceptable change is therefore a species-specific sliding scale in this case.

At habitat level, the upper threshold of acceptable change would be anything that compromises the ability of the habitat to function ecologically, or maintain the livelihoods of the species that inhabit it (tying in to the previous threshold).

More general guidance comes in the form of international conventions and agreements. According to the Convention on Biodiversity (CBD 1992) ''Biological diversity means the variability among living organisms from all sources, *inter alia,* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems".

Biodiversity has a non-quantifiable intrinsic value related to human appreciation and it also has utilitarian values related to the goods and services that ecosystems provide (Millennium Ecosystem

Assessment, 2005). These include production of harvestable products for many kinds of uses, processing and regulating functions (e.g. pollination, biological control, decomposition), carrying functions affecting the quality, health and safety of the environment in which people live, and product functions related to appreciation and research.

Mining-related activities should, where possible, avoid impacts on biodiversity altogether or at least mitigate the effects to the point that impacts become negligible. Where neither of these is possible, impacts may potentially be quantified well enough that the loss of biodiversity can be offset by the conservation measures somewhere else. Sometimes, however, there is no alternative measure other than the no-go option.

Together these strategies comprise the Biodiversity Impact Assessment (BIA) process.

4.2.1. Strategic Environmental Assessment for the central Namib Uranium Rush

The U-SEA (SAIEA 2010) was commissioned by the Government of the Republic of Namibia to address cumulative and regional environmental concerns associated with the Central Namib Uranium Rush. Although it depends on voluntary commitment by all parties and, as such, has relatively little legal standing, it stands central to the identification and assessment of impacts in the region and to defining ways to manage these. Relevant guidelines and principles for this project from the U-SEA are:

- Protection of key habitats is a core recommendation.
- The most important (i.e. ‘sensitive’) habitats are i) the ridges, inselbergs and valley flanks, ii) large ephemeral rivers, iii) coastal wetlands, iv) springs and ephemeral pans, v) caves, and vi) isolated sand patches.
- Every part of the central Namib is unique and can potentially harbour extremely range-restricted endemic invertebrates. The possibility of mining causing the extinction of certain species is real, but information on precisely where these species occur or how many other undescribed species are also threatened, is not available.
- Maintenance of not only species, but primarily ecological processes. Important processes such as surface hydrology and groundwater movement should not be compromised.
- Usage of ‘infrastructure corridors’, preferably along existing routes. Careful placement of infrastructure corridors to avoid important biodiversity areas, particularly ‘no-go’ areas, including consideration of alternatives and optimisation of service provision.
- Professional monitoring of key indicators and disclosure of their findings.
- Avoidance of impacts wherever possible, and rehabilitation/restoration after mining/development where avoidance is not possible. Restoration of biodiversity is a core strategy in the management of impacts, and, because so little is known about how to do this, much research is required. Closure and rehabilitation guidelines are:
    - All structural elements (site and external) will be removed from site, access roads ripped and graded over.

  - Alaskite mines: the open pit, waste rock dumps, and tailings dam or heap leach residue facility will remain.
  - Backfilling of shallow carnotite mine pits.
  - Closure planning starts many years ahead of the closure date to ensure that it is implemented in a logical, cost-effective and equitable manner. This includes ongoing rehabilitation of disturbed areas.

- Specific areas of high biodiversity value were identified. Amongst these, area 36, the 'Mountains surrounding Rössing', is especially relevant to this project. It was characterised by a high density of Lithops ruschiorum and Adenia pechuelli, the lizard Pedioplanis husabensis and the only known distribution of the spider Moggridgea eremicola.
- The Khan River (area 53) was characterised as a linear oasis with riparian woodland, important for aquifer recharge and rich in wildlife).
- Specific mention is further made that funding should be provided for long-term scientific research on specific threatened or iconic species, such as on the distribution and habitat requirements of Welwitschias in the central Namib, and source-sink relationships which can inform future rehabilitation strategies.

4.2.2. The Equator Principles and best practices

The Equator Principles of the Financial Institutions (EPFIs)were adopted to ensure that the projects that the EPFIs finance are developed in a manner that is socially responsible and reflect sound environmental management practices. The ten Equator Principles (EP) are operationalised through a number of Performance Standards, of which the relevant one in this regard is Performance Standard 6: *Biodiversity Conservation and Sustainable Natural Resource Management*.

Performance Standard 6 (PS6) reflects the objectives of the Convention on Biological Diversity (CBD) to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. As a result, (with a few minor exceptions) the guiding principles as defined in PS6 are adaptations of the CBD's general guidelines for the incorporation of biodiversity into the EIA process. Important principles are:

- BIA should cover the range of levels on which biodiversity is recognised: genetic[2], population, species, habitats and ecosystems.
- There is an explicit aim to minimise degradation of habitat and identify opportunities to enhance habitat value and, where conversion or degradation is unavoidable, to mitigate this.
- Overall, there is a strong drive to aim for no net loss of biodiversity values, through post-operation restoration of biodiversity, offsetting biodiversity losses by conservation of alternative areas, and compensation of biodiversity users.

[2]An investigation of biodiversity on the genetic level was not considered feasible or necessary for the current study.

- According to internationally recognized guidelines (e.g. Equator Principles, UN Convention on Biological Diversity) and the Constitution of the Republic of Namibia, the possibility of species extinction is a fatal flaw to a project.

4.2.3. Landscape-Level Assessment of key Biodiversity Vulnerability and Land use for the Central Namib

The purpose and scope of the Landscape-Level Assessment of key Biodiversity Vulnerability and Land use for the Central Namib project (LLA) was to:

1. Capture the key biodiversity patterns and ecological processes that characterise the Central Namib landscape and underpin the wide range of ecosystem services that support the range of land uses active in the region today;
2. Establish their status and value for contributing towards conservation objectives;
3. Determine the socioeconomic value of the Central Namib's natural assets and
4. Assess the vulnerability of biodiversity and ecological processes, and
5. Potential implications of current and future development, particularly mining, for biodiversity, ecological processes and other land uses (e.g. agriculture and tourism).

An important outcome of this project was that the project area (as part of the Khan River Valley) is a "Critical biodiversity and ecological support area" (Jenner et al. 2012, p35). Critical biodiversity priority areas represent areas that not only contribute to the achievement of conservation feature targets and landscape goals, but are at risk and deemed vulnerable in the landscape, within and outside the LLA defined study area. This categorisation is supported by its vital corridor function and key ecological processes, high vegetation unit diversity and high topographic diversity.

The project area consequently falls into an area with a relatively high Irreplaceability score (Figure 1), meaning that it is very difficult to achieve the expected conservation outcomes for the whole study area if such an area is lost due to development. In addition, the project area is close to areas where the threats to ecological integrity are considered to be high.

Overall the implication of the above results is that all potential impacts on critical biodiversity processes, functions and elements need to be scrutinised with great care, risks should be well defined and the precautionary principle applied.

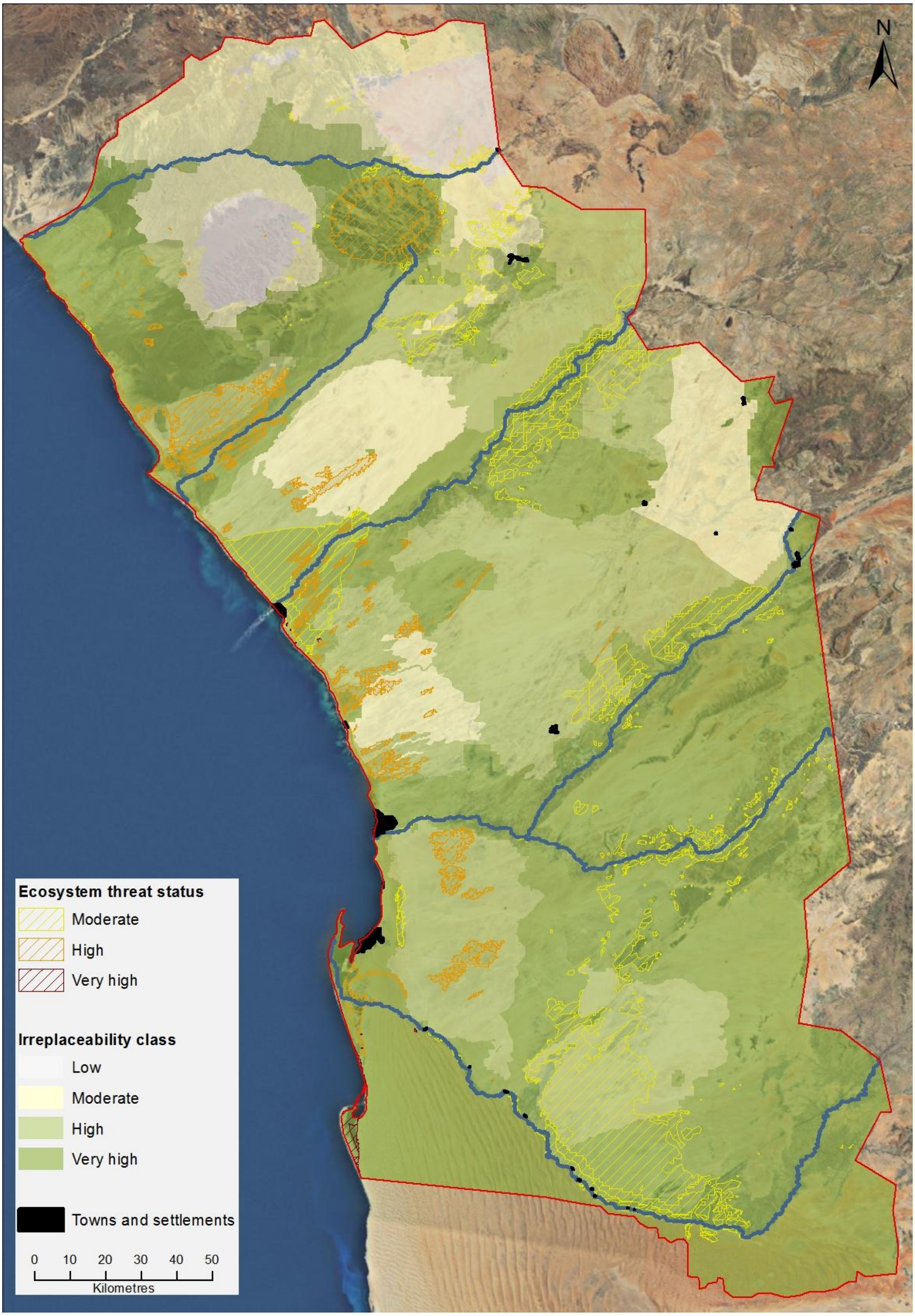

Figure 1. Ecosystem threat status (see Jenner et al. 2012) overlaid against summed irreplaceability values for all sites within the LLA study area. Irreplaceability values range from 0.0 to 1.0, with the latter representing areas of high irreplaceability. Dark grey indicates current township extents. Reproduced from Jenner et al. (2012).

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1. The National Context[3]

5.1.1. The study area

The Z20 Project is located south of the Khan River about 23km north-east of its confluence with the Swakop River in the central Namib, Erongo Region, Namibia (Figure 2).

The dominant geomorphologic features are large, gentle south-sloping gravelly plains, and deeply incised river valleys. Geologically the area is characterised by granites, gneisses, meta-sediments, marble ridges, and unconsolidated gravels and sands. Soils are shallow and, as is generally the case in the central Namib, organic components are poorly developed (Abrams et al. 1997). The northeast-southwest flowing ephemeral Khan River forms the main drainage. The Khan valleyis bordered along its length by deeply incised and twisting side valleys, which have been cut through granites and meta-sediments and which contain saline and fresh springs.

5.1.2. Climate

The region is hyper-arid, with a long-term average of less than 50mm rain pa (Mendelsohn et al. 2002). Spatial and temporal variability in rainfall is high (Mendelsohn et al. 2002), and, given that the rainfall mainly occurs as convective summer storms (Lindesay & Tyson 1990), the total annual average may fall as one shower. Summers are moderately hot (average maximum temperature during hottest month is about 30°C), but the climate is tempered by cool coastal conditions brought inland by prevailing westerlies, south-westerlies and southerlies (Lindesay & Tyson 1990; Mendelsohn et al. 2002). Winters are cool (average minimum temperature in coldest month is between 10 and 12°C), but hot easterly bergwind conditions can result in unseasonal warm conditions. Frost is rare and cloudy conditions are common, with approximately 125 days of fog per year at Swakopmund (Mendelsohn et al. 2002), although this decreases sharply with distance from the coast (Lancaster et al. 1984).

5.1.3. General biogeography

The study area falls in the “Namib Desert” biome (Irish 1994). Biogeographically the part of the Namib between the Kuiseb and Ugab Rivers, but excluding the Brandberg forms a distinctive subunit within the wider Namib Desert (AWR 2010a). This central Namib region harbours high numbers of range-restricted endemic invertebrates, plants, reptiles, and mammals (Barnard 1998; Irish 2009) and may be divided into the Inner and Outer Namib (Figure 3).Especially invertebrates exhibit high levels of range-restrictedness, with a median calculated distribution area of 25 km^2 (Irish 2009). Many distribution ranges tend to be narrow north-south elongated.

[3] All descriptions of the biophysical properties of the study area are paraphrased from AWR 2010a and AWR 2010b.

