ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE HUSAB MINE LINEAR INFRASTRUCTURE

Prepared For

Swakop Uranium (Pty) Ltd

METAGO PROJECT NUMBER: S039-01

REPORT NO.: 1

April 2011

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE HUSAB MINE LINEAR INFRASTRUCTURE

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ACRONYMS AND ABBREVIATIONS

Included below is a list of acronyms and abbreviations relevant to this report.

Acronyms	Description
a	Annum
AEB	AEB Atomic Energy Board of Namibia
amsl	above mean sea level
ATC	The Arandis Town Council
dBA	Decibels
BID	Background Information Document
bn	Billion
°C	Degree centigrade
CO	Carbon monoxide
CO_2	Carbon dioxide
CoM	Chamber of Mines
CTAN	Coastal Tourism Association of Namibia
dB	Decibels
DEA	Directorate of Environmental Affairs
DEM	Digital Elevation Model
DRFN	Desert Research Foundation of Namibia
DNP	Dorob National Park
DWAF	Department or Water Affairs and Forestry
EAP	Environmental assessment practitioner
EC	European Community
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
EPL	Exclusive Prospecting Licence
ERC	Erongo Regional Council
ESIA	Environmental and Social Impact Assessment
EVA	Economic value added
FENATA	Federation of Namibia Tourist Associations
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GIS	Geographical Information Systems
GRN	Government of the Republic of Namibia
GSN	Geological Survey of Namibia
GWe	Giga Watt of energy
h	Hour
NO_2	Nitrogen dioxide
HPA	Health Protection Agency
IAP	Interested and Affected Party
IBA	Important Bird Areas
ICMM	International Council on Mining and Metals
ICRP	International Commission on Radiological Protection
IDP	Integrated Development Plan

Acronyms	Description
IEM	Integrated Environmental Management
IFC	International Finance Corporation
IDC	Ida Dome Compartment of the Swakop River
IOE	index of erosion
K	Potassium
k	Kilo (a thousand)
K factor	Soil erodibility factor
kg	Kilogram
km^2	square kilometres
kV	Kilo Volt
ℓ	Litre
LA	Local Authorities
lb	pound (of weight)
LHU	Langer Heinrich Uranium Mine
LLRD	Long lived Radioactive Dust
LM	Local Municipality
LOM	Life of Mine
LSA	Later stone age
M	Mega, million, x 10^6
m	Milli one thousandth x 10^{-3}
m	Metre
M	Million
Mg	Magnesium
m/s	metres per second
mamsl	Metres above mean sea level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
masl	metres above sea level
MAWF	Ministry Water Affairs and Forestry
MAWRD	Ministry of Agriculture Water and Rural Development (now MAWF)
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
mg	Milligram
mg/ℓ	milligram/litre
MHSS	Ministry of Health and Social Services
mill	Millennium
ML	Mining Licence
MLR	Ministry of Lands and Resettlement
mm	Millimetres
mm/a	millimetres per annum
Mm^3	million cubic metres
Mm^3/a	million cubic metres per annum
MME	Ministry of Mines and Energy
MMSD	Mining Minerals and Sustainable Development Project
MoHSS	Ministry of Health and Social Services
MPC	Mineral Processing Complex

Acronyms	Description
MRA	Marine Resources Act
MRLGH	Ministry of Regional and Local Government and Housing
MTI	Ministry of Trade and Industry
MV	Medium Voltage
MW	Mega Watt
MWTC	Ministry of Works Transport and Communications
N$	Namibian Dollar
NamPower	Namibia Power Corporation
NamWater	Namibia Water Corporation Ltd
NGO	Non Governmental Organisation
NHA	National Heritage Act
NMCF	Namibian Mine Closure Framework
NMS	Namibia Meteorological Service
NNF	Namibian Nature Foundation
NNNP	Namib Naukluft National Park
O/C	Outcrop
P	Phosphorus
PAYE	Pay-As-You-Earn
Pers. comm.	Personal communication
PM10	Particulate matter less than 10 microns in size
PPP	Public Participation Process
ROD	Record of Decision
RSA	Republic of South Africa
RTE	Rare, threatened or endangered
RUL	Rössing Uranium Mine
SABS	South African Bureau of Standards
SADC	Southern African Development Community
SAIEA	Southern African Institute for Environmental Assessment
SEA	Strategic Environmental Assessment
SEMP	Strategic Environmental Management Plan
SIA	Social Impact Assessment
SO_2	Sulphur dioxide
STC	Swakopmund Town Council
TDS	Total Dissolved Solids
TOR	Terms of Reference
TSP	Total suspended particulates
TWQG	Target Water Quality Guidelines
U	chemical symbol for uranium
USC	Uranium Stewardship Council
W	Watt
WCRA	West Coast Recreational Area
WHO	World Health Organization
WTY	Waste Transition Yard
Zn	Chemical symbol for zinc

EXECUTIVE SUMMARY

General introduction

Swakop Uranium (Pty) Ltd (Swakop Uranium) is a wholly-owned subsidiary of Extract Resources Ltd (Extract), which is an Australian-based uranium exploration and development company. Swakop Uranium has received an environmental clearance certificate to develop the Husab Mine with a design capacity to produce approximately 8000 tonnes of uranium oxide per annum at 70% contained uranium which amounts to approximately 15 million pounds per annum.

Given the practicalities of planning and coordination with parastatal organisations such as NamPower and NamWater, the off site linear infrastructure components (although considered as part of the mining project during the scoping phase) were not assessed in the environmental impact assessment (EIA) for the Husab Mine (Metago 2010).

The proposed linear infrastructure is the subject of this EIA report. The regional and local settings of the proposed linear infrastructure are shown in figures 1 and 2 respectively.

Linear infrastructure environmental impact assessment process

Prior to the construction and operation of the linear infrastructure, authorisation is required on the basis of an EIA report. On request of Ministry of Environment and Tourism (MET): Directorate of Environmental Affairs, the draft EIA regulations (2010) have been used as a guideline for this EIA process and report. To supplement this, reference has also been made to the Namibian environmental assessment policy (1995). In accordance with this legal framework the EIA approach included the following:

- The scoping process (run as part of the scoping process for the Husab Mine EIA) was conducted to identify relevant environmental and social issues and to define the terms of reference for the required specialist studies and the EIA.
- Specialist studies were commissioned in accordance with the relevant terms of reference. The specialists were selected on the basis of their expertise and knowledge of the project area.
- The Linear Infrastructure EIA report was compiled on the basis of the findings of the specialist studies
- The Husab Mine EMP document was updated to include the mitigation objectives and actions that were described in the Linear Infrastructure EIA report.

Figure 1 – regional setting

Figure 2 – local setting

A project specific public participation process was conducted as part of the Husab Mine EIA (Metago 2010). As part of this process the regulatory authorities and interested and affected parties (IAPs) were given the opportunity to attend information sharing meetings, focussed workshops, submit questions and comments to the project team, and review the background information document, scoping report and EIA reports for the Husab Mine and Linear Infrastructure. All questions and comments (relevant to the linear infrastructure) that were raised by the authorities and IAPs, have been included and addressed in the Linear Infrastructure EIA report.

Linear infrastructure environmental impact assessment findings

The impact assessment presents the potential for positive economic and negative environmental and social impacts that can all be mitigated to acceptable levels when considered incrementally (in isolation of other developments). As with the EIA for the Husab Mine (Metago 2010), there are significant cumulative impacts (impacts from the linear infrastructure, the Husab Mine and other developments). The most significant potential cumulative impacts are:

- impacts on biodiversity from physical destruction, temporary water abstraction and general disturbance;
- air pollution impacts from particulate matter;
- visual impacts;
- noise impacts;
- traffic impacts; and
- impacts on the tourism and recreation sectors.

It must be noted that inward migration related impacts on the already stressed regional infrastructure and services (housing, education, health care, sanitation, power and water supply) remains a critical cumulative issue, but the linear infrastructure is not expected to materially add to this impact and it has already been identified and assessed as part of the Husab Mine EIA (Metago 2010).

In the case of people related impacts, the assessment focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

Swakop Uranium will be required to follow a two-pronged approach to managing impacts. The first ‘prong’ is the management of its incremental (Husab Mine and linear infrastructure) impacts. The second ‘prong’ is working collectively with other mines, the Uranium Institute of the Chamber of Mines, the SEMP office, non-government organisations, industry and government to tackle the regional strategic issues that have been identified and detailed in this EIA and in the Central Namib Uranium Rush Strategic Environmental Assessment.

Discussion of the potential impacts is provided below in no particular order of significance. A tabulated summary of the cumulative impacts is presented in Table 1 thereafter.

Topography – potential injury to people, birds and animals form hazardous excavations and infrastructure

Hazardous excavations and infrastructure include all structures into or off which third parties, birds and animals can collide or fall and be harmed. It also includes all electrical structures which can result in electrocution. If unmitigated, the potential negative impact is high. This potential impact can be mitigated to an acceptable level through the following measures:

- access control through the placement of barriers and warning signs;
- avoidance of collisions and electrocutions through the application of appropriate measures on power lines and related structures; and
- education and training of workers and the public.

Soil – potential loss of soil resources from pollution and/or physical disturbance

The physical loss of soils and/or the loss of soil functionality are important issues because as an ecological driver, soil is the medium in which most vegetation grows and in which a significant range of vertebrates and invertebrates exist. Soil is also a key requirement for site rehabilitation and restoration.

In the unmitigated scenario, there are a number of activities that will disturb and potentially damage the soils through physical disturbance and/or pollution. Key mitigation measures include the following:

- limiting the disturbance footprint of the project;
- stripping, storing and maintaining soils in accordance with the soil management plan;
- reusing stored soil during the rehabilitation and restoration process;
- pollution prevention through infrastructure design, appropriate transportation of materials, and education and training of workers;
- training in the use of hazardous materials and the implementation of procedures to enable fast reaction to contain and remediate spills; and
- post rehabilitation auditing to determine the success of the rehabilitation.

Notwithstanding the above, uncertainty remains about the possibility of reinstating and/or creating two specific soil features. These include the surface crust that has been identified on the plains and the less permeable calcrete layer that is situated below the topsoil horizon. Both of these features are considered to be important from a moisture retention perspective and the surface crust has the added role of erosion prevention. On-going pilot tests will be conducted by Swakop Uranium as part of the Husab Mine EMP commitments to determine the most effective means of creating similar features for the restoration and rehabilitation process.