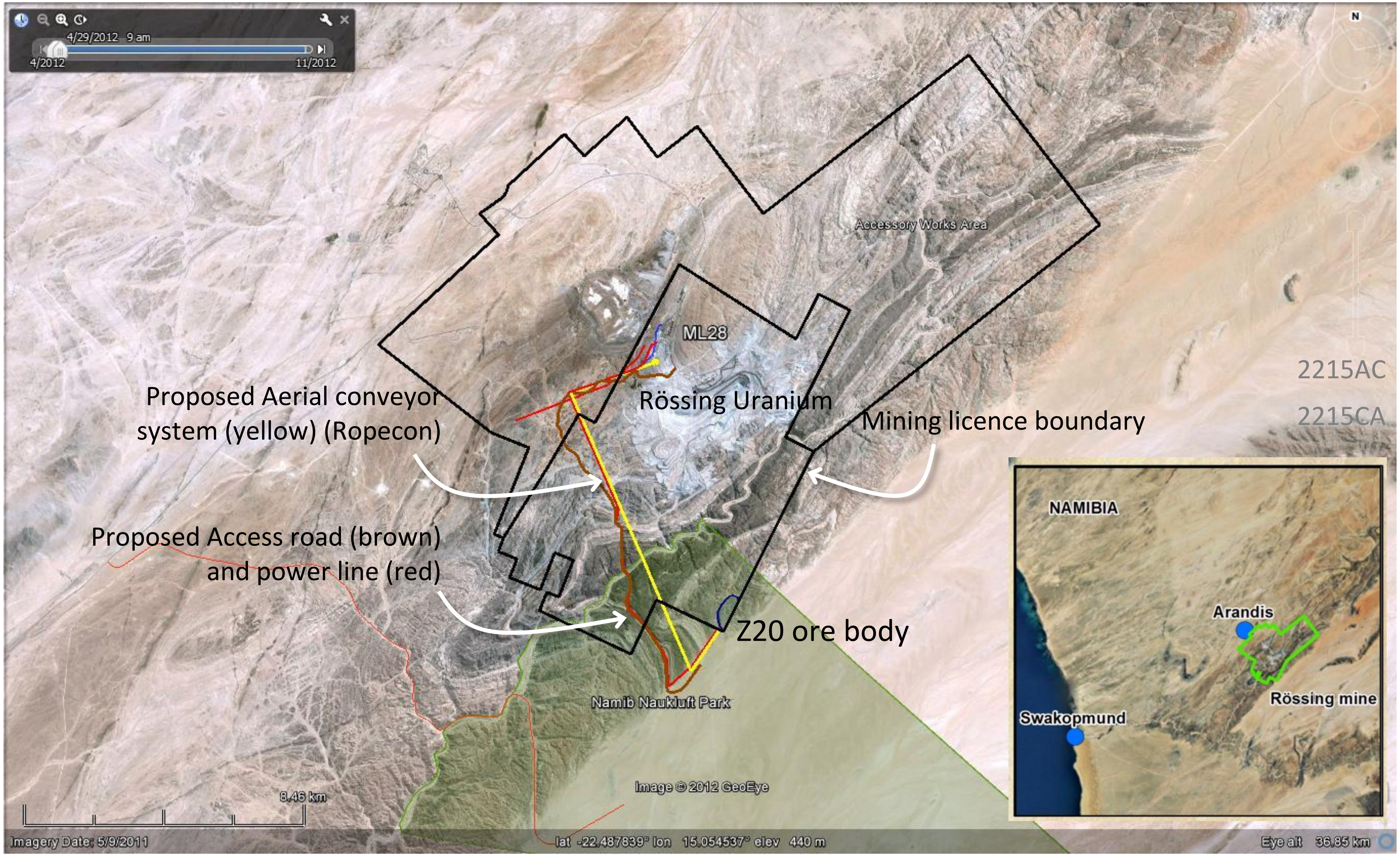

Figure 2.Location and approximate extent of the study area, showing the main features of the Z20 project relative the existing RUL pit, other RUL landmarks, the Z20 ore body itself and the boundaries of the Namib-Naukluft National Park.Source: Map drawn from data provided by Aurecon and RUL, using Google Earth.

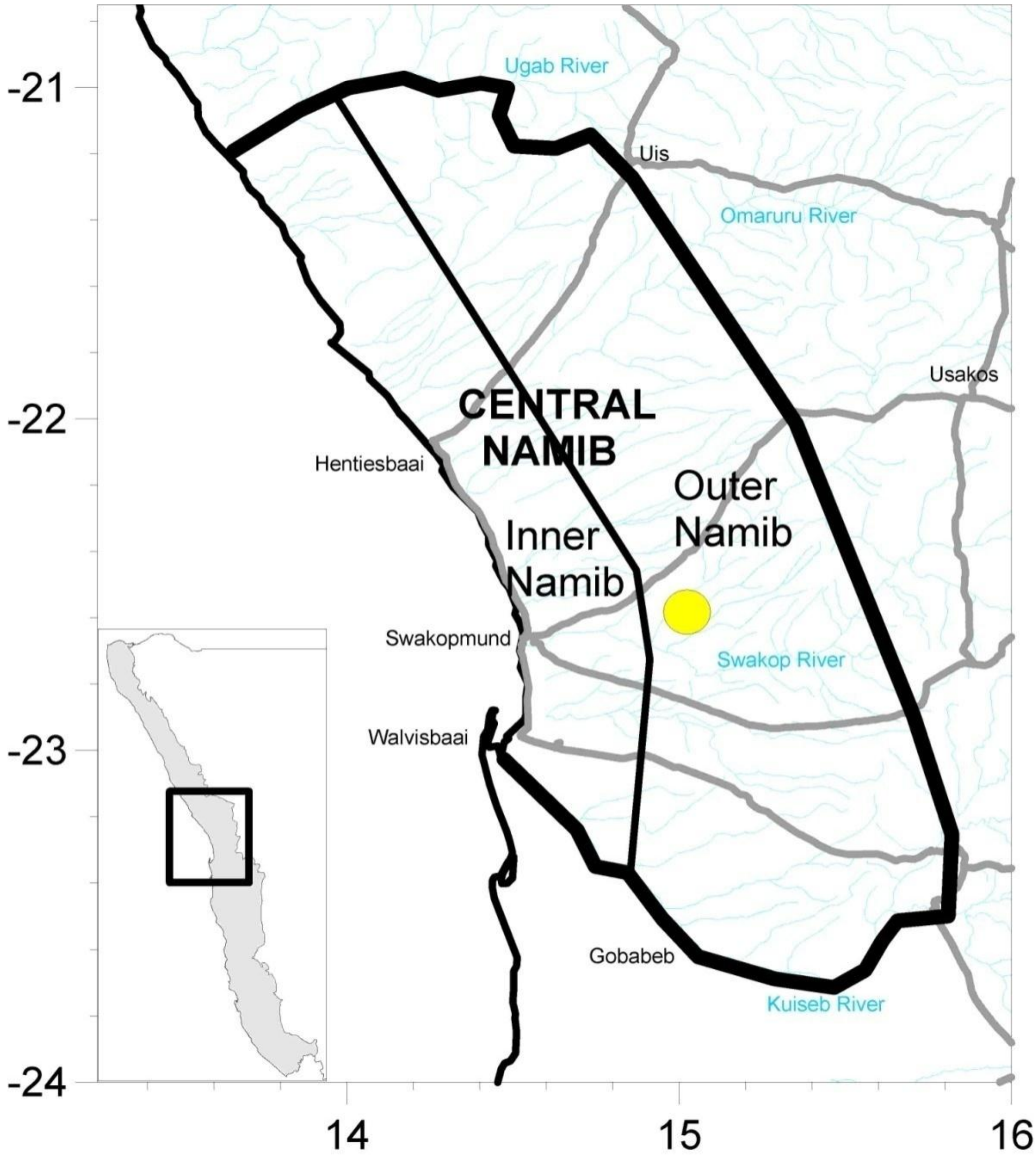

Figure 3. Outline map of the central NamibDesert, indicating the divisions into Inner Namib (fog belt) and Outer Namib. The approximate position of the study area is indicated by a yellow dot. Source: reproduced from AWR (2010a).

Distribution range size and shape can be correlated with the east-west environmental gradient in the Namib, and they show high correspondence to calculated bioclimatic envelopes for the same areas. A targeted survey (Irish 2011) to test the hypothesis that these observed small ranges were not real but an artefact of insufficient sampling confirmed their validity in the cases considered.

The key characteristic of the ~40km-wide Inner Namib, and most likely the principal driver of biogeographical patterns, is the frequent occurrence of fog and the scarcity of rain. Invertebrates in this ecological zone tend to be highly range restricted, and a high proportion is endemic. Fog seldom reaches the Outer Namib, and the ecosystem is driven by episodic rain events. Although it also has many endemic invertebrates, distribution ranges tend to be larger and extend further along a north-south axis. Many invertebrates from adjacent inland areas (e.g. the escarpment zone) also occur marginally in the Outer Namib.

These large-scale climatic drivers of biogeographical patterns, overlaid onto smaller-scale geological and substrate factors, result in relatively well-defined plant and animal communities. Vegetation cover is sparse, mostly concentrated in washes and ravines and on rocky marble ridges. In the fog zone, fog-dependent species such as Dollar Bush (*Zygophyllum stapffii*) and a number of Bushman grasses (*Stipagrostis* spp.) are generally dominant, but plant communities are set apart by numerous endemic and near-endemic taxa, including Swakopmund Corkwood (*Commiphora oblanceolata*), *Euphorbia giessii*, *Ruellia diversifolia*, Kraal Aloe (*Aloe asperifolia*) and others. The Vulnerable (IUCN, 2008) Hartmann's mountain zebra (*Equus zebra hartmannae*) is perhaps the most important of the large mammal fauna, but gemsbok (*Oryx gazella*) and springbok (*Antidorcas marsupialis*) also occur. Important small mammals are endemic species such as the dassie rat (*Petromus typicus*), the pygmy rock mouse (*Petromyscus collinus*) and Setzer's hairy-footed gerbil (*Gerbillurus setzeri*). Numbers of larger predators, like the cheetah (*Acinonyx jubatus*) seem to be increasing, with animals being spotted in close vicinity to the project area (pers. obs.).

Overall it is important to note that despite appearances, the Central Namib environment is diverse and heterogeneous at a very small scale, and even apparently small development footprints can have a big environmental impact. **This suggests that it would be prudent to approach Central Namib Desert impact assessments with a more than usual precautionary mindset**.

5.1.4. Floristic biogeography: national and regional diversity patterns

5.1.4.1 Floristic regions and biomes

Namibia falls into two floristic regions, the Karoo-Namib and the Sudano-Zambezian regions, belonging to the Palaeotropical floristic kingdom (Van Wyk & Smith, 2001). White (1983) followed a similar phytogeographical approach but emphasised the importance of specific combinations of endemic species in distinguishing between regions. He assigned Namibia to three floristic regions, the Zambezian regional centre of endemism, Kalahari-Highveld transition zone and Karoo-Namib regional centre of endemism, which includes both the Namib Desert (the location of the current study area) and the escarpment zone.

The biomes of Irish (1994) (Savanna, Nama-Karoo, Succulent Karoo and summer-rainfall Desert) correlate well with the vegetation types of Giess (1971, 1998). Importantly, Irish (1994) also described an east-west zonation in the desert with the western-most section bounded by the 20 mm rainfall isohyets.

This zone, where average annual fog precipitation usually exceeds rainfall, is dominated by fog-dependent chamaephytes, specifically *Arthraerua leubnitziae* and *Zygophyllum* spp. (the Dollar Bush genus), with the occurrence of annuals limited by extremely low rainfall. Further east therophytes dominate, although they grow only in the rainy season and are otherwise present as seed. As a result vegetation in the dry season is very sparse indeed. The easternmost zone exhibits chamaephytic-therophytic co-dominance.

Mendelsohn *et al*. (2002) defined 29 vegetation types grouped into five biomes, based on the work of Giess (1971, 1998)and modified in the light of later work by a number of ecologists in Namibia (C. Roberts pers. comm.). Similar to Giess(1971, 1998) it distinguishes between the winter and summer rainfall areas of the Namib and divides the latter into three sections, the southern Namib from around Lüderitz to the Kuiseb River, the central Namib between the Kuiseb and Huab rivers and the northern Namib between the Huab and the Kunene rivers.

5.1.4.2 Plant endemism in the central Namib and in the region

Only approximately 17% of the Namibian flora as a whole is thought to consist of endemic species (i.e. species restricted to within the political boundaries of Namibia) (Barnard 1998). However, over 30% of plants that occur in the Namib Desert in Namibia are believed to be endemic to the Namib, although this is mostly influenced by high endemism in the Kaokoveld and the southern Namib (Maggs *et al*. 1998).

Although the central Namib is therefore not generally regarded as a ‘hotspot’ of endemics for plants, about 36% of the plants recorded or expected in the two quarter-degree squares centred on the study area (2215Ac and 2215CA) are either endemic to Namibia or near-endemic (species whose range extend somewhat over the Namibian borders) (APPENDIX I).

Overall, of the list of 222 species that could occur in the habitats of the study area (APPENDIX I) there are 18 species that enjoy some sort of legal protection (either under the Forestry Act or the Nature Conservation Ordinance), and only one (*Lotononis tenuis*) is listed as near-threatened on the Namibian Red Data List (Loots, 2005).

To these lists of important species can be added those listed by Burke (2009) and in Aurecon (2011), which it is not possible to confidently assign to specific habitats in the current study.

5.2. The Regional Context

Within the wider Rössing area, extensive development already exists or is planned. Besides Rössing Mine and the already approved Husab Mine, dimension rock is being mined on a large scale, Arandis Town is developing an industrial area, including proposals for both coal and waste oil fired power stations. The wider cumulative effects of all these developments need to be taken into account on top of the individual impacts localised within each development's footprint.

5.3. The Local and Site Context

5.3.1. Habitats and their sensitivity

For plants, the biotopes of Burke (2009) and as described in Aurecon (2011) were used as is (Figure 4), with the addition of two habitats gleaned from the Husab studies: Plains (≈Gypsite Plains in AWR 2010a) and Aquatic Habitat. For animals, the three basic animal habitats of the Rössing Study (Pallet *et al*. 2008) were used as the common denominator, and Table 2 and Figure 4 indicate how the other habitat categorisations were correlated with this. The Aquatic Habitat from AWR (2010a) was also added as a main habitat for animals.

Table 2. Correlation of habitat types across different studies, including the current one. Bold type indicates those habitats that received higher sensitivity ratings in their respective studies. Sensitivity ratings for the habitats in the current study are described below.

<table>
<tr><th>Pallett et al. (2008)</th><th>Burke (2005; 2009)</th><th>AWR (2010b)</th><th>Current study (Plants)</th><th>Current study (Animals)</th></tr>
<tr><td rowspan="3">Watercourses</td><td>Khan River</td><td>Khan River</td><td>Khan River</td><td rowspan="3">Watercourse</td></tr>
<tr><td>Southwestern Rivers</td><td rowspan="2">Rocky Valley Drainages</td><td rowspan="2">Southwestern Rivers</td></tr>
<tr><td>Gorges</td></tr>
<tr><td rowspan="5">Hills and Mountains</td><td>Western Granite Hills</td><td></td><td>Western Granite Hills</td><td rowspan="5">Hillslope</td></tr>
<tr><td>South-western Hills</td><td></td><td>South-western Hills</td></tr>
<tr><td rowspan="2">Khan River Mountains</td><td>Pink Gramadoelas</td><td>Khan River Mountains</td></tr>
<tr><td>Black Gramadoelas</td><td></td></tr>
<tr><td>Khan Marble Ridges</td><td>Marble in Gramadoelas</td><td>Khan Marble Ridges</td></tr>
<tr><td>Plains</td><td></td><td>Gypsite Plain</td><td>Plains</td><td>Plains</td></tr>
<tr><td></td><td></td><td>Aquatic Habitat</td><td>Aquatic habitat</td><td>Aquatic habitat</td></tr>
</table>

The ecological characteristics of the different plant and animal habitats, with an emphasis on the occurrence of ecological functions and processes, as well as each habitat's sensitivity rating, are described in Table 3. For plants, Burke (2009) classified the biotopes into three categories based on the occurrence of a set of species of conservation concern, as critical, rare or general. To allow comparison, these categories were assumed to correlate more or less to sensitivity ratings of very sensitive, sensitive and least sensitive respectively, as used in all the other studies, and were treated as such here.

The proposed road is located almost entirely within the Watercourse habitat, and also crosses two of only three Aquatic habitats in the corridor. The proposed conveyor mostly crosses Hills and Mountains habitat. The proposed pipeline is aligned entirely with the road, and different parts of the proposed power line are aligned with either the road or the conveyor, so from a habitat loss view they can be considered together. The Plains habitat is confined to a narrow strip along the southern border of the corridor, and would potentially be crossed by all linear infrastructure considered here. The expected impact of development on these habitats is expected to be direct habitat loss in some cases, and loss of ecosystem functionality in others.

Table 3. A description of the ecological characteristics of habitats likely to be affected by the proposed linear infrastructure, with an indication of their sensitivity ratings. Sensitivity ratings for plants follow the ratings of biotopes as described by Burke (2009) and Aurecon (2011), except for the last two habitats which are correlated with AWR (2010a, 2010b). Sensitivity ratings of animal habitats follow Pallet et al. (2008).Ecological characteristics are based on those for similar habitats in AWR (2010a and 2010b) and in Aurecon (2011).

PLANTS			ANIMALS		
Name	**Ecological characteristics**	**Sensitivity**	**Name**	**Ecological characteristics**	**Sensitivity**
Khan River	• Discrete vegetation assemblage includes large trees that depend on regular replenishment of aquifer and in turn provides habitat to a suite of invertebrate trophic guilds dependent on large woody vegetation; • Dominant species: *Acacia erioloba*, *Faidherbia albida* (ana tree) and *Tamarix usneoides*;dense thickets of *Salvadora persica*; undergrowth comprises of a diverse assortment of herb, shrubs and grasses. Invasive aliens:*Prosopis glandulosa* (mesquite) and *Nicotiana glauca* (wild tobacco) are a threat to indigenous species, communities and ecosystem functioning. • Seasonal standing water; • The valley walls and large trees provide shelter from wind, blown sand and sun; • High disturbance rate with regular flooding (disturbance is an important ecological process); • Regular re-charge of aquifer; • Species richness medium (56 species).	General General	Watercourses	• Route for animal dispersal and movement, access route to critical resources such as water and food; • Seasonal standing water; • Supports kudu and ostrich populations, as well as predators preying on them; • Large trees and thickets are important as both shelter and food sources for invertebrates, reptiles, birds and small mammals-; • Large trees are important sources of shade for birds and large mammals; • Vegetation, both perennial and seasonal, provide grazing and browsing for large mammals; • Small perched aquifers may be common, and consequently also springs (forming the Aquatic Habitat - see below); • Well-defined movement corridors for wildlife; critical for zebra and other game to access springs and also to respond to spatial and temporal variability of available grazing; • Larger, wider watercourses also supports Rüppel's Korhaan and Ludwig's Bustard; • The occurrence of trees and freshwater seepages after good rains makes these gorges important habitats for animals;	Very Sensitive
Southwestern Rivers	• Two larger rivers draining into the Khan River; • Filled with coarse sand, boulders and other erosion material and receiving most of the run-off from the mountains;	General			

PLANTS			**ANIMALS**		
Name	**Ecological characteristics**	**Sensitivity**	**Name**	**Ecological characteristics**	**Sensitivity**
	• Supporting different vegetation than the surrounding mountain slopes; • *Zygophyllum stapffii* dominant in many sections, but the herb *Cleome foliosa* var. *foliosa* and the tall, endemic grass *Stipagrostis damarensis* also locally abundant; • Contains similar species composition to the Khan River with trees such as *Acacia erioloba*, *Parkinsonia africana* and *Tamarix usneoides*; • Endemic species recorded were *Aizoanthemum dinteri*, *Arthraerua leubnitziae*, *Hermbstaedtia spathulifolia* and *Sesamum marlothii*; • Species richness is low at 45.			• They function as resource reservoirs in unfavourable seasons in that animals from the Hillslope habitat through which they run temporarily descend into watercourses to feed when resources become scarce in the hills.	
Gorges	• The lower sections of water courses contain sandy gorges that support a range of plants also found in the Khan River itself and typical of river courses in this area (*Acacia erioloba*, *A. reficiens*, *Salvadora persica* and *Tamarix usneoides*; • Species richness medium to high (70 species).	General			
Western Granite Hills	• Although granite is prominent, other rock types also occur here; • Supporting diverse assemblages of plants: locally dominant are *Arthraerua leubnitziae*, *Euphorbia gariepina* and *Petalidium variabile*, *Adenia pechuelii*, *Aloe asperifolia*, several *Commiphora* species, *Sarcocaulon marlothii* and *Zygophyllum stapffii*; • Several populations of *Lithops ruschiorum* occur here;	Rare	Hillslopes	• High diversity of nooks and crannies forming shelter for a range of small mammals, reptiles and invertebrates; • Forms the only habitat for klipspringer, dassie rat, pygmy rock mouse, mountain ground squirrel and red rock rabbit, amongst other rupicolous species; • Very inhospitable to average life forms, therefore those that do live here have evolved to adapt to the adverse conditions. The result is a high percentage of endemic, range-restricted species, particularly	Very Sensitive

PLANTS			ANIMALS		
Name	**Ecological characteristics**	**Sensitivity**	**Name**	**Ecological characteristics**	**Sensitivity**
	• Species richness is medium (75), but the biotope is rated "rare" because of several range-restricted plants.			among the invertebrates.	
South-western Hills	• Relatively low and patchy plant cover; • Nevertheless support species of conservation importance such as *Arthraerua leubnitziae*, *Dauresia alliariifolia*, *Hermbstaedtia spathulifolia* and *Lotononis bracteosa*; • Locally dominant perennials on the hillslopes are Commiphora saxicola and *Tetragonia reduplicata*; • Species richness is relatively high at 71.	Rare			
Khan River Mountains	• Small gullies contain sandy substrates with many plant species, including *Commiphora oblanceolata;* • Steep schist mountains (of Kuiseb and Chuos formations) line the north- and south-banks of the Khan River, intruded by bands of granite and quartz; • Incised by deep channels, contains seepage areas; • Diverse microhabitats, supporting by far the highest number of plant species of all biotopes in the study area; • Several Commiphora species, Euphorbia virosa, Maerua schinzii, and Sterculia africana are some of the more conspicuous plants on these slopes; • Species richness is high at 136 species.	Critical			
Khan Marble Ridges	• Folded bands of marble of the Karibib formation cutting across the Khan River Mountains, with layers striking nearly vertical;	Sensitive			

PLANTS			ANIMALS		
Name	**Ecological characteristics**	**Sensitivity**	**Name**	**Ecological characteristics**	**Sensitivity**
	• Layered stone structure, many nooks and crannies; • Water retention probably high; • Layered character may result in water percolation and retention in rock fractures; • Shares many plant species with the Khan River mountains occur here, but also contains species that appear to be restricted to this habitat type: *Aloe namibensis*, *Commiphora oblanceolata*, *Euphorbia virosa*, and *E. lignosa* are only found here; • Richness is high at 88 species.				
Plains	• Indistinct area, located more or less along the Khan-Swakop watershed; • Hardpan gypsite layer, with shallow loamy gravel or sand cover; • Specific erosion pattern with sharp edges on small gullies, associated with high plant productivity; • Forms small (0.5 – 2m) mostly circular depressions that store water seasonally and results in vegetation rings, often containing perennial grasses and annual grasses and herbs, including endemics such as *Cleome carnosa*, *Jamesbrittenia barbata* and *Sporobolus nebulosus*; • Strong association of *Arthraerua leubnitziae* with gypsite plains; *A. leubnitziae* may represent a minor keystone structure; • Species richness is unknown (did not form part of	Least Sensitive	Plains	• The habitat represents a narrow outlier of the Inner Namib fog zone, due to higher fog precipitation on the edge of the Khan valley; • High percentage of fog-dependent species, all endemic, many range-restricted and substrate specific; • Gypsum substrate highly sensitive to disruption. Disrupted substrate renders habitat unsuitable for substrate specific taxa; • On the gypsite plains small mammal (primarily gerbil) burrows are apparently strongly associated with -depressions, possibly resulting in localised fertilisation and increased water penetration; may thus be a keystone feature; although underrepresented in the study area • Elsewhere, ample evidence of zebra grazing in this habitat, less so in study area .	Very Sensitive, but small part of study area

PLANTS			**ANIMALS**		
Name	**Ecological characteristics**	**Sensitivity**	**Name**	**Ecological characteristics**	**Sensitivity**
	biotope assessment).				
Aquatic Habitat	• Occurs mostly in the form of seepages or springs in the rocky valleys adjacent to the Khan River, but specifically as a spring in the southern tributary that leads up to the ore body; • Springs may be ephemeral or perennial; • Species richness is unknown (did not form part of biotope assessment).	Sensitive	Aquatic Habitat	• Provides critical habitat for specific plants, potentially some amphibians and a range of poorly-known but invariably water-associated invertebrate species; • Provides critical resource for a number of water-dependent mammal species such as zebra, as well as for many passerine birds; • Seasonal effect of ephemeral springs will be important determinant of space use by zebra; • High water temperature, high salinity and high risk of desiccation restricts possible range of aquatic taxa to those adapted to adverse conditions, expected to show high endemicity as a result.	Very Sensitive