Biodiversity – potential loss of biodiversity from physical destruction, reduction in sub surface water resources and/or various other pollution and physical disturbance factors

In the broadest sense, biodiversity (which includes vegetation, vertebrates and invertebrates) provides value for ecosystem functionality, aesthetic, spiritual, cultural, and recreational reasons. The known ecosystem related value includes: soil formation and fertility maintenance, primary production through photosynthesis as the supportive foundation for all life, provision of food and fuel, provision of shelter and building materials, regulation of water flows and water quality, regulation and purification of atmospheric gases, moderation of climate and weather, control of pests and diseases, and maintenance of genetic resources.

The linear infrastructure will traverse a range of biodiversity sensitivities. Sections of the permanent road and power line will cross the sensitive Pink Gramadoelas, all northern linear infrastructure will cross the sensitive Khan River, sections of the temporary southern pipeline will cross the sensitive Hard Undulating Plains and Pink Gramadoelas, all southern infrastructure will cross the sensitive Swakop River, the temporary access road and the temporary southern pipeline will cross the sensitive Welwitschia Plain and sections of the permanent pipeline will skirt the western extent of the sensitive Welwitschia Plain.

The relatively thin disturbance width but long disturbance length associated with the linear infrastructure means that that there is some concern about the destruction of specific habitats and species, but there is more concern about the fragmentation of habitats, and the obstructions and disturbances to the movement of key species, energy and water. In the mitigated scenario, the following hierarchy and related mitigation measures apply:

- reduce potential fragmentation by burying infrastructure where possible and/or by providing under and over passes where surface infrastructure will present a barrier;
- avoid highly sensitive and irreplaceable biodiversity areas and species;
- where this is not possible then implement measures to enable effective restoration and rehabilitation. These measures include:
    - delineation of the areas prior to disturbance,
    - relocation of species prior to disturbance,
    - obtaining permits for the destruction or removal of protected species, and
    - rehabilitation of the disturbed areas to restore biodiversity functionality; and
- if this is not possible then investigate appropriate biodiversity offsets.

In the Swakop River a key ecological driver is sub surface water. The possible temporary abstraction of water from the Ida Dome Compartment presents the possibility of impacts on riparian vegetation and associated ecological functions and processes.

Available research indicates that a sustained drop in sub surface water levels of more than 10cm per month may cause trees to struggle for survival. The death of riparian trees will have knock on effects for the ecological functions and processes associated with these trees particularly in regard to food sources and shelter for invertebrates and vertebrates. If water is to be temporarily abstracted from the Ida Dome Compartment of the Swakop River mitigation measures will focus on:

- controlling abstraction levels so that sub surface water levels do not drop more than 10cm per month;
- monthly monitoring of riparian tree health to ensure that the trees do not struggle to survive; and
- measures to adjust or stop abstraction rates or to water the affected trees where required.

No impacts on the supply of river water to downstream human water users are predicted.

Significant biodiversity and related linkages could also be lost (in the unmitigated scenario) through: the disturbing aspects of pollution in the broadest sense, lights, water reservoirs, noise, vibration, poaching and vehicle movement. In the mitigated scenario, the focus will be on training workers and enforcing practical solutions to address each risk. Key mitigation measures include:

- minimising the use of light and use yellow lights as a preference;
- keeping all construction camp occupants within the camps after working hours;
- supplying camps with cooking equipment so that fire wood is not required;
- zero tolerance of killing or the collection of biodiversity;
- vehicle speed control measures;
- enclosed reservoirs;
- prevention of pollution and littering; and
- maintenance of noisy equipment.

Water –pollution of ground and surface water

Pollution from linear infrastructure construction activities or from operational accidents and spills can be carried by surface and near surface water flow in either the Khan or Swakop Rivers. If the concentration of contaminated water exceeds the relevant water guidelines there may be impacts on third party users (impacts on fauna and flora have been discussed above).

In the mitigated scenario, the focus will be on containing pollution at source, remediation of spills and monitoring water quality in the Khana and Swakop Rivers. If monitoring indicates the potential for unacceptable pollution, additional pollution prevention measures will be implemented.

Air pollution

The quality component of concern is particulate matter less than 10 micron in size (PM10). Essentially, the incremental impact associated with the linear infrastructure and activities is localised and of low significance. However, the existing baseline PM10 concentrations for the region already exceed the evaluation criteria used, therefore cumulative impacts have a high significance at the closest third party receptor points (Arandis, Rössing Uranium Mine, Khan Mine, Khan River Valley, and the Welwitschia Plain related tourist sites) in both the unmitigated and mitigated scenario.

Key dust mitigation measures include the following:

- implementing tourism offsets (discussed in more detail in the tourism impact section below);
- dust suppression on roads through chemical binding agents and/or water sprays;
- dust control through reduction in travelling speeds;
- dust control at road building crushing and screening areas by water sprays;
- dust control at excavation, scraping, and material handling points by water spays; and
- monitoring of PM10 and fall out dust.

Noise pollution

The linear infrastructure and associated activities may negatively impact on tourist and recreation activities in the following areas in certain project phases: wilderness tours in the affected section of the Khan River and tributary valleys; camping activities in the affected section of the Khan River and tributary valleys; and camping activities at the Swakop River and Welwitschia camp sites.

Key noise mitigation measures include the following:

- implementing tourism offsets (discussed in more detail in the tourism impact section below);
- construction and transportation activities primarily limited to the daylight hours between sunrise and sunset; and
- recording and responding to noise related complaints.

Blasting

Limited blasting may be required for the establishment of foundations or widening of valleys to make way for the permanent road, power line and some borrow pits. Blasting is associated with the following pathways that can injure third parties and/or damage structures: fly rock, vibration and air blast. Key measures include the following:

- fly rock will be contained within 500m of each blast site;
- ground vibration at the closest third party structures will be less than 12mm/s peak particle velocity; and
- air blast at the closest third party structures will be less than 130dB.

Archaeology – potential damage to archaeology sites

The most important archaeological resources are the remains of the Welwitschia siding of the early colonial narrow gauge railway, the remains of the Khan Mine (and the associated plan to include this into a future heritage park) and the sites around the Husab Spring. The other identified sites are isolated finds of low archaeological significance. Despite their low individual significance, the sites form part of an archaeological landscape that will be significantly impacted by the linear infrastructure. This applies especially to the narrow gauge railway line and related earthworks.

Key mitigation measures include the following:

- avoid sites and landscapes of archaeological importance;
- reconstruction of the Welwitschia railway station if agreed to by the Directorate of Parks and Wildlife;
- education of workers; and
- where any archaeological sites will be disturbed and/or destroyed they will be surveyed and this information will be used to apply for the necessary destruction permits.

Visual impact

Most of the area in which the proposed linear infrastructure is situated is considered to have significant value as a visual resource. Determining features include: the landscape character, the sense of place, the aesthetic value, the sensitivity of the visual resource and sensitive views. In the latter case, the most sensitive views are those from the Namib Naukluft National Park (NNNP), Dorob National Park (DNP) and Khan River valley.

The potential visual impact on the sensitive views is significant especially within the Khan River valley and along the Welwitschia drive (from the C28 to the big tourist Welwitschia). Key related mitigation measures include the following:

- implement tourism offsets (discussed in more detail in the tourism impact section below);
- limit land disturbances and implement land rehabilitation measures when temporary and permanent linear infrastructure is no longer in use;
- bury the permanent pipeline where possible;
- night lights will be used sparingly to illuminate specific areas only. The use of high pole flood lights will be avoided; and
- prevent littering and dust plumes.

Socio-economic - traffic impacts

Until the permanent access road is commissioned, all traffic will use the C28 road and the gravel Welwitschia drive road that turns off the C28 and routes to the Husab Mine site via the Welwitschia plain. Once the permanent access road is in use, all traffic will use the B2 and the permanent mine access road that crosses the Khan River. Two road intersections have been identified as important focus points: the proposed intersection of the permanent access road with the B2 and the existing intersection between the C28 and the Welwitschia drive. By adding Husab Mine traffic to current traffic volumes there is potential for safety and maintenance impacts on both access routes.

Key related mitigation measures include the following:

- construction of formal intersections on both the B2 and C28;
- implementation of appropriate speed limits, road signs and siting distances at these intersections;
- coordination with the roads authority on required maintenance and upgrades;
- routing truck traffic off the B2 and onto the D1984 salt road when travelling between site and Walvis Bay;
- provision of continued assistance to Directorate of Parks and Wildlife for the maintenance of the Welwitschia drive from the C28 to the Husab Mine site; and
- promotion of basic road safety behaviour for all employees and contractors.

Socio-economic- impact on tourism

In the context of Swakop Uranium related impacts, the linear infrastructure and Husab Mine have the potential to expose various tourism and recreation areas to high severity noise, dust, visual and archaeological landscape disturbances. The areas in question are: the Welwitschia campsite, the Swakop River campsites, the Khan Mine, and the Khan River and tributary valleys to the northwest of the DNP.

Key related mitigation measures are as follows:

- establishment of specific tourism offsets that will provide the tourism and recreation sectors with the same or better facilities currently associated with the Welwitschia and Swakop River campsites within the NNNP;
- subject to Directorate of Parks and Wildlife agreement, assist with the upgrading of the facilities at the big tourism Welwitschia and continued assistance with the maintenance of the gravel Welwitschia drive from the C28 to the big tourist Welwitschia;
- subject to Directorate of Parks and Wildlife agreement, efforts will be made to preserve a similar length of the Khan River to that disturbed by the road and power line, to maintain the Khan River wilderness and camping type experience; and
- continued engagement with the relevant authorities and entities in the tourism, conservation and recreation sector to ensure that potential negative impacts from mines are continually managed in a way that related impacts on tourism are acceptable.

In the context of the cumulative impacts (from the linear infrastructure, Husab Mine and other mines in the study area), the severity of the impacts will increase. This is particularly relevant if the additional mine developments directly impact the Swakop River below the Khan confluence, the Moon Valley landscape and the drive along the Swakop River from the Swakop River campsites to the Moon Valley landscape. Moreover, the situation could be worsened if, by the development of perceived dangerous uranium mines in close proximity to these tourist attractions, the tourism brand for the Erongo region is tarnished in the eyes of the foreign tourism market. In this regard, it must be noted that Swakopmund and Walvis Bay are currently regarded as gateways to tourism in parts of Namibia because of the unique combination of the excellent accommodation and hospitality in the towns, together with the world renowned tourist attractions of the NNNP and DNP which are in such close proximity to the towns.