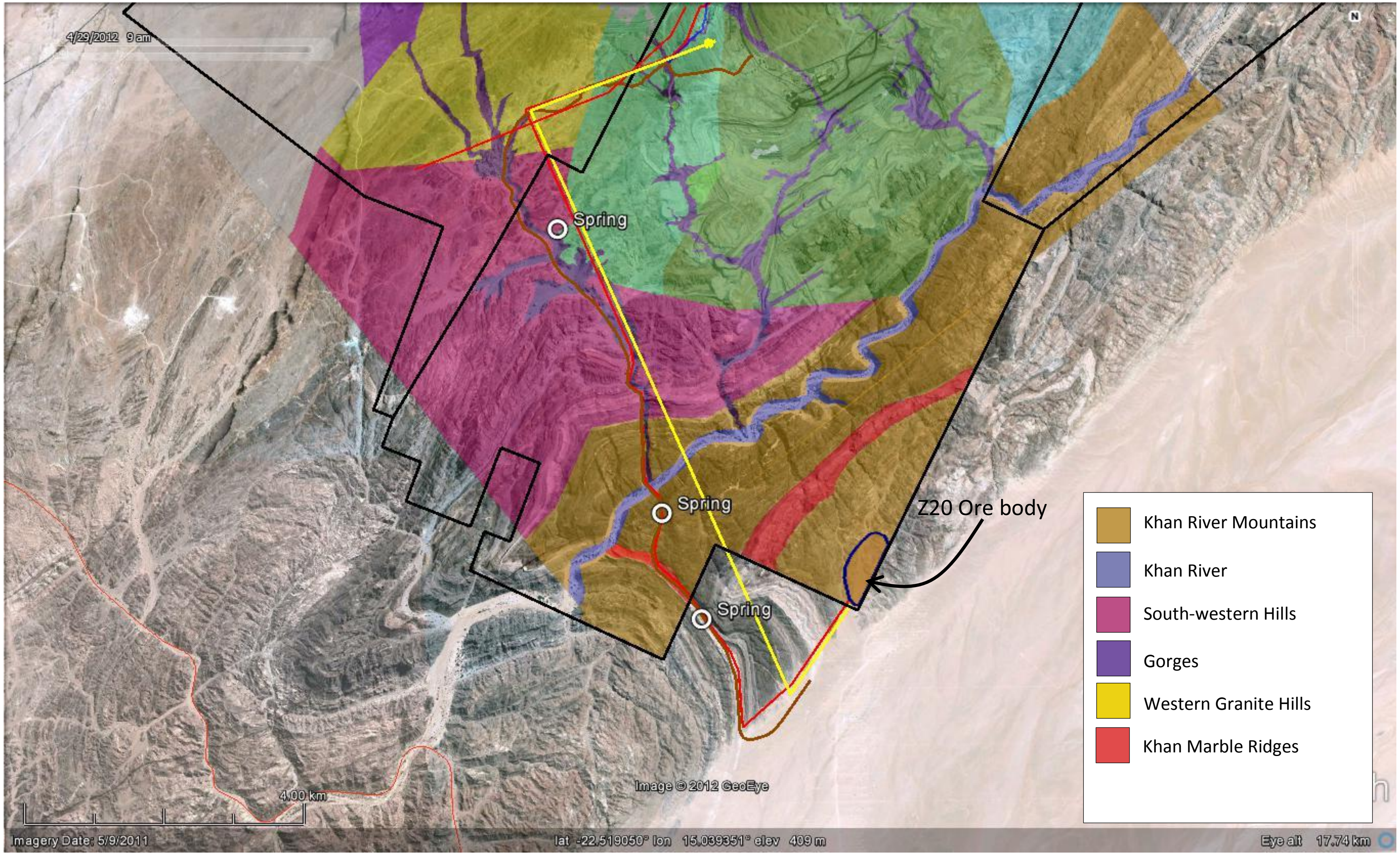

Figure 4: Biotopes of the study area, following Burke (2009). Note that only those biotopes relevant to the linear infrastructure have been rendered here. Biotopes are assumed to represent distinct habitats from the vegetation perspective. Habitats for animals essentially represent a coalescing of all drainage habitats into one singe Watercourse habitat, and all mountainous habitats into Hillslope habitat. Aquatic Habitat is represented by Springs. The additional two animal habitats are the same Aquatic and Plains habitat as for the vegetation. The part of the linear infrastructure south of ML28 crosses three habitats defined in the Husab mine EIA study (AWR 2010a): "Black Gramadoelas" (analogous to Khan River Mountains), "Marble in Gramadoelas" (~Khan Marble Ridges), and "Rocky Valley Drainages" (~Southwestern Rivers). The road further crosses onto the "Gypsite Plain", which has no analogy amongst the Biotopes.

5.3.2. Species expected or recorded in the habitats, conservation issues and important risks

5.3.2.1 Plant species

A comprehensive list of the plant species that could occur in the study area, including their endemic and other conservation status, can be found in APPENDIX I. Although vegetation communities in habitats along the linear infrastructure routes have not been studied in the field, it is unlikely that they will differ significantly from those described in Pallett *et al*. (2008), Burke (2009), AWR (2010a, 2010b) and Aurecon (2011). As in these previous studies, the main factors that distinguish different species associations appear to be geology/substrate, topography/landform and drainage pattern.

For the current report especially those species that are associated with the Watercourse habitat (e.g. camel thorn *Acacia erioloba*, ana tree *Faidherbia albida*, Lammerdrol - *Maerua schinzii*, leadwood - *Combretum imberbe*, sycamore fig - *Ficus sycomorus*, tamarisk - *Tamarix usneoides* and Salvadora bush - *Salvadora persica*) are important. The conveyor system will also cross a large marble ridge, where species such as elephant's foot - *Adenia pechuelii*, *Aloe asperifolia*, *A. namibensis* and *A. dichotoma*, *Commiphora oblanceolata*, *C. saxicola*, *Euphorbia guerichiana* and *E. virosa*, *Monechma cleomoides* and *Sarcocaulon marlothii* are important species that either are protected or have restricted ranges. Another important habitat that can not be avoided by the planned road is the Aquatic habitat, where thicker vegetation consisting of Salvadora bush, *Cyperus* sp. and *Euclea pseudebenus* provide important habitat and resources for invertebrate and vertebrate animals. In all cases, the principal risk to species and populations comes from a direct loss of individuals (thus impacting population dynamics) and destruction of habitat.

The Hillslope habitat harbours fewer species of conservation concern, with an important exception being the protected[4] succulent *Lithops ruschiorum*, which has been negatively affected by uranium mining in the past and is known to occur here (and on marble ridges) (Loots, in press, AWR 2010b). Similarly, the Plains habitat affected by the project is very small and therefore not important in the assessment of impacts on vegetation.

5.3.2.2 Animal species

The following 17 taxa of concern have been identified for the infrastructure corridor (Table 4). The most important impact on them is loss of potential habitat and interference with movement and dispersal. In the case of range-restricted species, habitat loss equates to a decline in living space and population viability. If severe enough, population numbers may decline and extinction becomes a possibility. Collisions are another concern, both by birds colliding with aerial infrastructure, and vehicles colliding with animals. If sufficiently severe, population numbers could be negatively affected, compounding any potential effects of habitat loss for the same species. The genetic contamination concerns for some species in the area are real, but the proposed development *per se* is largely neutral to the issue. Lastly, poaching is always a concern.

[4] Nature Conservation Ordinance 4 of 1975, Schedule 9, Protected Plants, all *Lithops* species.

Table 4.Species of concern for study area. E = Endemic, T = Threatened, L = Legal status, P = Plains habitat, H = Hillslope habitat, W = Watercourse habitat, A = Aquatic habitat.

Species	Common name	E	T	L	P	H	W	A	Potential impacts
REPTILES									
Pedioplanis husabensis	Husab Sand Lizard	X				X			Habitat loss. Range-restricted endemic species confined to core of Uranium Province. High potential of cumulative impacts. Seems to prefer marble substrates.
Varanus albigularis	Rock Monitor			X			X		Risk of poaching, but probability of occurrence low.
BIRDS									
Aegypius tracheliotus	Lappet-faced Vulture		X	X	X	X	X		Powerline collisions (which includes potential conveyor collisions, pending outcome of suggested monitoring study, also for next four species). Loss of nesting sites. Regular visitor, potential resident.
Aquila verreauxii	Black Eagle			X			X		Powerline collisions. Habitat loss. Known visitor, but not known to be resident currently.
Eupodotis rueppellii	Rüppell's Korhaan	X		X	X		X		Powerline collisions. Habitat loss. Habitat fragmentation.
Neotis ludwigii	Ludwig's Bustard		X	X	X		X		Powerline collisions. Habitat loss. Habitat fragmentation.
Polemaetus bellicosus	Martial Eagle		X	X			X		Powerline collisions. Known visitor, but unlikely to be resident in the area.
Struthio camelus	Ostrich			X	X		X		Genetic contamination concerns.
MAMMALS									
Equus zebra	Namibian Mountain Zebra	X	X	X		X	X		Habitat loss. Near-endemic subspecies with fragmented range. Important ecological role. Previous presence in the study area is evidenced by remains of zebra wallows, but no recent observations.
ARACHNIDS									
Heradida griffinae	Ant spider	X	X		X		X		Habitat loss. Habitat fragmentation. Range-restricted endemic only known from three samples from the Rössing area.
Moggridgea eremicola	Tingle trapdoor spider	X	X			X			Habitat loss. Habitat fragmentation. Range-restricted endemic, known from a single specimen from Lower Dome Gorge only. Has never been recaptured despite intensive efforts. The proposed Z20 pit is 7.5 km from the Lower Dome locality.
Namundra griffinae	Prodidomid spider	X	X			X			Habitat loss. Habitat fragmentation. Range-restricted endemic, known from two samples only, both within RUL's mining area.
INSECTS									
Acmaeodera	Jewel beetle	X	X		X	X	X		Habitat loss. Habitat fragmentation. Central Namib

Species	Common name	E	T	L	P	H	W	A	Potential impacts
liessnerae									endemic, also recorded from the Rössing area.
Hedybius irishi	Flower beetle	X	X				X		Habitat loss. Habitat fragmentation. Range-restricted endemic. Known from three specimens from Lower Ostrich Gorge (10 km NW of proposed Z20 pit) only.
Iselma deserticola	Blister beetle	X	X		X	X			Habitat loss. Habitat fragmentation. Range-restricted endemic, known only from the Arandis – Rössing Mine area.
Metaphilhedonus swakopmundensis	Flower beetle	X	X			X	X		Habitat loss. Habitat fragmentation. Range-restricted endemic, known only from three localities within a 10 km radius of the proposed Z20 pit.
Nothomorphoides irishi	Jewel beetle	X	X		X		X		Habitat loss. Habitat fragmentation. Range-restricted endemic, known only from the Arandis – Rössing Mine area.

5.4. Important biodiversity features

5.4.1. Key organism-related issues

- The Khan and Swakop River - which act as linear oases and are characterised by high plant biomass and diversity (as well as a high number of trophic guilds for invertebrates and high vertebrate species diversity);
- Large riparian trees (*Acacia erioloba*, *Faidherbia albida*) are both protected and keystone species, and form habitat for a range of other organisms;
- Permanent springs are important resources for mammals (and habitat for aquatic invertebrates and frogs);
- Woodland and savanna species whose presence in this hyper-arid zone are facilitated by the intact riparian vegetation in the Khan River;
- Presence in the region of, or movement through the region by a number of bird species of conservation concern. Example of resident or nomadic species: Lappet-faced Vulture, Ludwig's Bustard, Rüppell's Korhaan. Example of migratory species that may use the affected area as migratory corridors: Lesser Flamingo and Greater Flamingo, Great White Pelican;
- The presence of Lappet-faced Vulture and White-backed Vulture as important scavengers;
- The presence of the Namib endemic habitat specialist Rüppell's Korhaan and Husab Sand Lizard;
- The particular issue of movement of mammals:
  Animal movement has to be understood in view of the fact that part of the project area falls

inside a National park where animals are supposed to have the freedom to roam. This puts a bigger onus on the proponent to prevent local extinction and a stronger emphasis on the preservation of species and natural processes. Additionally, the proliferation of linear infrastructure serving the mines in the region, as well as the presence of the mines themselves and the attendant traffic and disturbance, means that animal movement is severely being hampered.

Although theoretically none of the linear obstructions are impermeable to wildlife, a rapid assessment of wildlife overpasses and pipe sections the Langer Heinrich Uranium (LHU) pipeline next to the C28 road showed very little usage of the ~30m wide wildlife overpasses, and high density of movement at the point where the pipeline goes underground (AWR 2011). The low frequency of crossing along the length of the aboveground pipeline is ample evidence of the potentially disastrous effect that aboveground pipes, of even the relatively small diameter of about 300mm, resulting in an average minimum obstruction of 400 mm high from ground level, may have on the movement of large mammals. In the specific case of the LHU pipe the impact was almost solely on springbok and gemsbok, but any aboveground pipes in the Khan-Swakop triangle may potentially also interfere with zebra movement.

5.4.2. Key functional and cross-cutting issues

- Surface and/or subsurface flow of water maintaining perennial species typical of washes and drainages. These species, including several central Namib endemics, are threatened by potential cumulative losses due to uranium mining throughout the central Namib;
- Access routes for wildlife to the Khan and the springs and grazing areas in its adjacent valleys;
- Normal movement of large mammals between foraging and water, and as part of their normal social behaviour, especially in the corridor formed by the Khan River;
- Connectivity and linkages of sub-populations of a number of larger vertebrates (mammals and the Common Ostrich) across the central Namib region, and sub-populations of the Husab Sand Lizard;
- Intactness of riparian vegetation which depends on groundwater in the sandy river aquifers.

6. IMPACT ASSESSMENT

6.1. Impact of watercourse habitat loss due to road construction

Nature of the impact: The proposed road will replace natural habitat with an artificial surface, reducing the amount of available habitat. The disturbance of traffic and movement will extend the affected area beyond the actual road into a surrounding envelope of sub optimally functioning habitat. Because this road will be additional to the developing access road for Husab Mine in the old railway valley somewhat further west, it will have a cumulative effect.

Why is this important: The watercourse habitat is important for its ecological support role. Most vegetation in the area is confined to watercourses. Vegetation is a source of food and shelter. The loss of relatively small areas of vegetation, even individual large trees like *Acacia erioloba*, can have a knock-on effect on the viability of animal populations in a wide surrounding area. Trees are also important as nesting sites for e.g. the Threatened Lappet-faced Vulture. The proposed road route can be seen in the provided fly-though visualisation to go-straight over and through large trees (e.g. at 02:52). Namib *A. erioloba* growth is very slow (60 cm trunk diameter in 400 years - deduced from data in Vogel 2003), therefore the current trees in Panner Gorge will not regenerate on human timescales following decommissioning. The damage will likely be permanent.

Of relevance here is also the Forest Act 12 of 2001 that prohibits the cutting, destruction or removal of vegetation within 100 m of a watercourse, on any land which is not part of a surveyed erven in a local authority area, without a permit.

Project phases: The impact commences during the construction phase, persists during operation, and persists post-decommissioning.

Extent: Regional. The impact of vegetation loss will affect the surrounding areas as well. There are other Khan tributaries in the area with significant tree growth, but none as extensive as Panner Gorge.

Magnitude: High. Natural processes will be severely altered in that parts of the habitat will become unsuitable for taxa that currently depend on the presence of large woody vegetation for survival.

Duration: Long term, on a century scale as indicated above.

Probability: Probable.

Confidence: Sure.

Reversibility: Irreversible, trees will not regenerate within 10 years.

Mitigation: Adapt the routing of the road to miss all *Acacia erioloba*, and to avoid as much other significant vegetation as possible. Based on a qualitative assessment of the amount of food and shelter provided to animals by particular tree species, their known or assumed regrowth rates and their relative abundance in Panner Gorge, Table 5can be used to evaluate the comparative impact of alternative route alignments. In cases where the route cannot be aligned to avoid all large vegetation, trees towards the top of this list should be preferentially avoided.

Table 5.Tree value assessment for Panner Gorge watercourse habitat, with higher valued trees towards the top. The table can be used to assess the relative impact of alternative road alignments. Single individuals of other trees not on the list do occur but canbe ignored in this context.

Tree	Food source	Shelter value	Regrowth rate	Abundance
Acacia erioloba	High	High	Very slow	Medium
Salvadora persica	High	High	Slow	Medium
Boscia foetida	High	High	Slow	Medium
Acacia reficiens	Medium	Medium	Medium	Medium
Parkinsonia africana	Low	Low	Medium	Low
Tamarix usneoides	Low	Low	Fast	Low

Cumulative impacts: The only Khan tributary in the area with comparable, albeit much less, woody vegetation is the old railway route through which the Husab Mine access road is planned to be taken. If both roads go ahead, much of this type of habitat in the area will be removed

Significance. Before mitigation: High Negative. After mitigation, assuming a best case scenario where most, but not all, large woody vegetation remains unaffected: Low Negative.

Offsets: Given the impossibility of regenerating trees at sensible time scales, and the absence of similar habitats elsewhere that could be conserved, no potential offsets are immediately apparent.

Issues to be referred to EMP: A study to assess the use of all tributary valleys by wildlife – a single survey counting spoor density and a monitoring plan to follow up at frequent intervals.

6.2. Impact of road construction and operation on animal movement

Nature of the impact: The proposed road and pipeline will affect the ability of a number of large mammal species as well as the Common Ostrich to use the Khan River and its tributaries as movement corridors. Because this road will be additional to the developing access road for Husab Mine in the old railway valley somewhat further west, it will have a cumulative effect.

Why is this important: The watercourses are widely used as corridors for movement and as grazing, browsing and hunting areas by a number of species such as Common Ostrich, oryx, springbok, possibly zebra and cheetah. Construction of a road here will significantly affect their ability to access resources, which is potentially exacerbated by the cumulative nature of his impact. The construction of a bridge over the Khan River will have unknown effects on the rate of movement along the river. Although it appears that the design prescribes a sufficient size bridge to allow even species such as kudu to move underneath it, it is not certain to what extent kudu will learn to adapt to move through what is effectively a broad tunnel (from their perspective). Limiting the ability to move freely is perhaps the most important long-term negative effect that roads can have on gene flow and local population dynamics.

Project phases: The impact commences during the construction phase, persists during operation, and may persist post-decommissioning.

Extent: Regional. The impact of movement limitation will affect other sub-populations as well and remove potential seasonal refugia for species moving from further inland.

Magnitude: Medium. Natural processes may be altered for specific large animal species.

Duration: Medium term.

Probability: Probable.

Confidence: Sure.

Reversibility: Reversible.

Mitigation: Allow enough space below bridge and where bridge berm starts for easy animal access during design (avoid the creation of narrow traversing points). Bury water pipe for stretches along the route, to allow as many opportunities for unhindered animal movement as possible.

Cumulative impacts: If both roads go ahead, the potential for obstruction of free movement is much higher than with only one road.

Significance. Before mitigation: Medium Negative. After mitigation it is Low Negative.

The potential for mitigation to decrease expected impacts on animal movement is unknown and the assessment of Very Low Negative for this impact is therefore dependent on adequately demonstrating the extent of use of the tributaries and the bridge underpass by animals, to put the impact into its proper regional context.

Offsets: Given the nature of the expected impact, no potential offsets are immediately apparent.

Issues to be referred to EMP: Monitor use of river and tributary corridors by large animals.

6.3. Impact of road construction and operation on Husab Sand Lizard

Nature of the impact: The movement by individual Husab sand lizards between sub-populations may be affected by the road on the south of the Khan, which will cut between two marble ridges (the presumed ideal habitat for this species in this area – Cunningham et al. 2012). The occurrence of the species on the ridges north of the Khan has not been documented in detail yet, so it is uncertain to what extent the road here will be a barrier to movement between sub-populations.

Because this road will have an impact that is additional to those caused by the infrastructure of the developing Husab Mine, it will have a cumulative effect.

Why is this important: Population viability of the endemic, restricted range Husab Sand Lizard can be affected through a decline in gene flow among sub-populations. Given their short generation times, such an effect can theoretically occur very quickly.

Project phases: The impact commences during the construction phase, persists during operation, and may persist post-decommissioning.

Extent: Regional. The impact of movement limitation will affect other sub-populations as well and remove potential seasonal refugia for species moving from further inland.

Magnitude: High negative.

Duration: Medium term.

Probability: Probable.

Confidence: Unsure.

Reversibility: Reversible.

Mitigation: If road does affect movement of significant numbers of individuals, careful translocations of individuals among sub-populations, guided by a species management plan, could mitigate the effect of loss of gene flow.

Cumulative impacts: Other projects may also affect the movement of individuals among sub-populations.

Significance. Before mitigation: High Negative. After mitigation it is Low Negative.

The potential for mitigation to decrease expected impacts is unknown. Overall too little is yet known about the biology and ecology of this species to be confident about the significance ratings of this potential impact.

Offsets: Given the nature of the expected impact, no potential offsets are immediately apparent.

Issues to be referred to EMP: Efforts by Gobabeb are currently underway to understand the biology and ecology of this species better. These studies should be supported materially and philosophically to extend the knowledge of their dynamics into areas that have not yet been studied, such as around the Rössing ML.

6.4. Impact of aquatic habitat loss due to road construction

Nature of the impact: There are three springs in the immediate vicinity of the proposed road route (Table 6, Figure 5). Piet-se-gat is located away from the proposed route and unlikely to be directly affected by the development on a habitat level. The two springs south of the Khan River are located right under the proposed footprint of the road. The narrowness of the valley precludes realignment to avoid them, and the extensive filling proposed for this section will cover the habitats and render them non-functional.

Table 6.Coordinates of aquatic habitats along proposed road route.

Spring	Latitude	Longitude
Piet-se-gat	-22.492018°	15.019750°
Unnamed 1	-22.529729°	15.033254°
Unnamed 2	-22.543209°	15.039220°

Why is this important: Water points in the desert are essential resources that ensure the survival of many vertebrate species. They are rare and widely spaced to begin with. The removal of one or more will render a surrounding area less suitable or unsuitable as habitat for a variety of more or less water-dependent species. Apart from their resource value, water points are also aquatic habitats for a variety of drought, salinity and heat-tolerant invertebrates that are almost unstudied in Namibia, but can be expected to show high levels of range-restricted endemism due to specialization for an extreme habitat. It is not known how many other similar water points occur in the area, since the only way to locate them is on foot: none of these three are recognizable as such on available aerial imagery. One of the others that is known is located under the proposed footprint of the Z20 waste rock dump. The proposed road route therefore has the potential of destroying a significant proportion of the currently known natural springs in the area.

Figure 5: Aquatic habitats (placemarks) near the proposed road route (yellow line). Image courtesy of Google Earth.

The loss of these particular (apparently perennial) springs may thus have a significant multiplicative negative impact on the ability of a range of water-dependent large mammals to persist in the area.

Of relevance here is also the Inland Fisheries Resources Act 1 of 2003 that applies to any freshwater body that is not situated on private property, and that requires Ministerial consultation prior to the erection or installation of any structure in a river or stream.

Project phases: Impact commences during construction, persists during operation and post-decommissioning as well.

Extent: Regional, given that the loss of a water point affects the fauna of a surrounding area beyond the 100 m limit for a local impact extent.

Magnitude: High. The springs are expected to be severely altered, probably to cease functioning, after a road is built over them.

Duration: Long term. Given the projected lifetime of the mine, the road will remain and the effect will persist longer than 10 years.

Probability: Definite.

Confidence: Sure.

Reversibility: Potentially reversible by removal of road post-decommissioning, but in practice this will depend on the extent to which mining had altered the current geohydrological processes which give rise to the springs, or not.

Mitigation: Refer back to route planners with instructions to devise a route that avoids the springs, which we will re-assess. Given the narrowness of the valley, simple re-routing within the valley does not seem possible, nor do there seem to be obvious alternative springless valleys available.

Cumulative impacts: It is expected that other planned or already approved developments in the area will further block access to springs in other tributaries south of the Khan River as well. The removal of waterpoints will exacerbate the reduction of habitat viability caused by concomitant habitat loss, vegetation removal and habitat fragmentation.

It should be noted that the magnitude of this impact on large mammals and birds is essentially unknown because there is little data available on their use of springs in the region. It is therefore necessary to 1) establish the number and spatial distribution of water points, and 2) to quantify their use over time by different species. Such a study will help to quantify the risks posed by this impact to ecosystem integrity in the region.

Significance. Before mitigation: High Negative. After mitigation: cannot be calculated because of the absence of viable mitigatory measures.

Offsets: Natural water points cannot be recreated once lost. The establishment of replacement artificial waterpoints has been suggested, but these are fraught with management problems. The excessive provision of water in previously waterless areas (which is usually what happens when artificial water is provided) may lead to local overexploitation of resources, defeating the object of the exercise. In addition, the long term maintenance of such waterpoints beyond decommissioning is problematic. Artificial provision of water should therefore be seen as a last resort.

Issues to be referred to EMP: A survey of the use of water points by animals (see below for more detail).

6.5. Impact of Hillslope habitat loss due to conveyor construction

Nature of the impact: The conveyor system will cross the Hillslope habitat (animals) and Western Granite Hills South-western Hills, Khan River Mountains and Khan Marble Ridges (vegetation habitats), all of which have been identified as either sensitive or very sensitive (the “critical” Khan River Mountains biotope) in their respective previous studies. The footprints of pylons represent direct physical loss of habitat. It is expected that an area surrounding the pylon as well as the area covered by access tracks will also be disturbed during construction. Where the conveyor runs close to the ground (far northern and southern sections), the constant movement might disturb more skittish animals and render the habitat unusable for them. Footprint effects are of particular concern in the Western Granite Hills area where populations of *Lithops ruschiorum* have been identified.

Why is this important: Most of the conveyor system is located in the Western Granite Hills and Khan River Mountains/Hillslope habitat that have all been identified as of particular biodiversity concern.

The Khan River Mountains/Hillslope habitat is already highly impacted by the Rössing open pit and waste rock dumps.

Project phases: Impact commences during construction, persists during operation, may partially disappear after decommissioning, depending on extent of rehabilitation possible.

Extent: Local, expected to be confined to immediate vicinity of pylon footprints only.

Magnitude: Very low, negligible ecosystem function alteration expected.

Duration: Long term, given the uncertain rehabilitation potential of rocky hillslopes.

Probability: Definite.

Confidence: Sure.

Reversibility: Irreversible, again pending more study of the rehabilitation potential of rocky hillslopes.

Mitigation: Use a helicopter for the transport of materials, equipment and personnel to pylon sites as suggested in planning, and do not build a construction access track along the conveyor route, as that would extend habitat loss far beyond the pylon footprints. For the same reason, use the conveyor's inspection gondola for maintenance activities as suggested and do not build a service track along the conveyor route.

Cumulative impacts: the Khan Hillslope habitat is already heavily impacted. Looking forward to following project phases, the addition of the Z20 open pit and waste rock dumps, and the concomitant Dome tailings expansion, will effectively fragment the habitat and sever populations. The conveyor will play a minor role in that.

Significance. Before mitigation: Very low negative. After mitigation: Very low negative, since mitigation measures are already included in construction planning.

Offsets: Not applicable.

Issues to be referred to EMP: Rehabilitation of all disturbances around construction footprints.

6.6. Impact of conveyor and power line on bird populations due to bird collisions

Nature of the impact: Due to the placement of their eyes some bird species have a blind spot that renders them prone to collision with power lines, even in daytime. They die from impact, not electrocution. Night-migrating birds, like flamingo, do not see power lines in time to prevent collision, and the effect is multiplied because flocks fly head to tail and one collision tends to kill many birds.