The recommended mitigation measures are focussed on state intervention and the establishment of a state fund to financially assist the affected tour operators in redeploying their businesses elsewhere in the DNP and NNNP. This financial assistance could (amongst other mechanisms) be in the form of loans, tax reductions and/or grants. In addition to financial assistance, institutional support will be required to advise and assist with strategies and tactics for the redeployment of the affected part of the tourism industry.

Table 1: Summary of potential cumulative impacts associated with the linear infrastructure

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)	
		Unmitigated	Mitigated
Topography	Injury to people, birds and animals from hazardous excavations and infrastructure.	**H**	**M**
Soils and land capability	Loss of soil resources from pollution	**H**	**L**
	Loss of soil resources from physical disturbance	**H**	**M**
Biodiversity	Physical destruction of biodiversity from clearing land and placing infrastructure	**H**	**M-H**
	Loss of biodiversity from the loss of subsurface water resources in the Swakop River	**H**	**L**
	General disturbance of biodiversity	**H**	**M-H**
Water	Pollution of surface and groundwater	**M**	**L**
Air quality	Air pollution (PM10)	**H**	**H**
Noise	Noise pollution.	**H**	**M**
Blasting	Blast injury to third parties or damage to structures	**M**	**M-L**
Archaeology	Damage to archaeological sites and landscapes	**H**	**M**
Visual impacts	Visual impact from sensitive views within the NNNP	**H**	**M**
Socio-economic impacts	Traffic	**H**	**M**
	Tourism	**H**	**M-L**

Project time table

Subject to authorisation, the linear infrastructure construction phase will commence between quarter three 2011 and early 2012 and continue to end 2013 or early 2014, depending upon when the mining licence and project funding for the Husab Mine is secured. Temporary infrastructure will be decommissioned and removed once the permanent infrastructure is commissioned. The permanent linear infrastructure will remain operational for at least as long as the Husab Mine which is until at least 2028.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE HUSAB MINE LINEAR INFRASTRUCTURE

1 INTRODUCTION

1.1 INTRODUCTION TO THE PROPOSED PROJECT

Swakop Uranium (Pty) Ltd (Swakop Uranium) is a wholly-owned subsidiary of Extract Resources Ltd (Extract), which is an Australian-based uranium exploration and development company. Swakop Uranium has received an environmental clearance certificate to develop the Husab Mine with a design capacity to produce approximately 8000 tonnes of uranium oxide per annum at 70% contained uranium which amounts to approximately 15 million pounds per annum.

Given the practicalities of planning and coordination with parastatal organisations such as NamPower and NamWater, the off site linear infrastructure components (although considered as part of the mining project during the scoping phase) were not assessed in the environmental impact assessment (EIA) for the Husab Mine (Metago 2010).

The proposed linear infrastructure is the subject of this EIA report. The regional and local settings of the proposed linear infrastructure are shown in Figures 1-1 and 1-2 respectively.

1.2 INTRODUCTION TO THE ENVIRONMENTAL IMPACT ASSESSMENT

Prior to the commencement of the linear infrastructure components, environmental clearance is required on the basis of an approved EIA report. The content of the EIA report is informed by the requirements of the Namibian Environmental Assessment Policy (1995). As an added guide, the most recent version of the draft EIA regulations (2010) have been used in parallel with the Policy requirements to inform the approach to and structure of this EIA. Additional information on relevant environmental laws and policies is provided in Chapter 2.

The required components of the EIA report are included in Table 1-1 below:

TABLE 1-1: REQUIREMENTS FOR EIA REPORTS

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
Details of the environmental assessment practitioner (EAP) that compiled the report and the expertise of the EAP to carry out the EIA, including CVs.	List of compilers.	Section 1.2.2 and Appendix A.
Detailed description of the proposed activity.	Project proposal.	Section 6.
Description of the environment that may be affected by the activity.	The affected environment.	Section 4.

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
Details of public participation process: List of persons, organisations and organs of state that were registered as interested and affected parties (IAPs). A summary of comments received from and a summary of issues raised by IAPs, the date of receipt of these comments and the response of the environmental assessment practitioner (EAP) to the comments. Copies of any representations, objections and comments received from IAPs.		Section 3, Appendix B, Appendix C, Appendix D.
Description of need and desirability of proposed activity and identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity.		Executive summary, Section 5.3.
Indication of methodology used in determining the significance of potential impacts.		Section 7.
A description and comparative assessment of all alternatives identified during the environmental impact assessment process.		Section 5.
A description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures.		Section 7.
An assessment of each identified potentially significant impact, including - • cumulative impacts; • the nature of the impact; • the extent and duration of the impact; • the probability of the impact occurring; • the degree to which the impact can be reversed; • the degree to which the impact may cause irreplaceable loss of resources; and • the degree to which the impact can be mitigated;	The assessment and evaluation.	Section 7.
A description of any assumptions, uncertainties and gaps in knowledge;	Assumptions and limitations. Incomplete or unavailable	Section 8

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
	information.	
An opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation.	Conclusions and recommendations.	Section 9.
An environmental impact statement which contains: • a summary of the key findings of the environmental impact assessment; and • a comparative assessment of the positive and negative implications of the proposed activity and identified alternatives; and • any specific information that may be required in terms of the Act.		Section 9 Executive summary.
	Management plan Monitoring programme Audit proposal.	Appendix O.
	Executive summary Contents page Introduction.	See above.
	Terms of reference.	Appendix B.
	Approach to study.	Section 1.2.1
	Administrative, legal and Policy requirements.	Section 2
	Environmental contract.	To be issued by MET.
	Definitions of technical terms. Acknowledgements.	See above.
	Appendices.	See end of report.

FIGURE 1-1: REGIONAL SETTING

FIGURE 1-2: LOCAL SETTING

1.2.1 EIA APPROACH AND PROCESS

A summary of the approach and key steps in the EIA process and corresponding activities are outlined in Table 1-2.

TABLE 1-2: EIA PROCESS

Objectives	Corresponding activities
Project initiation/screening phase done as part of Husab Mine EIA (June – August 2009)	
• Notify the decision making authority of the proposed project. • Initiate the environmental impact assessment process.	• Project initiation meetings and site visit with the Swakop Uranium technical team to discuss the project requirements, identify environmental and social issues and to determine legal requirements. • Meeting with the Ministry of Environment and Tourism (MET): Directorate of Environmental Affairs (DEA). • Written notification submitted to MET (27 July 2009).
Scoping phase done as part of Husab Mine EIA (August – February 2009)	
• Identify interested and/or affected parties (IAPs) and involve them in the scoping process through information sharing. • Identify potential environmental issues associated with the proposed project. • Consider alternatives. • Identify any fatal flaws. • Determine the terms of reference for additional assessment work.	• Notified government authorities and IAPs of the project and EIA process (telephone calls, e-mails, faxes, distribution of background information documents, newspaper advertisements and site notices). • Scoping meetings with authorities, and IAPs (11-13 August 2009). • Confirmation that there were no identified fatal flaws. • Compilation of scoping report (August 2009). • Distribute scoping report to relevant authorities and IAPs for review (December 2009). • Forward finalised scoping report and IAPs comments to MET for review (February 2010). • Confirmation from Mr Freddy Sikabonga of MET to proceed on the basis of the scoping report.
EIA/EMP phase (October 2010 to June 2011)	
• Provide a detailed description of the potentially affected environment. • Assessment of potential environmental impacts. • Design requirements and management and mitigation measures. • Receive feedback on EIA and EMP.	• Investigations by technical project team and appointed specialists. • Compilation of EIA and EMP reports. • Distribute EIA and EMP reports to authorities and IAPs for review (April 2011). • Forward EIA and EMP reports and IAPs comments to MET for review (May/June 2011). • Receive and circulate MET decision

1.2.2 EIA TEAM

Metago Environmental Engineers (Pty) Ltd (Metago) is the independent firm of consultants that has been appointed by Swakop Uranium to undertake the environmental impact assessment and related processes. Brandon Stobart (the project manager) has approximately 14 years of relevant experience and is certified with the Certification Board for Environmental Assessment Practitioners of South Africa (EAPSA) as an Environmental Assessment Practitioner (EAP). Alex Pheiffer (the Metago reviewer) has approximately 10 years of experience and is registered as a professional natural scientist in South Africa. The relevant curriculum vitae documentation is attached in Appendix A.

The environmental project team is outlined in Table 1-3.

TABLE 1-3: ENVIRONMENTAL PROJECT TEAM

Team	Name	Designation	Tasks and roles	Company
EIA project leader	Michele Kilbourn Louw	Swakop Uranium environmental manager	Responsible for the interface between Swakop Uranium and the environmental team, and for ensuring implementation of the EIA outcomes	Swakop Uranium
EIA Project management	Brandon Stobart	Project manager	Management of the process, team members and other stakeholders. Report compilation	Metago
	Natasha Daly and Caitlin Pringle	Project assistant		
	Alex Pheiffer	Project review	Report and process review.	
Specialist investigations	Hanlie Liebenberg-Enslin	Air quality	Air quality impact assessment	Airshed Planning Professionals
	Ian Jones	Soils and land capability specialist	Soils and land capability assessment	Earth Science Solutions
	Graham Young	Visual specialist	Visual impact assessment	Newtown Landscape Architects
	John Kinahan	Archaeologist	Heritage resource assessment	Quaternary Research Services
	Gerrie Muller	Socio-economic specialist	Socio-economic impact assessment	Metago4Good
	Theo Wassenaar	Biodiversity	Project leader/ecologist	African Wilderness Restoration
	Coleen Mannheimer		Vegetation assessment	Independent consultant
	Mike and Ann Scott		Bird assessment	Independent consultants
	Arnold Bittner	Water scientist	Groundwater assessment	BIWAC
	Ben van Zyl	Acoustical Engineer	Noise Study	Acusolv
	Gordon MacPhail	Engineer	Engineering mitigations and Hydrology assessment	Metago
	Leon Roets	Traffic specialist	Traffic impact assessment	Siyazi

1.2.3 CONTACT DETAILS FOR RESPONSIBLE SWAKOP URANIUM PARTIES

The Swakop Uranium contact details for the project are included in Table 1-4.

TABLE 1-4: SWAKOP URANIUM CONTACT DETAILS

Title	**Environmental manager**	**CEO**
Name	Ms Michele Kilbourn Louw	Mr Norman Green
Postal address	PO Box 81162 Olympia Windhoek Namibia	PO Box 81162 Olympia Windhoek Namibia
Telephone number	+264 61 300 220	+264 61 300 220
Facsimile number	+264 61 300 221	+264 61 300 221

2 ENVIRONMENTAL LAWS AND POLICIES

The Strategic Environmental Assessment for the Central Namib Uranium Rush (SEA) (SAIEA, 2010) provides a comprehensive overview of relevant Namibian laws and policies. This section draws information from the SEA and other legal sources in Namibia.

The Republic of Namibia has five tiers of law and a number of policies relevant to uranium mining and these include:

- The Constitution.
- Statutory law.
- Common law.
- Customary law.
- International law.

Key policies currently in force include:

- Namibia's Environmental Assessment (EIA) Policy for Sustainable Development and Environmental Conservation (1995).
- The Minerals Policy of Namibia (2002).

As the main source of legislation, the Namibian constitution makes provision for the creation and enforcement of applicable legislation. In this context and in accordance with its constitution, Namibia has passed numerous laws intended to protect the natural environment and to mitigate against adverse environmental impacts.

However, current Namibian legislation is a mixture of pre and post independence laws, some of which has yet to be repealed with modern, updated legislation. This has led to the development of gaps in the enforceability of parts of the legislation. These gaps stem from parts of current legislation not being geared to the needs of modern development in Namibia.

Namibia's policies provide the framework to the applicable legislation. Whilst policies do not often carry the same legal recognition as official statutes, policies can be and are used in providing support to legal interpretation when deciding cases.

2.1 APPLICABLE LAWS AND POLICIES

In the context of uranium mining and related infrastructure in Namibia, there are several laws and policies currently applicable. Each of these is discussed in detail below.

2.1.1 NAMIBIA'S ENVIRONMENTAL IMPACT ASSESSMENT (EIA) POLICY OF 1995

This policy promotes accountability and informed decision making through the requirement of EIAs for listed programmes and projects.

2.1.2 ENVIRONMENTAL MANAGEMENT ACT

To enforce the policy on EIAs, the Environmental Management Act (EMA) (7 of 2007) has been compiled, but is yet to practically come into force because the required regulations are still in draft form. The EMA is expected to improve the management of impact assessments in Namibia through the establishment of an environmental commissioner, who will approve environmental plans and through requiring government agencies to work as a cohesive decision-making agents to ensure long term sustainable resource use.

2.1.3 THE ENVIRONMENTAL INVESTMENT FUND OF NAMIBIA

The Environmental Investment Fund of Namibia Act (13 of 2001) provides for the creation of a fund that will be used to support sustainable environmental and natural resource management. The source of the funds will include penalties/fines paid and/or property forfeited in terms of non-compliance and/or crimes as set out in EMA.

2.1.4 THE MINERALS ACT

The Minerals Act (33 of 1992) is another tool which is used to ensure compliance to the EIA policy by requiring that adequate environmental protection is guaranteed on projects prior to issuing a mining or prospecting permit.

2.1.5 THE WATER ACT

The Water Act (54 of 1956) regulates the abstraction of groundwater for mining purposes. This Act is also an example of the older legislation which does not meet the needs of Namibia's modern development patterns. In recognition of this, the Water Resources Management Act (24 of 2004) has been drafted and published. It is still to come into force. This Act is more relevant to addressing Namibia's geohydrological and climatic contexts.

2.1.6 THE NAMIBIA WATER CORPORATION

The Namibia Water Corporation Act (12 of 1997) charges the corporation to supply bulk water, based on need and availability. The corporation is also charged with the duty of conserving water resources in the long-term.

2.1.7 THE FOREST ACT

The Forest Act (12 of 2001) allows for the declaration of protected areas in terms of soils, water resources, plants and other elements of biodiversity. This includes the proclamation of protected species of plants and the conditions under which these plants can be disturbed, conserved, or cultivated.

2.1.8 PARKS AND WILDLIFE MANAGEMENT BILL

The Parks and Wildlife Management Bill (2009) aims to provide a legal framework for the sustainable use and maintenance of Namibia's ecosystems, biological diversity and ecological processes; and repeals the Nature Conservation Ordinance (4 of 1975). This Bill allows the Namibian Ministries of Environment and Tourism and Minerals and Energy, to allow mining to take place within parks subject to the relevant assessments and authorisations.

2.1.9 NATURE CONSERVATION ORDINANCE

The Nature Conservation Ordinance (4 of 1975) provides for the declaration of protected areas and protected species.

2.1.10 NAMIB NAUKLUFT NATIONAL PARK MANAGEMENT AND TOURISM DEVELOPMENT PLAN

The Development plan (2004) provides a set of policies and guiding principles. A key topic is restoration of degraded ecosystems. The plan also states that no development should result in a decline of more than 10% in the population of a species of special interest (eg. *Welwitschia mirabilis).*

2.1.11 NATIONAL HERITAGE

The National Heritage Act (27 of 2004) provides protection and conservation of places and objectives of significance, as all archaeological and paleontological objects belong to the state.

2.1.12 RADIATION PROTECTION

The Atomic Energy and Radiation Protection Act (5 of 2005) is concerned specifically with ionizing radiation, including hazardous substances from radiation sources or materials. The Act lists all activities requiring authorisation including possession of nuclear material, disposal, storage, and the operation or use of radiation sources.

Two draft regulations have been developed to assist in the implementation of the Act and both of these regulations are expected to be promulgated in the near future. These are:

- Regulation for protection against ionizing radiation and for the safety of radiation sources (MoHSS, 2008a); and

- Regulations for the safe and secure management of radioactive waste (MoHSS, 2008b).

2.1.13 STRATEGIC ENVIRONMENTAL ASSESSMENT FOR THE CENTRAL NAMIB URANIUM RUSH

The final SEA report was published in September 2010. The SEA provides a big picture overview and advice on how to avoid and/or limit cumulative negative impacts and to enhance opportunities in the uranium sector. The Strategic Environment Management Plan (SEMP) provides a practical framework in terms of which existing and proposed mines can plan, collaborate, monitor, and manage issues that can impact on society, the economy and the environment. Some of the key recommendations from the SEA and SEMP that relate to the proposed linear infrastructure developments are as follows:

- The Welwitschia plains and the Khan and Swakop Rivers are red flag biodiversity areas. The related recommendation is that the red flag areas should be avoided and actively conserved and in particular no new power lines, pipelines and roads linked to the Uranium Rush should be routed through red flag areas. Where this is not possible then offsets must be considered to offset the loss occurring in the area. If an offset is not possible then the no-go option should be considered. In the process of evaluating linear infrastructure routes alternatives must be considered.
- Linear infrastructure footprints (including roads, railways, power lines and pipelines) should be minimised by: following existing routes, by keeping infrastructure in corridors, by mines sharing infrastructure, by planning for future capacities and upgrading the capacity of existing infrastructure rather than creating new infrastructure in parallel, and by using the shortest feasible routes.
- Tour operators must be able to continue to utilise the Welwitschia plains, the associated big tourist Welwitschia, and the Khan and Swakop Rivers as a significant component of their tourist package offering.
- The public must be able to continue to use the Khan and Swakop Rivers as public recreational use areas.
- The main Husab Mine access road should be from the B2 in the north and not via the gravel road in the south. The associated recommendation is that once the access road from the B2 has been constructed then the gravel road to the south should be used exclusively for tourist purposes.
- Accidents on public roads and at key intersections should decline from current trends. Related to this is a recommendation that the B2 between Swakopmund and Arandis is strengthened to prevent wear and tear, widened to a four lane road and provided with more regular maintenance interventions. In addition, all roads carrying more than 250 vehicles per day must be strengthened, tarred and provided with proper intersections to the mines. The mine intersections need to have clear road signs and road markings.
- As a possible solution to preventing future congestion on roads, a cost-benefit analysis (including environmental costs and benefits) is required to determine whether railway links to mines are desirable and feasible. The objective is to transport 80% of all bulk goods by rail instead of road.

- All heavy vehicles should avoid the B2 coastal road between Swakopmund and Walvis Bay and should rather make use of the D1984 from Swakopmund to Walvis Bay. This road should be tarred and designated as an industrial vehicle route.
- In order to control dust emissions access roads to mines should be tarred.
- Groundwater can be abstracted for exploration and mine construction phases so long as the abstraction is based on a comprehensive hydrogeological investigation, including modelling of the affected compartment and downstream users. The modelling must show that downstream human users will not be negatively impacted and that there will be no unusual loss of wetland and riparian vegetation.
- All mines must use desalinated water for the operational phase.
- In order to conserve water and control dust from roads, dust emissions from un-surfaced roads should be controlled by chemical binding agents rather than water.
- New power lines should be positioned to follow existing infrastructure routes, avoid tourist routes and view points and to avoid bird flight paths. Bird flapper and bird diverters are required wherever lines cross rivers.
- New substations should be located to have minimal impact on tourist views and biodiversity while maintaining minimum technical requirements.
- All mining and related developments are subject to archaeological assessment and no unauthorised archaeological impacts should occur.

2.1.14 EQUATOR PRINCIPLES

Equator Principles were compiled by representatives of various banks who identified the need to create a banking industry framework to address environmental and social issues in project financing. These principles are used as a benchmark for the financial industry to evaluate and manage the social and environmental impacts of projects financed through institutions which are Equator Principle signatories. The Principles and related commentary are presented in Table 2-1.