It is possible that the RopeCon conveyor can have a similar effect, but it is unknown whether this will indeed be so. The larger size of the conveyor relative to a power cable might render it less of a collision risk, while the expected noise and movement might also help to alert birds to its presence, but whether this will indeed be so and be sufficient to prevent night collisions as well would need to be tested.

Collision risk is not expected to be the same along the entire route. Where the power line or conveyor run parallel to bird movement corridors (like in Panner Gorge), the risk is lower than where they run across such corridors (like in the Khan valley). The Khan Valley is therefore considered the highest risk area, and should be the focus of mitigation efforts. Monitoring will be needed to determine whether other sections also carry higher collision risk and need to be targeted by mitigation measures as well.

Why is this important: Some species that occur in the area, like Rüppell's Korhaan, Ludwig's Bustard and various large raptors, are known to be particularly collision-prone. In the case of Ludwig's Bustard, studies in South Africa have correlated population declines with power line collisions, leading to a change in its conservation status from previous Vulnerable to current Endangered in late 2011.

Phases: Impact commences during construction phase, persists during operational phase and disappears after decommissioning.

Extent: Regional, because of the potential for affecting birds from outside the area migrating through it. As an example, flamingos migrate between coastal feeding and inland breeding sites, like Etosha, Bushmanland or Makarikari. Their migration routes are largely unknown, because they fly at night, but there is reason to believe that birds leaving the Central Namib coast follow river valleys, like the Swakop or Khan, on their way inland. This is evidenced e.g. by recorded flamingo flock collisions where the Walmund – Rossing power line crosses the Swakop River Valley (Scott & Scott, 2010).

Magnitude: Expected to be Low, but might change when results of suggested monitoring are available.

Duration: Long term, will persist for as long as the infrastructure stands, presumed more than 10 years.

Probability: Probable.

Confidence: Sure. Collision prone species will certainly collide with the power line. What is uncertain is whether this will happen regularly enough to be significant, and whether there will be collisions with the conveyor as well.

Reversibility: Potentially reversible by removing infrastructure at decommissioning.

Mitigation: Implement bird collision avoidance mitigation measures at the Khan River crossing. The NamPower/NNF Strategic Partnership is studying the effectiveness of different mitigation methods in Namibia, and it would be premature to suggest a specific measure at this time. Liaise with them as to appropriate mitigation when a definite construction date is available. Following construction, monitor both power line and conveyor for bird strikes for the first two years of operation and then re-address mitigation in the light of real data, as needed.

Cumulative impacts: There are already many power lines in place in the Central Namib, and more will be added if a power station is built at Arandis as planned. However, because the powerline in this case is relatively small, and the conveyor system is probably fairly visible to most birds, it is expected that the incremental effect of the current project will be minor.

Significance. Before mitigation: Low Negative. After mitigation: apart from the recommendation to monitor bird strikes, no mitigation actions are foreseen.

Offsets: None.

Issues to be referred to SEMP: Monitor bird strikes, see below.

6.7. Impact of road operation on susceptible vertebrate populations due to road kills

Nature of the impact: Some animals in the area are prone to vehicle collisions, particularly at night. This might be due to instinctive threat-avoidance behaviour that works for predators but is fatal when practiced against a vehicle (bat-eared foxes, Cape foxes, aardwolf), headlight-blinding that renders usual escape flight ineffective (owls, other night birds) or movement that is too slow to avoid vehicles (Namaqua Chameleon).

Why is this important: Over time, and because of the linear shape (and thus extensive nature) of roads, repeated road kills can drain populations of collision prone animals. If they occur in low numbers to begin with, the relative effects are exacerbated. Occasionally, when the collision is with a large animal (e.g. gemsbok) there is a possibility of property damage and human fatalities. Again, because this road will be additional to other planned or existing roads, an incremental additive or multiplicative effect could result.

Phases: Commences during construction, persists during operation, disappears after decommissioning.

Extent: Regional, since populations are affected.

Magnitude: Low, slight alteration of natural processes expected.

Duration: Long term, assuming road in operation for more than 10 years.

Probability: Definite.

Confidence: Certain.

Reversibility: Potentially reversible following decommissioning, assuming viable ecosystem functionality otherwise.

Mitigation: Enforce a speed limit on the road. The planned 60 km/h limit is good for daytime. Suggest monitoring to determine whether a different night-time limit is needed.

Cumulative impacts: Besides existing roads in the area (B2, Rössing access road, Valencia access road), the Husab Mine access road and the Arandis power station access road are also planned.

Significance. Before: Low Negative. After, assuming speed limit is effective in reducing road kills to zero, impact becomes Neutral.

Offsets: None.

Issues to be referred to EMP: Suggest monitoring of road kills to determine effectiveness of speed limit and determine whether a different night-time limit is required.

6.8. Impact of habitat loss on Khan Hillslope habitat range-restricted endemics

Nature of the impact: Parts of the conveyor route both south and north of the Khan River, and the road and power line mainly south of the Khan River, cross over the Hillslope habitat.

Why is this important: The Hillslope habitat was identified as of particular biodiversity importance in the Rössing Expansion SEIA, with many poorly known, range-restricted and / or Threatened species. The habitat is trophically poorly endowed, resulting in low population densities and hence high vulnerability to habitat disruption. Even small habitat losses have the potential of negatively impacting on vulnerable species.

Examples of range-restricted Hills and Mountains habitat endemics include the Husab Sand Lizard, *Pedioplanis husabensis*, and the spider *Moggridgea eremicola*.

Phases: The impact commences during construction, increases during operation, and persists after decommissioning.

Extent: National, given the potential to negatively impact endemic Namibian species.

Magnitude: Low. The footprint on the actual habitat will be relatively small – the largest footprint south of the Khan, the road, is located more in a watercourse and only partly in the Hills and Mountains habitat.

Duration: Medium term, because of the relatively small footprint.

Probability: Probable.

Confidence: Sure.

Reversibility: Irreversible. The complexities of hillslope habitats can not be recreated artificially.

Mitigation: Maintain the small footprint and do not plan additional infrastructure in this habitat. None additional measures apparent.

Cumulative impacts: In addition to the current infrastructure corridor, the existing Rössing Mine, the planned Z20 mine and the planned Husab Mine infrastructure corridor already impact on this habitat, or will impact on it in future.

Significance. Before: Medium Negative. After: Medium Negative.

Offsets: None.

Issues to be referred to EMP: None.

6.9. Impact of project on ecological integrity of Namib-Naukluft Park

Nature of impact: All of the proposed infrastructure corridor south of the Khan River is located within the Namib-Naukluft Park.

Why is this important: Under the Nature Conservation Ordinance, Article 14, the purpose of a protected area is stated to be for the '*propagation, protection, study and propagation therein of the wild animal life, fisheries, wild plant life and object of geological, ethnological, archaeological, historical and other scientific interest and for the benefit and enjoyment of the inhabitants of Namibia and other persons.*' The erection of mining infrastructure is incompatible with the reason for proclamation and intended land use of the Namib-Naukluft Park, and runs contrary to the internationally accepted purpose of a National Park.

Phases: The impact commences during construction, and persists during operation. Some impacts may disappear after decommissioning if infrastructure is removed (e.g. power lines), but those involving landscape modification (e.g. habitat lost due to cutting and filling for the road) may persist indefinitely.

Extent: National, due to its impact on a National Park, intended to be preserved for the benefit of all Namibians.

Magnitude: High. In that part of the corridor within the National Park, natural processes are expected to be severely altered because of habitat loss, compounded by the loss of a water point.

Duration: Long term, permanent. While some infrastructure could be removed following decommissioning, lost habitat is unlikely to be regained.

Probability: Definite. The proposed development is in a National Park.

Confidence: Certain. The proposed development is in a National Park.

Reversibility: Irreversible. In some cases, habitat loss will be permanent.

Mitigation: No mitigation possible. The proposed development is site-bound.

Cumulative impacts: The Namib-Naukluft Park is already the focus of other mining activities, ranging from exploration to operational. From a developer's viewpoint this is often considered as a validation that the erection of additional infrastructure would be justified, reasoning that if it was allowed before it can not be disallowed subsequently. From an environmentalist's viewpoint, the existence of prior infrastructure developments, against the background of cumulative impacts, rather argues against allowing additional infrastructure placement in the Park.

Significance: Before, High Negative. After, remains High Negative since no mitigation possible.

Offsets: None possible.

Issues to be referred to EMP: None.

6.10. Impacts not considered further

Two potential impacts that were identified were considered to be minor enough to warrant only a mentioning without any further assessment.

6.10.1. Poaching

Poaching is a potential problem, but is not expected to become an actual problem in the controlled security environment of a mining area where no-one lives on site.

6.10.2. Genetic contamination

Genetic contamination is a real issue, but the infrastructure corridor as such is neutral with respect to it.

7. Environmental Management Plan

The following issues were referred to an operational EMP above:

- Monitor bird collisions with power line and conveyor. The object is to obtain data to determine whether or not mitigatory measures are effective and whether additional measures might be needed. A monitoring period of two years is recommended, after which the situation should be re-assessed. In South Africa, power line monitoring has been used to quantify Crane (Shaw *et al*. 2010a) and Bustard (Shaw *et al.* 2010b) mortality, while locally the Nampower/NNF Strategic Partnership has begun monitoring power lines for a range of susceptible birds. Suggested monitoring method for power line: walking route monthly, looking out for carcases / feathers. Suggested monitoring method for conveyor: binocular observation from inspection gondola, preferably monthly but timed to coincide with inspections. Responsibility: Rössing environmental section, alternatively, an experienced local birder on contract. The suggested time span of two years was chosen as long enough to obtain useful data, but not so long as to decimate populations in the case that there is indeed a problem.
- Monitor road kills. The object is to obtain data to determine the efficiency of speed limits in preventing road kills, particularly at night. A monitoring period of two years is recommended, after which the situation should be re-assessed. Suggested monitoring method: driving route daily. Responsibility: delegate to a suitably knowledgeable individual who is driving the route on a daily basis anyway.
- Survey the area to log the location and type of natural water points (springs and seeps) and monitor the use of these resources by animals. Do this through spoor transects and installation of camera traps at the most important springs to be affected as well as two unaffected ones nearby. Repeat spoor transects once a month for 12 months, thereafter once a quarter for the next year. This should be done for at least two years (including two dry and two "wet" seasons). A decision about the significance of the two affected springs should be based on their relative importance: If they are visited more often or more regularly than other springs, and if they support a higher density of animals, they are probably key features in the area and the cumulative impact of losing them will be great.
- Simultaneously to the previous study, do spoor transects in the tributaries and on both sides of the Khan River bridge route to quantify the frequency and extent of use of these watercourses by large mammals before and after construction of the road.
- Support and extend current efforts by other institutions to understand the biology and ecology of Husab Sand Lizard better.

8. RECOMMENDATIONS

8.1. General approach

We consider the cumulative[5] nature of the impacts of especially the road to be potentially significant. With this in mind, we recommend four principal approaches:

1. Understand the level of risk posed by potential cumulative effects of road on animal movement and loss of natural water points through dedicated study and subsequent monitoring of indicator variables;
2. In accordance with principles as defined in the SEA, coordinate management of specifically potential cumulative impacts with other developing projects to prevent a fragmented management effect; and
3. Decrease area disturbed through consistent application of environmental management principles in design and careful management of construction teams.

8.2. Specific recommendations

1. As far as possible, use only existing tracks for construction and maintenance of infrastructure.
2. Control of unnecessary collateral damage due to vehicle activity, particularly during construction will largely dictate the extent of the damage caused.
3. Sand and other material for building, topping and compaction should not be sourced from the Khan River.
4. Populations and individuals of all protected plants along the route of all linear infrastructure should be identified, marked and studiously avoided as a matter of design principle as well as during construction. See APPENDIX I and in Burke 2009 for a list of protected plant species; but with special emphasis on high-profile species such as *Acacia erioloba*, *Lithops ruschiorum* and *Adenia pechuelli*.
5. A permit to remove and/or damage protected plants should be obtained, as should a collecting permit for plant rescue.
6. Rehabilitation:
    a. All disturbances associated with the construction of the road, power and water lines have to rehabilitated. Should infrastructure be decommissioned in the future, their footprint areas have to be rehabilitated. Rehabilitation should aim to reinstate a state that is consistent with the main land-use and considering the general principle of ecological sustainability.
    b. Rehabilitation should only be conducted within the limits of a properly developed restoration/rehabilitation plan. Such a plan will contain clear objectives, a strategy, a work plan, a monitoring plan and management response guidelines.
    c. Construction of all linear infrastructure types will result in disturbance of soil along the line of the route, which for the power and pipelines will be concentrated in areas where the pylons or plinths were erected. For the roads, physical disturbance will be found along the length of the road, as well as where borrow pits are located.

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[5]Cumulative effects result from actions that, when viewed individually, are not considered as a source of significant impacts, but which are significant when added to other actions.

d. Rehabilitation aims should focus on the repair of pre-existing or installation of an analogue topography (meaning that soil heaps must be levelled and raked to smooth over the surface, rocky areas should be re-built).
e. Ensure that water flow is not impeded and that natural flows are re-instated.
f. Assist colonisation of rehabilitation areas. For example, should there be quartz rocks around, seed the rehabilitation area with some of these (they typically contain cyanobacteria, part of the biological soil crust), making sure that the colonised parts of the rocks are placed face down onto the ground.
g. In cases where plants were rescued before construction, reintroduce these under the guidance of a properly qualified horticulturalist.
h. Monitor success of rehabilitation as part of a rehabilitation/restoration plan and instigate management response procedures where appropriate.

9. CONCLUSIONS

The current study, based on a very brief field visit, literature study and previous experience in the area, has showed that there are no fatal flaws from a biodiversity perspective and that most impacts can potentially be decreased to at least a level of Low Negative with appropriate mitigation or avoidance.

Important exceptions to the rule are the expected loss of two springs (a critical resource for numerous animals and plants) and the likelihood of cumulative impacts both because of this loss and as a result of interference of movement of animals by the construction and maintenance of the access road and water pipeline. Additional cumulative impacts could occur as a result of the insidious loss of small parcels of habitat in the important Khan River Mountain/Hillslope habitats.

The loss of the springs cannot be mitigated and can only be avoided by an alternative route for the access road. Such an alternative route, if planned in cooperation with neighbouring developments, will also achieve the SEA's objective of combining liner infrastructure in corridors.

There is a proviso on the expected impacts as a result of the loss of the two springs and the interference of movement by the road and pipeline. The magnitude, extent and importance of these impacts can only be guessed at this stage because there are no data available on the distribution, types and temporal dynamics of natural water points, or on the frequency of use of these resources by animals. We therefore recommend that a study be done to properly quantify the extent of the risk that these developments pose, and to better place the overall impact into context.

The specific expected impact on the Husab Sand Lizard is also shrouded in uncertainty related to the ecology and biology of this species. Specifically, it is yet unknown whether its apparent affinity for certain rock types as described in the project area (Cunningham et al. 2012) is a general feature across its range (in which case cumulative impacts may very well occur and may significantly affect the species' persistence), or site-specific (in which case it is unlikely that the additive impacts here will significantly affects its chances of persistence). By supporting current efforts to understand the species better, Rössing Uranium will thus gain valuable clues to the best management options for the species.

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APPENDIX I.List of plant species that may occur in the study area or its immediate surroundings

This Appendix lists all the plant species that have previously been recorded for the quarter degree grid squares 2215CA and AC (not as part of the current study).

It additionally provides information on these species' likely occurrence in one or more of the five habitats in the study area (for those species for which this is known), as well as information on each species' conservation status and endemic status. Additionally, those species that are important for humans in some way are noted.

- *Life form codes are A: Annual, B: Biennial, P: Perennial.*
- *Occurrence codes are: O: Observed, E: Expected (based on AWR 2010a and b).*
- *Range codes are: cN: central Namib only, cN+1: central Namib plus one more vegetation zone, cN+<1: central Namib plus more than one other vegetation zone.*
- *Endemism codes are: E: Endemic, N-E: Near-endemic.*
- *Habitat codes are: water: Watercourses, hill: Hillslopes, marble: Marble ridge, plains: Plains habitat, aquatic: aquatic habitat.Distribution of endemics/near-endemics scored using Mendelsohn et al. 2002. Sources: National Herbarium Database (SPMNDB), TAP database. Totals per category can be found at the bottom of the list.*

						Range				Habitat					
SPECIES	Protected	Alien	Red Data	Life form	Occurrence	cN	cN+1	cN+>1	Endemism	water	hill	marble	plains	aquatic	NOTES
Abutilon pycnodon Hochr.				B	E										
Acacia erioloba E.Mey.	X			P	O			1		1		1			
Acacia reficiens Wawra subsp. reficiens				P											
Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan										1					
Acanthosicyos horridus Welw. ex Hook.f.	X			P					N-E						
Adenia pechuelii (Engl.) Harms				P	O			1	E		1	1			
Adenolobus garipensis (E.Mey.) Torre & Hillc.										1		1	1		

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN>1		water	hill	marble	plains	aquatic	
Adenolobus pechuelii (Kuntze) Torre & Hillc. subsp. pechuelii				P	O				N-E	1			1		
Aizoanthemum dinteri (Schinz) Friedrich				A				1	E	1	1	1			
Aizoanthemum galenioides (Fenzl ex Sond.) Friedrich				A	O	1			E	1	1	1	1		
Aizoanthemum rehmannii (Schinz) H.E.K.Hartmann				A	E				E						
Aloe asperifolia A.Berger	X			P	O			1	E			1			
Aloe dichotoma Masson	X			P	O				N-E			1			Used as ornamental in water-wise gardens
Aloe namibensis	X			P	O		1		E			1			
Anthephora schinzii Hack.															
Anticharis ebracteata Schinz				P	O			1	E						
Anticharis imbricata Schinz				P/A	O			1	E	1	1				
Anticharis inflata Marloth & Engl.				A/P	O			1	E		1	1	1		
Aristida parvula (Nees) De Winter				A	O				N-E	1	1		1		
Arthraerua leubnitziae (Kuntze) Schinz				P	O			1	E		1	1	1		
Asparagus pearsonii Kies				P	O										
Atriplex vestita (Thunb.) Aellen var. appendiculata Aellen															
Bergia polyantha Sond.				A											
Blepharis grossa (Nees) T.Anderson				A	O				N-E	1			1		
Blepharis obmitrata C.B.Clarke				P											
Blepharis pruinosa Engl.				P				1	E						
Boscia albitrunca (Burch.) Gilg & Benedict	X									1					Unlikely to be affected
Boscia foetida Schinz subsp. foetida				P	O					1	1	1			

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range: cN	Range: cN+1	Range: cN+>1	Endemism	Habitat: water	Habitat: hill	Habitat: marble	Habitat: plains	Habitat: aquatic	NOTES
Brachiaria glomerata (Hack.) A.Camus				A	E					1			1		
Brownanthus kuntzei (Schinz) Ihlenf. & Bittrich				P					N-E						
Calostephane marlothiana O.Hoffm.				A				1	E						
Calicorema capitata (Moq.) Hook.f.				P	O					1	1	1			
Camptoloma rotundifolium Benth.				P	O						1				
Centropodia glauca (Nees) Cope				P											
Chascanum garipense E.Mey.				P	O					1	1				
Chenopodium amboanum (Murr) Aellen															
Cladoraphis spinosa (L.f.) S.M.Phillips															
Cleome carnosa (Pax) Gilg & Gilg-Ben.				A	O	1			E	1			1		
Cleome foliosa Hook.f. var. foliosa				A	O					1			1		
Cleome kalachariensis (Schinz) Gilg & Gilg-Ben.				A											
Coccinia rehmannii Cogn.															
Codon royenii L.				A/P	E				N-E	1	1				
Codon schenckii Schinz				A/P	E				N-E	1	1				
Combretum imberbe Wawra	X			P	O					1					Considered a sacred tree by the Herero people, threatened in savanna areas by illegal harvesting for charcoal
Commicarpus squarrosus (Heimerl) Standl.				P	O										
Commiphora dinteri Engl.															Avoid
Commiphora glaucescens Engl.				P	O				N-E			1			All *Commiphora* species should be regarded as potential sources of gum for the perfume industry.
Commiphora oblanceolata Schinz				P	O				N-E		1	1			Avoid
Commiphora saxicola Engl.				P	O			1	E		1	1	1		Avoid

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Commiphora tenuipetiolata Engl.				P	O							1			ditto
Commiphora virgata Engl.				P	O			1	E			1			ditto
Corbichonia rubriviolacea (Friedrich) C.Jeffrey				P	O			1	E	1			1		
Cordia sinensis Lam.															
Cotula anthemoides L.				A											
Crotalaria colorata Schinz subsp. colorata				P	E		1		E	1					
Cryptolepis decidua (Planch. ex Hook.f. & Benth.) N.E.Br.				P	O					1	1				
Cucumella aspera (Cogn.) C.Jeffrey				P	E										
Cucumis africanus L.f.				P	E					1					
Cucumis meeusei C.Jeffrey															
Cullen obtusifolia (DC.) C.H.Stirt.															
Cyamopsis serrata Schinz															
Cyperus laevigatus L.				P										1	
Datura innoxia Mill.		X		A	E					1				1	Alien invasive, should be eradicated when found.
Dauresia alliariifolia (O.Hoffm.) B.Nord. & Pelser				P	O			1	E		1				
Diclis petiolaris Benth.															
Dicoma capensis Less.				P	O					1	1				
Doellia cafra (DC.) Anderb.															
Dyerophytum africanum (Lam.) Kuntze				P	O						1	1			
Emilia marlothiana (O.Hoffm.) C.Jeffrey				P	O				N-E		1				
Engleria africana O.Hoffm.				A											
Enneapogon desvauxii P.Beauv.				P	O								1		

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN>1		water	hill	marble	plains	aquatic	
Enneapogon scaber Lehm.				P	E										
Euclea pseudebenus E.Mey. ex A.DC.	X			P	O					1					
Euphorbia damarana L.C.Leach									E		1		1		
Euphorbia gariepina Boiss. subsp. balsamea (Hiern) L.C.Leach				P	E						1	1			
Euphorbia glanduligera Pax				A/P	E					1	1		1		
Euphorbia guerichiana Pax				P	O							1			
Euphorbia mauritanica L. var. namaquensis N.E.Br.				P											
Euphorbia phylloclada Boiss.				P	O								1		
Euphorbia virosa Willd.				P	O							1			
Fagonia isotricha Murb. var. isotricha				P											
Fagonia sinaica Boiss. var. minutistipula (Engl.) Hadidi															
Faidherbia albida (Delile) A. Chev.	X			P						1					
Felicia anthemidodes (Hiern) Mendonça															
Ficus cordata Thunb. subsp. cordata	X			P											
Ficus sycomorus L.	X			P						1					
Forsskaolea candida L.f.				P	O						1				
Forsskaolea hereroensis Schinz				A	E				N-E	1					
Foveolina dichotoma (DC.) Källersjö															
Galeomma stenolepis (S.Moore) Hilliard									N-E						
Gazania jurineifolia DC. subsp. scabra (DC.) Roessler				P	O				N-E						

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Geigeria alata (Hochst. & Steud.) Benth. & Hook.f. ex Oliv. & Hiern															
Geigeria ornativa O.Hoffm.				A/P	O								1		
Geigeria rigida O.Hoffm.				P				1	E						
Gomphocarpus filiformis (E.Mey.) D.Dietr.				P	O										
Grewia bicolor Juss.															
Grewia tenax (Forssk.) Fiori															
Gymnosporia senegalensis (Lam.) Loes.				P	O										
Helichrysum herniarioides DC.															
Helichrysum roseo-niveum Marloth & O.Hoffm.				A	O						1	1	1		
Heliotropium curassavicum L.		X		P											
Heliotropium oliveranum Schinz				P	O								1		
Heliotropium ovalifolium Forssk.															
Heliotropium tubulosum E.Mey. ex A.DC.				P	O					1	1		1		
Hermannia affinis K.Schum.				P	O								1		
Hermannia amabilis Marloth ex K.Schum.				P	O			1	E	1					
Hermannia helianthemum K.Schum.				P	E					1			1		
Hermannia modesta (Ehrenb.) Mast.															
Hermannia solaniflora K.Schum.				P	O			1	E				1		
Hermbstaedtia argenteiformis Schinz				A					N-E	1			1		
Hermbstaedtia spathulifolia (Engl.) Baker				P	O			1	E				1		
Hexacyrtis dickiana Dinter				P					N-E						
Hoodia currorii (Hook.) Decne. subsp. currorii	X			P	O				N-E						Hoodias are used to produce appetite suppressants, and are often subject to

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
															illegal collection
Indigastrum argyroides (E.Mey.) Schrire				A	O					1					
Indigofera adenocarpa E.Mey.				P	E										
Indigofera auricoma E.Mey.				A/P	E					1	1				
Jamesbrittenia barbata Hilliard				P	O			1	E				1		
Jamesbrittenia hereroensis (Engl.) Hilliard				A/?P	E			1	E		1				
Jamesbrittenia maxii (Hiern) Hilliard				P	O				N-E	1	1	1	1		
Juncus rigidus Desf.				P											
Kissenia capensis Endl.				P	E										
Kohautia caespitosa Schnizl. subsp. brachyloba (Sond.) D.Mantell															
Kohautia ramosissima Bremek.				A/P	E						1				
Laggera decurrens (Vahl) Hepper & J.R.I.Wood				P						1					
Launaea intybacea (Jacq.) P.Beauv.															
Lemna aequinoctialis Welw.															
Lipocarpha rehmannii (Ridl.) Goetgh.				A											
Lithops ruschiorum (Dinter & Schwantes) N.E.Br.	X			P	O		1		E		1	1			Often illegally collected
Lobelia erinus L.															
Lophiocarpus polystachyus Turcz.															
Lotononis bracteosa B.-E.van Wyk				A				1	E						
Lotononis platycarpa (Viv.) Pic.Serm.															
Lotononis schreiberi B.-E.van Wyk				A				1	E						
Lotononis tenuis Baker			NT						N-E						