TABLE 2-1: EQUATOR PRINCIPLES

High level description of Principles	Comments in relation to the proposed project.
Equator Principle 1: Review and Categorisation	
All projects are categorised based on the magnitude of their potential environmental and social risks and impacts. Category A projects have potential significant adverse social or environmental impacts that are diverse, irreversible, or unprecedented. Category B projects have limited adverse social or environmental impacts, which are site-specific and largely reversible, while Category C projects have minimal social or environmental impacts.	The proposed Husab Project is a category A project.
Equator Principle 2: Social and Environmental Assessment	
A social and environmental impact assessment (SEIA) process, relevant to the nature and scale of the project,	The EIA and EMP reports address most of the related issues as set out in Exhibit ii

High level description of Principles	Comments in relation to the proposed project.
must be undertaken to address the potential social environmental risks and impacts of the project, incorporating specialist studies where necessary. The assessment is also required to propose relevant mitigation and management measures.	of Principle 2. Some aspects not covered in the EIA and EMP report will be covered as part of on-going environmental, health, safety and social management.
Equator Principle 3: Applicable Social and Environmental Standards	
For projects located in non-OECD* countries, the assessment will refer to the IFC** Performance Standards (1-8) and the applicable industry-specific Environment, Health and Safety Guidelines. The performance standards address Social and Environmental Assessment and Management Systems, Labour and Working Conditions, Pollution Prevention and Abatement, Community Health, Safety and Security, Land Acquisition and Involuntary Resettlement, Biodiversity Conservation and Sustainable Natural Resource Management, Indigenous Peoples and Cultural Heritage. The relevant EHS Guidelines include: General EHS Guidelines (environment, occupational health and safety, community health and safety, decommissioning and closure) and EHS Guidelines for Mining. The SEIA must also address compliance with relevant host country laws, regulations, and permits that pertain to social and environmental matters.	While the EIA and EMP cover many of the applicable aspects of these performance standards, some will be covered through the proposed on site management systems and procedures.
Equator Principle 4: Action Plan and Management System	
An action plan, the level of which must be appropriate to the nature and scale of the project, which describes and prioritises the actions needed to implement the mitigation measures, corrective action and monitoring measures necessary to manage the social and environmental risks and impacts identified in the SEIA must be compiled. A social and environmental management system must be established and maintained to implement the action plan and corrective actions required to comply with host country laws and regulations as well as the requirements of the IFC performance standards and guidelines.	The management recommendations in the EIA and the plans in the EMP will be integrated into a formal on site management system.
Equator Principle 5: Consultation and Disclosure	
Projects which may have a significant adverse impact on local communities are required to undertake a consultation process. The consultation process must ensure the community's free, prior, and informed consultation, and it must be demonstrated that the project has adequately incorporated the community's concerns.	A comprehensive disclosure and consultation process was followed as part of the EIA process.
Equator Principle 6: Grievance Mechanism	
Consultation, disclosure and community engagement must continue through the construction and operational phases of a project. A grievance mechanism must be established as part of the management system in order to receive and facilitate the resolution of concerns and grievances raised by those affected by the project. The affected communities must be informed about the grievance mechanism process, which must address all concerns promptly and transparently, in a culturally appropriate manner, and must be accessible to all community members.	Objectives and actions in this regard have been included in the EIA and EMP reports.
Equator Principle 7: Independent Review	

High level description of Principles	Comments in relation to the proposed project.
Equator Principle compliance of the SEIA, action plan and public consultation process must be assessed by an independent social or environmental expert, who is not directly related to the borrower, on behalf of the lending institution	The EIA and EMP reports will be reviewed by independent experts.
Equator Principle 8: Covenants	
Covenants must be incorporated into the financing documentation whereby the borrower is committed to comply with relevant host country environmental legal requirements, comply with the action plan, to provide periodic reports as required by the financial institution to document compliance with the action plan and host country environmental and social laws, regulations and permits, and to decommission the facilities in accordance with an agreed decommissioning plan.	Swakop Uranium is committed to these covenants.
Equator Principle 9: Independent Monitoring and Reporting	
The project is required to appoint an independent environmental and/or social expert, or to retain qualified and experienced external experts to verify monitoring information which is reported to the financial institution.	Swakop Uranium will implement this as required.
Equator Principle 10	
Financial institutions which are signatories to the Equator Principles are required to report publically at least annually about their Equator Principle implementation processes and experience. The reports typically include, as a minimum, the number of transactions, project categorisation, and the implementation process.	This principle is relevant to financial institutions (banks) which are signatories to the Equator Principles.

**Organisation for Economic Co-operation and Development*

***International Finance Corporation*

3 PUBLIC CONSULTATION

The range of environmental issues to be considered in the EIA has been given specific context and focus through consultation with authorities and IAPs. Included below is a summary of the people consulted, the process that was followed, and the issues that have been identified.

3.1 AUTHORITIES AND INTERESTED AND AFFECTED PARTIES (IAPS)

The following authorities and IAPs are involved in the EIA process:

- **National authorities:**
    - Ministry of Environment and Tourism (MET);
        - Directorate of Environmental Affairs (DEA);
        - Directorate of Parks and Wildlife (DPW);
    - National Heritage Council of Namibia;
    - Ministry of Mines and Energy (MME);
    - Ministry of Agriculture, Water and Forestry (MAWF);
    - Ministry of Health and Social Services (MHSS);
    - Ministry of Labour and Social Welfare; and
    - Ministry of Works, Transport and Communications.
- **IAPs:**
    - farmers and landowners;
    - mines and industries;
    - non-government organisations and associations;
    - local authorities (Erongo Regional Council, Swakopmund and Walvis Bay Municipalities);
    - parastatals such as NamWater and NamPower; and
    - any other people/entities that choose to register as IAPs.

3.2 STEPS IN THE CONSULTATION PROCESS

Table 3-1 sets out the steps in the consultation process that has been conducted to date:

TABLE 3-1: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES

TASK	DESCRIPTION	DATE
Notification - regulatory authorities and IAPs		
Written notification to MET	A background information document (BID) regarding the project was sent to MET. A copy of the covering e-mail is attached in Appendix B.	27 July 2009
IAP identification	Stakeholder databases of other uranium projects in the area were used as a starting point to compile a database for the Project. The database was updated to include additional IAPs and has been updated during the EIA as required. A copy of the IAP database is attached in Appendix C.	July 2009

TASK	DESCRIPTION	DATE
Distribution of BID	BIDs were distributed via email to all IAPs on the project's public participation database and were available at the scoping meetings. A copy of the BID is attached in Appendix B. The purpose of the BID was to inform IAPs and authorities about the proposed project, the EIA process, possible environmental impacts and means of participating in the EIA process. Attached to the BID was a registration and response form, which provided IAPs with an opportunity to submit their names, contact details and comments on the project.	July – August 2009
Site notices	Site notices were placed at the Swakopmund Library, the Walvis Bay Library, Arandis Town Hall, the Swakopmund Information Centre, the Swakopmund Town Council, the Ida Camp office and the Ida Camp entrance on the C28. Copies of the site notices and photographs of the places where site notices were displayed are attached in Appendix B.	30 July 2009
Newspaper advertisements	Block advertisements were placed as follows: o The Namibian (31 July, 5 August and 10 August) o The Republikein (28 July) o The Allgemeine Zeitung (28 July and 10 August); and o The New Era (31 July, 4 August and 10 August). Copies of the advertisements are attached in Appendix B.	July - August 2009
Scoping stage meetings and submission of comments		
Scoping meetings	Four scoping meetings were arranged, one in Windhoek, Swakopmund, Arandis and Walvis Bay respectively. The same project information was presented at all meetings. Minutes of the meetings are attached in Appendix B.	11 – 13 August 2009
Review of scoping report		
IAPs and authorities (excluding MET) review of scoping report	Copies of the scoping report were made available for review at the following places: MET library and Windhoek National library, Walvis Bay public library, Swakopmund public library, Arandis public library and the Swakop Uranium town office in Swakopmund. Electronic copies of the report were made available on request (on a CD). Summaries of the scoping report were distributed to all authorities and IAPs that are registered on the project's public involvement database via post and/or e-mail. Authorities and IAPs were given 30 days (excluding the school holiday period) to review the scoping report and submit comments in writing to Metago. No written comments were received.	end November 2009 to end January 2010.
MET review of scoping report	A copy of the final scoping report, including authority and IAP review comments, was forwarded to MET on completion of the public review process. No substantial comments were received. Metago received verbal instruction with a follow up letter from Mr Sikabonga to proceed with the EIA on the basis of the scoping report terms of reference. These are included in Appendix B.	February 2010

TASK	DESCRIPTION	DATE
Review of EIA report		
IAPs and authorities (excluding MET) review of EIA report	Copies of the EIA report have been made available for review at the following places: MET library and Windhoek National library, Walvis Bay public library, Swakopmund public library, Arandis public library and the Swakop Uranium town office in Swakopmund. Electronic copies of the report were made available on request (on a CD). Summaries of the EIA report have been distributed to all authorities and IAPs that are registered on the project's public involvement database via post and/or e-mail. Authorities and IAPs have been given three weeks to review the EIA report and submit comments in writing to Metago.	12 May to 3 June 2011
MET review of EIA report	A copy of the final EIA report, including authority and IAP review comments, will be forwarded to MET on completion of the public review process.	June 2011

3.3 SUMMARY OF ISSUES RAISED

A description of issues relevant to the linear infrastructure that have been raised to date by authorities and IAPs is given in the issues table included in Appendix D. Issues raised pertain to:

- the EIA procedure;
- the technical project aspects;
- decommissioning and closure;
- blasting;
- biodiversity;
- heritage resources;
- visual;
- water;
- air quality;
- noise; and
- socio-economic (traffic and tourism).

4 DESCRIPTION OF THE CURRENT ENVIRONMENT

The baseline information provided in this chapter must be read in the context of a unique area of the Namib Naukluft National Park (NNNP) and the Dorob National Park (DNP) formerly known as the West Coast Recreation Area.

4.1 CLIMATE BASELINE

Information in this section was sourced from the Husab Mine EIA (Metago, 2010), and the surface water study included in Appendix G (Metago Australia, 2011).

4.1.1 INTRODUCTION AND LINK TO IMPACTS

As a whole, the various aspects of the climate that are discussed influence the potential for environmental impacts and related mine design. Specific issues are listed below:

- Rainfall and fog influence erosion, evaporation, vegetation growth, rehabilitation planning, dust suppression, and surface water management planning for the linear infrastructure that crosses rivers.
- Temperature influences air dispersion through impacts on atmospheric stability and mixing layers, vegetation growth, and evaporation which influences rehabilitation planning.
- Wind influences erosion, the dispersion of potential air pollutants, and rehabilitation planning.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.1.2 DATA COLLECTION

On site meteorology was obtained from the Husab weather station. Hourly average wind speed, wind direction, temperature and rainfall data were measured over the period October 2008 to June 2010.

Historical rainfall data was sourced from the Digital Atlas of Namibia and more recent daily rainfall records were also sourced from Rössing Uranium Mine from 1987 to April 2009, as well as by Langer Heinrich Uranium, from February 2007 to April 2009.

4.1.3 RESULTS

4.1.3.1 Rainfall and fog

According to the Directorate of Environmental Affairs, Ministry of Environment and Tourism Digital Atlas of Namibia, rainfall within the Erongo Region ranges between 0-50 mm at the coast to 400 mm in the northeast of the region. The Husab linear infrastructure falls within the less than 100 mm/year rainfall belt (http://209.88.21.36/Atlas/Atlas_web.htm). Monthly rainfall recorded at Husab is presented in Figure 4-1.