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Maerua schinzii Pax	X			P	O						1				
Melanthera marlothiana O.Hoffm.															
Mesembryanthemum guerichianum Pax				A/B	E					1					
Microcharis disjuncta (J.B.Gillett) Schrire var. disjuncta															
Monandrus squarrosus (L.) Vorster subsp. squarrosus ms.				A											
Monechma cleomoides (S.Moore) C.B.Clarke				P	O				N-E	1	1	1	1		
Monechma desertorum (Engl.) C.B.Clarke				A	E			1	E				1		
Monsonia luederitziana Focke & Schinz									N-E						
Monsonia umbellata Harv.				P	O										
Moringa ovalifolia Dinter & A.Berger	X								N-E						
Myxopappus hereroensis (O.Hoffm.) Källersjö				A				1	E						
Nesaea sarcophylla (Hiern) Koehne															
Nicotiana glauca R. Graham		X		P	E					1					Invasive alien, produces copious seed, should be destroyed whenever found
Odyssea paucinervis (Nees) Stapf				P											
Oldenlandia herbacea (L.) Roxb. var. herbacea															
Ophioglossum polyphyllum A.Braun				P	O								1		
Ornithogalum stapffii Schinz				P	O			1	E				1		
Orthanthera albida Schinz				P	O				N-E	1	1	1			
Othonna lasiocarpa (DC.) Sch.Bip.				P	O						1	1			
Othonna protecta Dinter				P	E										
Parkinsonia africana Sond.				P	O						1				

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Pelargonium otaviense R.Knuth				P	E			1	E						
Pergularia daemia (Forssk.) Chiov. var. daemia				P	O										
Pergularia daemia (Forssk.) Chiov. var. leiocarpa (K.Schum.) H.Huber															
Petalidium canescens (Engl.) C.B.Clarke				P	O			1	E		1				
Petalidium pilosi-bracteolatum Merxm. & Hainz				P	O			1	E						
Petalidium setosum C.B.Clarke ex Schinz				P					N-E						
Petalidium variabile (Engl.) C.B.Clarke var. variabile				P	O				N-E	1	1	1			
Phaeoptilum spinosum Radlk.				P	O										
Phragmites australis (Cav.) Steud.															
Polygala guerichiana Engl.				P	E			1	E						
Polygala pallida E.Mey.				A					N-E						
Polygonum plebeium R.Br.				A											
Psilocaulon salicornioides (Pax) Schwantes				A/P	O			1	E						
Pycreus pumilus (L.) Nees				A											
Radyera urens (L.f.) Bullock															
Rogeria longiflora (Royen) J.Gay ex DC.															
Ruellia diversifolia S.Moore				P	O					1	1				
Salsola gemmifera Botsch.				P											
Salvadora persica L. var. persica				P	O					1					Seeds eaten by humans
Sarcocaulon marlothii Engl.				P	O			1	E			1			
Sarcocaulon mossamedense (Welw. ex Oliv.) Hiern				P	E				N-E						

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Schmidtia kalahariensis Stent															
Searsia marlothii (Engl.) Moffett				P	O							1			
Senecio engleranus O.Hoffm.				P				1	E						
Sericocoma heterochiton Lopr.															
Sericorema sericea (Schinz) Lopr.															
Sesamum capense Burm.f.															
Sesamum marlothii Engl.				A/P				1	E						Related to commercial sesame, crop breeding potential.
Sesbania pachycarpa DC. subsp. dinterana J.B.Gillett				A/P	O			1	E	1					
Setaria verticillata (L.) P.Beauv.															
Solanum rigescentoides Hutch.				P	E			1	E						
Sporobolus nebulosus Hack.				P	O			1	E				1		
Sporobolus nervosus Hochst.															
Sterculia africana (Lour.) Fiori	X			P	O							1			
Stipagrostis ciliata (Desf.) De Winter var. capensis (Trin. & Rupr.) De Winter				P	O					1	1	1	1		
Stipagrostis damarensis (Mez) De Winter				P	O			1	E						
Stipagrostis dinteri (Hack.) De Winter				P	O				N-E		1				
Stipagrostis giessii Kers				P					N-E						
Stipagrostis hirtigluma (Steud. ex Trin. & Rupr.) De Winter subsp. Hirtigluma															
Stipagrostis namaquensis (Nees) De Winter				P	E					1					
Stipagrostis obtusa (Delile) Nees				P	O								1		
Stipagrostis schaeferi (Mez) De Winter				P	O					1					

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN+>1		water	hill	marble	plains	aquatic	
Stipagrostis subacaulis (Nees) De Winter				A	O				N-E				1		
Stipagrostis uniplumis (Licht.) De Winter var. intermedia (Schweick.) De Winter				A	O				N-E				1		
Stipagrostis uniplumis (Licht.) De Winter var. uniplumis				P	O					1	1	1	1		
Suaeda plumosa Aellen				P											
Tamarix usneoides E.Mey. ex Bunge	X			P	O					1					
Tapinanthus oleifolius (J.C.Wendl.) Danser				P	O					1					
Tephrosia dregeana E.Mey. var. dregeana				A/P	O										
Tetragonia reduplicata Welw. ex Oliv.				P	E					1	1	1			
Trachyandra laxa (N.E.Br.) Oberm. var. laxa				P	E								1		
Trianthema parvifolia E.Mey. ex Sond. var. parvifolia															
Trianthema triquetra Rottler ex Willd. subsp. parvifolia (Sond.) Jeffrey				A	O								1		
Tribulus zeyheri Sond.				P	O					1					
Trichodesma africanum (L.) Lehm.				A/B	O					1					
Tricholaena monachne (Trin.) Stapf & C.E.Hubb.				P/A	E								1		
Tripteris microcarpa Harv. subsp. septentrionalis (Norl.) B.Nord.				A	O					1	1				
Tripteris nervosa Hutch.									E						
Triraphis pumilio R.Br.				A	O								1		
Typha capensis (Rohrb.) N.E.Br.															
Vahlia capensis (L.f.) Thunb. subsp. capensis				A/P											
Waltheria indica L.															

SPECIES	Protected	Alien	Red Data	Life form	Occurrence	Range			Endemism	Habitat					NOTES
						cN	cN+1	cN>+1		water	hill	marble	plains	aquatic	
Welwitschia mirabilis Hook.f.	X			P	O				N-E		1		1		Tourist attraction
Zygophyllum cylindrifolium Schinz				P	O			1	E			1			
Zygophyllum simplex L.				A/B	O					1	1	1	1		
Zygophyllum spongiosum Van Zyl ined.									N-E						
Zygophyllum stapffii Schinz				P	O			1	E	1	1	1	1		
TOTAL	18	3	1			2	3	39	79						

APPENDIX II. **List of animalspecies** of potential concern for **the study area or its immediate surroundings**

List compiled from related previous studies as listed, and showing reasons for exclusion from the current study where applicable.

End. (Endemism): RCN = Range-restricted Central Namib endemic; CN = wider Central Namib endemic; NM = Namib endemic; NA = Namibian endemic; NRE = Namibian Near-endemic.

IUCN Conservation status: VU = Vulnerable; DD = Data Deficient; LC = Least Concern; NE = Not evaluated.

Legal status: CITES Appendix as listed, PG = Protected Game.

Expected habitat occurrence: P = Plains, H = Hills and Mountains, W = Watercourses, A = Aquatic habitat.

Concerns: short summary of issues. Includes motivation for excluding from current study where appropriate.

Source: R = Rössing Expansion SEIA (Aurecon 2010), H = Husab Mine EIA (AWR 2010a).

Species	Common name	End.	IUCN	Legal	P	H	W	A	Notes	Source
REPTILES										
Atractaspis bibronii	Bibron's Burrowing Asp		NE						**Excluded**. A widespread inland species, that does not have IUCN status as claimed. The presumed unique Arandis population remains formally undescribed, and the species might be habitat-incompatible with much of the study area.	H
Meroles sp.	Shovel-snouted Lizard								**Excluded**. The species remains undescribed.	R
Pedioplanis husabensis	Husab Sand Lizard	RCN	NE			X			Range-restricted species confined to core of Uranium Province, high potential of cumulative impacts. The species does not have IUCN status as claimed, but remains of concern for the reasons above.	H, R
Pedioplanis spp.	Sand Lizards								**Excluded**. Two species that remain undescribed. In both cases the study area is marginal to their presumed ranges anyway. Neither have IUCN status as claimed.	H
Stigmochelys pardalis	Leopard tortoise		NE	CITES					**Excluded**. The supposed occurrence of this inland species along	H, R

Species	Common name	End.	IUCN	Legal	P	H	W	A	Notes	Source
				II, PG					Central Namib rivers now appears to be based on erroneous information. Resident populations are unlikely, as was already stated in the Rössing Expansion SEIA. The species also does not have IUCN status as claimed.	
Telescopus sp.	'Damara Tiger Snake'								**Excluded**. The taxon has remained undescribed for more than 10 years, and the expert in question is retired. Being undescribed, it can not have IUCN status as claimed.	H
Varanus albigularis	Rock Monitor		LC	CITES II, PG			X		The species does not have IUCN status as claimed, but remains of concern because of the risk of poaching.	H
BIRDS										
Aegypius tracheliotus	Lappet-faced Vulture		VU	CITES II, PG	X	X	X		Power line collisions, loss of nesting sites (large trees, e.g. *Acacia erioloba*). Regular visitor, potential resident.	H
Ammomanopsis grayi	Gray's Lark	NRE	LC	PG	X				**Excluded**. A predominantly plains-living species.	H
Aquila verreauxii	Black Eagle		LC	CITES II, PG			X		Power line collisions, habitat loss. Known visitor, but not known to be resident currently.	R
Eupodotis rueppellii	Rüppell's Korhaan	NRE	LC	CITES II, PG	X		X		Power line collisions, habitat loss.	H
Falco naumanni	Lesser Kestrel		VU	CITES II, PG					**Excluded**. A Palaearctic migrant that does not breed here. It is generally uncommon in Namibia, and while it has been seen in the area it is unlikely to be a regular visitor.	R
Neotis ludwigii	Ludwig's Bustard		EN	CITES II, PG	X		X		Power line collisions, habitat loss.	H
Polemaetus bellicosus	Martial Eagle		NT	CITES II, PG			X		Power line collisions. Known visitor, but unlikely to be resident in the area.	R

Species	Common name	End.	IUCN	Legal	P	H	W	A	Notes	Source
Struthio camelus	Ostrich		LC	PG	X		X		Genetic contamination concerns.	H
MAMMALS										
Cistugo seabrai	Namibian Wing-gland Bat	NRE	LC						**Excluded**. A widespread (ZA to Angola), albeit poorly known, species that does not have IUCN status as claimed.	H
Crocuta crocuta	Spotted Hyaena		LC						**Excluded**. The species does not have IUCN status as claimed.	H
Equus zebra	Namibian Mountain Zebra	NRE	VU	CITES II, SP		X	X		Previous presence in the study area as evidenced by remains of zebra wallows, but no recent observations.	H, R
Felis silvestris	African Wild Cat		LC	CITES II					**Excluded**. While the genetic contamination concerns are valid, the study area is marginal habitat for them and the species does not have IUCN status as claimed.	R
Proteles cristatus	Aardwolf		LC	PG					**Excluded**. Predominantly plains-living. The species does not have IUCN status as claimed.	H
Procavia capensis	Rock Dassie		LC						**Excluded.** Common and widespread. Does not have IUCN status as claimed.	H
ARACHNIDS										
Blossia planicursor	Solifuge	RCN	CR		X				**Excluded**. Predominantly plains-living.	H
Blossia spp.	Solifuge	CN	EN						**Excluded**. Two species remain undescribed.	R
Caesetius sp.	Ant spider	RCN	CR				X		**Excluded**. Species remains undescribed.	R
Cyrioctea namibiensis	Ant spider	RCN	CR		X				**Excluded**. Predominantly plains-living.	R
Daesiella pluridens	Solifuge	RCN	CR		X				**Excluded**. Predominantly plains-living.	R
Heradida griffinae	Ant spider	CN	EN		X		X			R
Lawrencega longitarsis	Solifuge	CN	EN		X				**Excluded**. Predominantly plains-living.	H
Lawrencega solaris	Solifuge	CN	EN		X				**Excluded**. Predominantly plains-living.	H

Species	Common name	End.	IUCN	Legal	P	H	W	A	Notes	Source
Lawrencega sp.	Solifuge	CN	EN			X			**Excluded**. Species remains undescribed.	R
Moggridgea eremicola	Tingle trapdoor spider	RCN	CR			X			Known from a single specimen from Lower Dome Gorge only. Has never been recaptured despite intensive efforts. The proposed Z20 pit is 7.5 km from the Lower Dome locality.	R
Namundra griffinae	Prodidomid spider	CN	EN			X				R
Seothyra annettae	Velvet Spider	RCN	CR		X				**Excluded**. Predominantly plains-living.	R
INSECTS										
Acmaeodera liessnerea	Jewel beetle	CN	VU		X	X	X			H
Ctenolepisma occidentalis	Fishmoth	RCN	CR		X				**Excluded**. Predominantly plains-living.	H, R
Ctenolepisma sp.	Silverfish	CN	EN		X		X		**Excluded**. Species remains undescribed.	R
Hedybius irishi	Flower beetle	RCN	CR				X			R
Heterotropus apertus	Bee fly	RCN	CR		X				**Excluded**. Predominantly plains-living.	R
Iselma deserticola	Blister beetle	CN	EN		X	X				R
Julodis namibiensis	Jewel beetle	CN	EN		X				**Excluded**. Predominantly plains-living.	H
Metaphilhedonus swakopmundensis	Flower beetle	RCN	CR			X	X			H,R
Nothomorphoides irishi	Jewel beetle	RCN	CR		X		X			H, R
Pteraulacodes hessei	Bee fly	RCN	CR		X				**Excluded**. Predominantly plains-living.	H,R
Zophosis (Z.) cerea	Toktokkie	CN	EN		X				**Excluded**. Predominantly plains-living.	H
Zophosis (Z.) dorsata	Toktokkie	CN	VU		X				**Excluded**. Predominantly plains-living.	H