FIGURE 4-1: MONTHLY RAINFALL

FIGURE 4-2: DIURNAL TEMPERATURE PROFILE

As is typical of arid areas, rainfall can vary considerably and can be of great intensity and depth when it occurs. The maximum design rainfall depths for various return periods have been determined using long term stochastic extrapolations based on an observed daily rainfall (Rössing) for the period 1987-2009. The 22 year daily record was extrapolated to a 1000 year rainfall record using a stochastic model developed by the Australian Bureau of Meteorology. Extreme events (design rainfall depths) were then determined by fitting a gamma distribution function, as this was a best fit to the synthetic rainfall record, and compared well to the observed rainfall data. The resulting rainfall depths per return period are as follows:

TABLE 4-1: RAINFALL DEPTHS AND RETURN PERIODS

Return periods	10 years	20 years	100 years	10000 years
Rainfall depths	9mm	13mm	27mm	50mm

Fog, a form of precipitation, is characteristic of this region. Swakopmund, for instance, has high incidences of fog days of more than 125 days per year (http://209.88.21.36/Atlas/Atlas_web.htm). Within the Erongo Region, fog can extend up to 110 km inland with an average number of days per annum recorded at Gobabeb of 102 between 1964 and 1967. The annual fog precipitation at Swakopmund was estimated to be 35-45 mm in relation to 20 mm that was measured 40 km inland. Fog is expected to occur at the Husab linear infrastructure sites in the range between 50 and 90 days per year.

4.1.3.2 Temperature

Air temperature is an important parameter for the development of the mixing and inversion layers with relative humidity being the inverse function of ambient air temperature, increasing as ambient air temperature decreases. Historical data for the region indicate similar average monthly and annual temperatures along the Namib Coast. The range between the coldest and warmest months is also small being 9℃ at both Swakopmund and Walvis Bay. Frost is not associated with the region but extreme temperatures of over 40℃ have been linked to strong easterly "berg" winds. Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers. The diurnal temperature trend for the Husab linear infrastructure sites is presented in Figure 4-2.

4.1.3.3 Evaporation

Evaporation rates are between 2400-3400 mm per year increasing from the coast inland and reaching a maximum in the central part of the Erongo Region (http://209.88.21.36/Atlas/Atlas_web.htm). The Husab linear infrastructure sites falls within the 3000-3200 mm per year evaporation rate region. This indicates that evaporation will significantly exceed rainfall making the area a water stressed area.

4.1.3.4 Local atmospheric dispersion potential

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations and diurnal and seasonal changes in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

The occurrence of the various stability classes associated with the 16 main wind directions are presented in Figure 4-3. Stable atmospheric conditions tend to result in high ground level concentrations for ground level emitters such as fugitive dust from unpaved roads and crushers. At the Husab Mine site (and by inference at most of the linear infrastructure sites) a high frequency of very stable (F – stability) conditions occur predominantly from the north to the north western sector.

4.1.3.5 Local Wind Field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses, reflect the different categories of wind speeds; the red area, for example, representing winds of 6 to 10 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories in 6% increments. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

Seasonal and monthly variations in the wind field recorded on site are provided in Figure 4-4 and Figure 4-5 respectively.

The wind field is characterised by dominant north westerly winds. Wind from the north-northwest occurred 13% of the time with calm conditions occurring 20% of the time. There is not much variation between night-time and day-time wind flow, with a slight increase in frequency of winds from the north and northeast during the night. The night-time conditions are also characterised by lower wind speeds and a higher percentage of calm conditions.

Significant variation in the seasonal wind field was observed. During the summer and spring months north-north westerly winds dominate with an increase in easterly, east-north easterly and west-south westerly airflow during the autumn and winter months. The so-called “easterly winds” associated with high wind speeds occurred most frequently during the month of July (Figure 4-5).

The above trends are expected at most of the linear infrastructure sites. In addition, channelling of wind in river valleys is also expected to provide micro climatic variations to the above wind trends. This is particularly relevant to the linear infrastructure that will route from the north across the Khan River and associated valleys.

FIGURE 4-3: WIND DIRECTION AND STABILITY CLASS

FIGURE 4-4: SEASONAL WIND ROSES

FIGURE 4-5: MONTHLY WIND ROSES

The greater the wind speed, the greater is its potential for mobilising particles and dispersing them. The main particle source associated with the linear infrastructure is soil which has a wind speed threshold of 8.7 m/s. It follows that wind speeds above this threshold will mobilise and disperse particles.

4.1.4 CONCLUSION

The above discussion provides an understanding of the baseline climate and the potential related impacts. In summary:

- Average rainfall and fog related precipitation is low but evaporation is high. This means that the area is water stressed which has implications for water supply and management, dust suppression, and vegetation growth.
- There is potential for flood events, which means that storm water and flood control will have to cater for long dry periods and short storm events. Furthermore, erosion control measures will be required to cater for the storm events.
- The range of temperatures, and contrast between stable atmospheric periods and windy periods will influence the dispersion of airborne pollution. In the more stable periods the ground level concentrations at the linear infrastructure sites will be greatest, which will have potential impacts on worker health and vegetation. The stronger winds from the east will more easily mobilise dust and disperse this over greater distances. This may impact third parties and wind erosion must be controlled.

4.2 TOPOGRAPHY BASELINE

Information for the topography section was sourced from site visits by the EIA team, desktop review of the surface water specialist study in Appendix G (Metago Australia, 2011) and the topographical characterisation of the visual specialist study in Appendix L (NLA, 2011). More detailed descriptions of the surface water and visual aspects are provided in Sections 4.6 and 4.11 respectively.

4.2.1 INTRODUCTION AND LINK TO IMPACTS

Changes to the current topography through the development of linear infrastructure may impact on surface water drainage, visual aspects and the safety of people and wildlife. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.2.2 DATA COLLECTION

The main source of data collection was a series of site visits by the EIA project team, review of topographical maps and a review of the project layout in relation thereto.

4.2.3 RESULTS

The Husab linear infrastructure sites are located on a range of land types and topographies. The infrastructure to the south of the Husab Mine is located on gently sloping plains and in the Swakop River and associated valleys. The infrastructure to the north of the Husab Mine is located on a flat plateau to the west of the B2 and in the Khan River and associated valleys. Close to the Husab Mine site all linear infrastructure is located on gently sloping plains.

The fauna and people that have access to the linear infrastructure sites are not currently faced with any particularly dangerous excavations or infrastructure because the area is mostly undeveloped and represents a natural environmental state. Topography is depicted on Figure 1-2 and Figure 4-6.

4.2.4 CONCLUSION

The linear infrastructure and related temporary excavations will alter the topography and influence topographical aspects such as surface water drainage, visual landscapes and the safety of people and wildlife.

4.3 SOIL AND GEOLOGY BASELINE

Information in this section was sourced from the soil specialist study included in Appendix E (ESS, 2011).

4.3.1 INTRODUCTION AND LINK TO IMPACTS

Soils are a significant component of most ecosystems. As an ecological driver, soil is the medium in which most vegetation grows and a range of vertebrates and invertebrates exist. In the context of mining and related linear infrastructure, soil is even more significant if one considers that mining is a temporary land use where-after rehabilitation (using soil) is the key to re-establishing post closure land capability that will support post closure land uses.

The proposed project has the potential to damage the soil resource through physical loss of soil and/or the contamination of soils, thereby impacting on the soils ability to sustain natural vegetation and altering land capability. Contamination of soils may in turn contribute to the contamination of surface and groundwater resources.

Loss of the topsoil resource reduces chances of successful rehabilitation and restoration.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.3.2 DATA COLLECTION

Geological and topocadastral information was used to provide an overview of the linear infrastructure sites.

The field survey of the sites was performed using various survey grids, with the majority of the area being assessed on a grid of between 100m and 500m depending on the complexity of the soil patterns noted and the degree of anticipated impact. The areas of potential impact by infrastructure construction were assessed in more detail. The majority of field observations and classifications were done on the basis of samples taken with a hand operated Bucket Auger and Dutch (clay) auger.

Terrain information, topography and any other infield data of significance was recorded, with the objective of identifying and classifying the area in terms of:

- soil forms to be disturbed/rehabilitated;
- soil physical and chemical properties;
- soil depth;
- erodibility of the soils;
- construction soil utilisation potential, and
- soil nutrient status.

Representative samples were sent for laboratory analyses of both chemical and physical parameters.

4.3.3 RESULTS

4.3.3.1 Soil Forms

The linear infrastructure will traverse all of the major lithological units that make up the geology of the study area. These range from the amphibole and pyroxene bearing gneiss of the Khan Formation (Nossib Group) to the quartzites and schists comprising interbedded fine-grained metapelite, metagreywacke and calcsilicate beds. It is these complexes of lithologies combined with the extremes of topographic change that produce the complex of differing soil forms and dominant groups mapped These complexes have influenced the soil textures produced and the chemistry and resultant soil structures. As with any natural system, the transition from one system to another is often complex with multiple facets and variations. In this context, four groupings of soil Forms were identified (read this section with reference to the soils map in Figure 4-6):

- The rocky **"Mountainous"** group covers the steep slopes that make up the escarpment zone (mountain and valley sides), and comprise of outcrop and very shallow rocky soils These soils are general less than 200mm in depth, returned poor nutrient pools and have poor water holding capabilities. This environment is characterised by erosive mechanisms.

- The **"transition zone"** group comprises a variety of moderately shallow to shallow (400mm to 800mm) in-situ to colluvial derived materials founded on a hard saprolite horizon or hard rock base that is associated with the outcropping ridge zones that divide the "ephemeral channels/washes" from the very shallow rocky outcrop zones and rugged mountain terrain. This group of soils have single grained sandy loam to silty loam textures and single grained or apedel to weak crumby structure, better than average clay content, moderate to poor water holding characteristics, and are relatively better soils with regard to nutrient status and growth potential rating, albeit that these levels are still poor.
- The **"Alluvial"** group is characterised by stratified horizons. These soils are generally deep (600mm to greater than 1200mm), and vary in texture from fine grained silt and sand to pebble and cobble size materials and occasionally boulders. Radically differing extremes of energy environments would have occurred for these profiles to be present, and are indicative of the extremes of climate that characterise the environment in which they were deposited. In almost all cases mapped, the alluvial materials are founded on a hard rock base that comprises either the host lithology (bedrock) or a sequence of evaporite derived sediments of varying consistency (calcium carbonate). A general statement, but one that holds true for the majority (80%) of cases mapped, is that, the alluvial materials with a calcrete base ("C" Horizon) are associated with the ephemeral channels on the desert plain, while the major rivers and their tributaries returned alluvials on a hard rock base/"R" horizon. This is an important factor when considering the utilization and handling of these materials, and has an important bearing on the soil water characteristics. This underlying "evaporite/calcrete" layer is significant to the overall ecological success of the area in its natural state, and is thought to form a barrier layer that can potentially hold water close to the surface, but below the sands where it does not as easily evaporate and is still available to animals and plants, but does not easily evaporate. Concentration of salts and stores of nutrients within these soils are again a sensitive balance that should be noted.
- The **"Desert Plains"** group is characterised by soils with a moderately deep to shallow (700mm to 400mm) rooting depth, generally poor water holding capabilities, and better than average infiltration rates. A distinctive feature of many of the desert plain soils is the presence of a calcrete layer at the base of the soil profile ("C" horizon), and the surface crust or capping. The clay content varies down the profile, with the calcrete barrier layer returning moderate clay contents and better than average water holding capabilities, while the sandy topsoils are almost devoid of clay. The presence or absence of the very sensitive and unique surface crusting/capping is not a defining characteristic of these soils, albeit that they are only found within or on the desert plains.

In terms of the taxonomic classification the major soil forms encountered include those of the Oakleaf, Dundee, Mispah, Glenrosa, Augrabies, Coega, Trawal, and Prieska Forms with sub dominant forms that include the Montagu Pinedene and Avalon forms.

FIGURE 4-6: SOILS MAP

4.3.3.2 Soil Physical Characteristics

The majority of the soils mapped at the linear infrastructure sites exhibit apedel to single grained structure, low to very low clay content and a leaching character. With high evaporation and low rainfall, the conditions are conducive to the formation of evaporate layers which are crusted calcifications at, or close to, the surface. The calcrete layers so formed may be an important feature of the biosphere and may contribute to the sustainability of the ecological systems in the desert environment.

In addition, the normal soil forming processes are at work, with in-situ soils with shallow depth and sandy loam textures characterising the rocky hill slopes and rocky desert, while the colluvial derived soils are characterised by deeper, sandy loams and sandy clay loams that bound on a hard rock or calcrete “C” horizon.

In contrast to the colluvial derived materials, the alluvial soils or stratified alluvium is characterised by variable texture and grain size distribution through the profile, with a mixture of fine and coarse materials in layers, a result of flood events and changes in the depositional energy of the events with time.

The soils do not retain water other than possibly between the evaporate surface crust and deeper calcrete layers and are prone to erosion if the vegetative cover is removed and/or the surface is disturbed. They are also prone to compaction by heavy vehicle traffic or if overlain by heavy structures.

4.3.3.3 Soil chemical characteristics

Soil acidity/alkalinity

The dominant soils mapped at the linear infrastructure sites are slightly alkaline (pH = 7.5 to 8.2), but are still generally within the accepted range for good nutrient mobility.

In general, it is accepted that the pH of a soil has a direct influence on plant growth. This may occur in a number of different ways including:

- the direct effect of the hydrogen ion concentration on nutrient uptake;
- indirectly through the effect on major trace nutrient availability; and
- by mobilising toxic ions such as aluminium and manganese, which restrict plant growth.

A pH range of between 6 and 7 most readily promotes the availability of plant nutrients to the plant. However, pH values below 3 or above 9, will seriously affect, and reduce the nutrient uptake by a plant.

Soil salinity/sodicity

The salinity/sodicity is of importance in a soil's potential to sustain growth. Highly saline soils will result in the reduction of plant growth caused by the diversion of plant energy from normal physiological processes, to those involved in the acquisition of water under highly stressed conditions. Salinity levels below 60 mS/m will have no effect on plant growth. From 60 – 120 mS/m salt sensitive plants are affected, and above 120 mS/m growth of all plants are affected.

In addition soil salinity may directly influence the effects of particular ions on soil properties. The sodium adsorption ratio (SAR) is an indication of the effect of sodium on the soils. At high levels of exchangeable sodium, certain clay minerals, when saturated with sodium, swell markedly. With the swelling and dispersion of a sodic soil, pore spaces become blocked and infiltration rates and permeability are greatly reduced.

In general the mapped soils at the linear infrastructure sites are in the range of non to slightly saline with salinity levels below 60mS/m. The soils are prone to sodic/salt development where evaporation concentrates the salts at surface in a crust, or within the soil profile as a calcrete layer. In these cases the salinity levels were recorded at 196 mS/m. It follows that for salts to be retained, good water management will be required for areas where the soils are disturbed.

Soil fertility

The soils at the linear infrastructure sites have moderate levels of some of the essential nutrients required for plant growth with sufficient stores of calcium and sodium. In this regard, levels of zinc, phosphate, magnesium, aluminium, copper and potassium are generally lower than the optimum required. There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area.

Nutrient Storage and Cation Exchange Capacity (CEC)

The potential for a soil to retain and supply nutrients can be assessed by measuring the cation exchange capacity (CEC) of the soils. The low organic carbon content and very low clays are detrimental to the exchange mechanisms, as it is these elements which naturally provide exchange sites that serve as nutrient stores. These conditions will result in a low retention and supply of nutrients for plant growth. Generally, the CEC values for the soils mapped at the linear infrastructure sites are low.

Soil organic matter

The soils mapped at the linear infrastructure sites are all extremely low in organic matter as would be expected for a desert environment.

4.3.3.4 Soil Erosion and Compaction

Erosion of a soil is expressed by an index of erosion. This is determined by multiplying the land slope factor by the erodibility factor ("K") which is determined from soil texture, permeability, organic matter content and soil structure.

The soils on the more mountainous terrain have a high erodibility index which is determined by the low level of vegetation cover and steepness of the slopes. In contrast, the valley environments and desert plains are characterised by moderate erosion indices due to the flatness of the terrain, the presence of the hardened evaporite layer and the generally better vegetation cover associated with a better soil cover.

The concerns around erosion and compaction are directly related to the disturbance of the protective vegetation cover and topsoil that will be disturbed during any linear infrastructure construction. Once disturbed, the actions of wind and water are increased.

4.3.4 CONCLUSION

In summary, the findings of the soil study for the proposed Husab Mine linear infrastructure are as follows:

Large areas of soil with low levels of plant nutrition were mapped. Furthermore, soils have a high permeability and low clay and organic content making them susceptible to erosion and compaction.

Many of the soils are associated with an evaporite layer either at surface as a crust and/or as a calcrete layer deeper in the soil profile. These layers may be significant to the ecological balance of the desert environment because they may retain water content in the soil horizons beneath the crust and above the calcrete layer.

Well planned management actions will save time and money in the long run, and will have an impact on the potential for successful rehabilitation of the disturbed areas.

4.4 LAND CAPABILITY BASELINE

Information in this section was sourced from the soil specialist study included in Appendix E (ESS, 2010).

4.4.1 INTRODUCTION AND LINK TO IMPACTS

The land capability classification is based on the soil properties and related potential to support various land use activities. The construction of the proposed linear infrastructure has the potential to significantly transform the land capability. To understand the basis of this potential impact, a baseline situational analysis is described below.

4.4.2 DATA COLLECTION

The South African Chamber of Mines Land Capability Rating System in conjunction with the Canadian Land Inventory System were used as the basis for the land capability study.

Using these systems, the land capability of the study area was classified into four distinctly different and recognisable classes: wetland, arable land, grazing land and wilderness.

4.4.3 RESULTS

The land capability classification as described above was used to classify the land units identified during the pedological survey. In summary, of the total area investigated was ~2241ha. Figure 4-7 illustrates the distribution of land capability classes.

4.4.3.1 Arable Land

The very low rainfall of this region (<100mm/a) limits the utilization potential of the land to very low intensity grazing and wildlife conservation. There is little prospect of using the land for crop cultivation.

4.4.3.2 Grazing Land

The areas that classify as grazing land are generally confined to the well-drained soils. These soils are generally darker in colour, but are capable of sustaining palatable plant species. In addition, there should be no rocks or pedocrete fragments in the upper horizons of this soil group. If present this will limit the land capability to wilderness land. The extremes of climate and rainfall out weigh the soil and geomorphological aspects for sustainable livestock grazing in the areas studied, and thus can best be described as wilderness grazing.

4.4.3.3 Wilderness / Conservation Land

The majority of the linear infrastructure sites classify as either conservation or wilderness land based on the shallow rocky nature of the soils and their inability to sustain grazing and crop yield. An added factor is the extreme dry and hot desert climate.

4.4.3.4 Wetland

Wetland areas are defined in terms of soil characteristics, the topography as well as vegetation criteria. These zones (wetlands) are dominated by hydromorphic soils (wet based) that often show signs of structure, and have plant life (vegetation) that is associated with seasonal wetting or permanent wetting of the soil profile.

The wetland soils are generally characterised by dark grey to black (organic carbon) in the topsoil horizons and are often high in transported clays and show variegated signs of mottling on gleyed backgrounds (pale grey colours) in the subsoils.

There are no true wetland soils (wetness must be within 500mm of surface) present within the linear infrastructure sites.

4.4.4 CONCLUSION

The current land capability for the linear infrastructure sites is wilderness with some marginal grazing. The basis for this conclusion is the underlying soil conditions assessed in conjunction with the desert climate. The land capability will be changed by the development of linear infrastructure. Therefore, impact management and rehabilitation planning are required to achieve acceptable post rehabilitation land capabilities.

FIGURE 4-7: LAND CAPABILITY

4.5 BIODIVERSITY BASELINE

Information in this section was sourced from the biodiversity study included in Appendix F (AWR 2011).

4.5.1 INTRODUCTION AND LINK TO IMPACTS

In the broadest sense, biodiversity provides value for ecosystem functionality, aesthetic, spiritual, cultural, and recreational reasons. The known value of biodiversity and ecosystems is as follows:

- soil formation and fertility maintenance;
- primary production through photosynthesis, as the supportive foundation for all life;
- provision of food and fuel;
- provision of shelter and building materials;
- regulation of water flows and water quality;
- regulation and purification of atmospheric gases;
- moderation of climate and weather;
- control of pests and diseases; and
- maintenance of genetic resources.

The ecosystem under consideration is a virtually pristine Namibian ecosystem that occurs in the NNNP, the DNP and the surrounding areas. It is mostly untouched by any anthropogenic developments except for the old German railway, and some tourism and exploration activities. Development of the proposed linear infrastructure will impact on the land surface and water availability which may impact one or more of the following biodiversity parameters:

- Biodiversity composition in terms of species and their abundance. Key engineer species are particularly important because a limited change in their numbers may have a disproportionate effect on the ecosystem's stability or resilience. Rare, threatened or endangered (RTE) species are important because impacts on them have wider relevance than the site alone.
- Biodiversity structure which is the organisation of biological units in time and space. The spatial structure component of this concept refers to the distribution of organisms across space; for example, species populations may be driven from one habitat to the next or may be fragmented, and movement patterns may be disrupted. The food web structure and interactions component of this concept refers to the flow of energy and nutrients through an ecosystem by the mechanisms of predation, herbivory and parasitism; for example, the loss of particular habitats may have disproportionate impacts on a particular species, because its food resource occurs there. In addition, the habitat linkages component of this concept refers to the flow of matter and energy across the landscape and thus the persistence of spatially separate habitat patches and ecosystems.
- Key biodiversity processes in terms of functional linkages of parts or components of an ecosystem through a directed flow process; for example, in an arid environment, run-off and run-on of water

dictate the spatial arrangement and hence scale of ecological processes; without these the ecosystem may collapse. Predation is another key process, as is dispersal.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.5.2 DATA COLLECTION

4.5.2.1 Methods

In addition to the conventional concepts around the investigation of biodiversity, there are two principles that were applied to the Husab Project investigation and assessment:

- First, ecosystems are complex, multi-interacting systems with sometimes unpredictable behaviour. This means that precaution is always a high-level guiding principle, and assessment and management must be done in a continuously learning and adaptive approach.
- Second, an ecosystem should be studied and understood from both the perspective of structure (the identity and abundance of species that it contains) and function (the way in which matter and energy flows through the ecosystem by virtue of processes and interactions among species).

Omitting either of these two aspects will limit one's ability to understand and manage impacts on the ecosystem. Given this, neither structure nor function can be completely understood without a specific spatial context. The landscape influences organisms' activities and interactions on a basic level and therefore the data collection emphasis was placed on the detection of spatial patterns in structure and function (habitats), with the aim of presenting an explicit visual picture of where in the project area the most sensitive places and processes are located.

The following basic methods were used to achieve the above:

- A literature study was done to describe the physical and ecological context of the project, and species lists were compiled from various published sources and museum records. A key literature source was the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010).
- Habitat definitions were taken from the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010).
- To augment the work done as part of the Husab Mine EIA (AWR 2010) additional field surveys were conducted of the ecological processes, vegetation assemblage, mammals and birds that could be affected by the linear infrastructure. Particular attention was paid to identifying keystone structures or species, because of their critical role in ecosystem function.

4.5.3 RESULTS

4.5.3.1 Habitats

The structure and function of the biodiversity of the project area could be described by focussing on plant communities, vertebrate communities or invertebrate communities. However, in order to present one reference point of the structure and function of the project area, the biodiversity is also described by habitat.

In broad terms, habitats are places where organisms live. Habitat requirements include characteristics such as availability of required nutrients, energy, water, the absence of toxins, shelter, geophysical conditions, and suitable micro-climatic conditions.

Twelve habitats were defined and described in the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010). Of these, only ten may be affected by the linear infrastructure. The location of the habitats are presented visually on figure 4-8 and discussed in detail in Table 4-2. The habitats include: Khan and Swakop River, Rocky Valley Drainages, Plains Drainage Channels, Pink Gramadoelas, Black Gramadoelas, Gypsite Plain, Grassy Plain, Koppies and Ridges on Plains, the Welwitschia Plain, and Aquatic habitat.

FIGURE 4-8: COLLECTIVE HABITATS

TABLE 4-2: HABITATS

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
Khan and Swakop River	• Large drainage channel • Deep sandy bottom with silt layers and gravels • Deeply incised valley • Low gradient	• High disturbance rate with regular flooding • Regular re-charge of superficial aquifer • Route for animal dispersal and movement • Supports significant kudu and ostrich populations • 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 • Seasonal standing water	• Large trees and thickets are probably important for invertebrate diversity • Grazing and browsing for large mammals • Movement corridor • The valley walls and large trees provide shelter from wind, blown sand and sun • Aquifer recharge
Rocky Valley Drainages	• Smaller drainage channels • Sandy bottom • Deeply incised rocky valley • Gradient varies, can be high	• Often contain saline or fresh perennial or ephemeral springs with associated vegetation and birdlife • Springs may actually be considered a habitat on their own • Small perched aquifers may be common • Well-defined movement corridors for wildlife; critical for zebra and kudu to access springs. Also supports Rüppel's Korhaan • Carries a diverse assemblage of herbs that includes a high proportion of endemics and near-endemics	• Springs • Large trees • Drainage lines
Plains Drainage Channels	• Distinct large (5 - 15 m across), sinuous drainage channels • Sandy bottom • Low gradient	• Represents the largest drainage channels of the Grassy Plain; all smaller tributaries are grouped with the Grassy Plain habitat itself • Experiences infrequent disturbances through flooding • Sandy substrate is well-drained • May form perched aquifers where sub-surface geology allows it • Important for the transport of water for downstream Welwitschia populations	• Large trees • Welwitschias • Drainage lines
Pink	• Complex incised gneiss/granite	• High diversity of nooks and crannies forming	• Nooks and crannies, complex

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
Gramadoelas	bedrock • Friable rock, steep sides, many nooks and crannies, loose scree slopes • Small gullies and drainages with pockets of sand accumulation • Water retention features	shelter for a range of mammals, reptiles and birds • Small gullies contain sandy substrates with many plant species, including *Commiphora oblanceolata* • Forms the only habitat for klipspringer, dassie rat, pygmy rock mouse and red rock rabbit, amongst other rupicolous species • Includes an ecotone of gneiss hillocks along the southern edge dissected by numerous small rivulets and gullies that form the headwaters of the rocky valley drainages and contain a diverse assemblage of plants, including a high proportion of endemics and near-endemics	structure • Small gullies (drainage lines)
Black Gramadoelas	• Complex incised metamorphosed sediments, mostly black or dark grey • Small gullies and drainages with pockets of sand accumulation	• High diversity of nooks and crannies, but little resource retention • Small gullies contain sandy substrates where most of the vegetation is located	• Drainage lines
Gypsite Plain	• Indistinct area, best expressed in northern part of study area, located more or less along the Khan-Swakop watershed • Hardpan gypsite layer, possibly caused by long-term condensation and evaporation of fog pushing out of the Khan River, with shallow loamy gravel or sand cover • Specific erosion pattern with sharp edges on small gullies	• 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* • Small mammal (primarily gerbil) burrows are apparently strongly associated with these depressions, possibly resulting in localised fertilisation and increased water penetration; may thus be a keystone feature • Ample evidence of zebra grazing in these areas • Erosion patterns (numerous parallel sharply cut rivulets) on the edges of the plain apparently associated with high vegetation productivity • Strong (although not complete) association of *Arthraerua leubnitziae* with Gypsite Plains; *A.*	• Circular depressions • Gerbil burrows • *A. leubnitziae* shrubs

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
		leubnitziae may represent a minor keystone structure	
Grassy Plain	• Largest part of study area, consists of pale semi-consolidated eroded material • Substrate mostly deep loamy gravel-sand • Drained by numerous sinuously twisting drainage channels that often fan out and disappear on very gentle or flat slopes • Includes sheet drainages that are too small to map out separately • Includes area underlain by metamorphosed sediments of the Kuiseb formation forming fine-grained dark sandy surfaces • Includes small pockets of aeolian sand at the edge of the gramadoelas, integrating with the sandy bottom of rocky valley drainages	• Contains high numbers of annual and perennial grasses • Primary habitat for small burrowing and digging mammals: gerbils, suricates and a number of unidentified viverids; especially gerbil burrowing may result in localised fertilisation (potential keystone process and keystone group) • Possibly important area for re-charge of superficial aquifer/s on the plain (needs to be confirmed through dedicated study) • Probably seasonally important grazing areas for zebra; year-long important grazing areas for springbok and ostrich • Represents the only habitat with significant numbers of Cape hare • Together with Rocky Valley Drainages and Plains Drainage Channels, is important habitat for Rüppel's Korhaan • Includes a significant part of the *Welwitschia* population; those parts of this habitat containing *Welwitschia* plants are dealt with as an independent habitat (Welwitschia Plain)	• Level areas that are potentially important aquifer recharge areas • Gerbil burrows
Koppies and Ridges on Plains	• Composite of all rocky ridges, some of which consist of marbles and limestones (these are extensions of the prominent marble bands in the gramadoelas), others of metamorphosed sediments of the Khan Formation • Ranges in height from barely above the surface of the grassy plains to ~150m	• Discrete and unique habitat distinctly different from grassy plain • Mostly elevated above plain, possibly good fog traps, which may explain relatively high vegetation biomass and species diversity • Contains a number of plant species uniquely associated with it in this area, including *Euphorbia giessii, Aloe asperifolia, Avonia albissima, Commiphora virgata, Commicarpus squarrosus, Larryleachia marlothii, Hereroa puttkamerana, Hoodia pedicellata* and others. Also the favoured	• Nooks and crannies • Possibly fog traps

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
	• Almost always have an erosion fan consisting of loose, marble-derived sand and pebbles	habitat of *Commiphora oblanceolata*. • Erosion fans may be prime habitat for gerbils, with relatively higher numbers there • Marble ridges overall of higher biodiversity value than the ridges formed by metasediments • Most are seed traps and form shelter from wind and wind-blown sand for many plants and animals.	
Welwitschia Plain	• Represents those parts of the Grassy and Hard Undulating Plains that also contain numerous *Welwitschia mirabilis* plants • Has loamy-gravel substrate cut with numerous small sheet and shallow linear washes in twisting and herringbone patterns • The washes on the grassy part of the plain are clearly visible from the air but often indistinct on the ground.	• This plain is distinguished from the rest of the Grassy Plain mainly by the dominance of *Welwitschia mirabilis* that appears to be strongly associated with washes on the plain • Welwitschias may be keystone structures because each individual plant harbours a range of vertebrate and invertebrate animals that would not otherwise occur here. Some invertebrate species may be symbiotic with Welwitschia.	• Drainage lines (numerous shallow washes) • Individual Welwitschia plants.
Aquatic Habitat	• Occurs mostly in the form of seepages or springs in the rocky valleys adjacent to the Khan and Swakop Rivers. Also a relatively large saline spring on the southern edge of the study area. • Springs are ephemeral or perennial	• Provides critical habitat for specific plants, birds, amphibians and a range of invertebrate species • Provides critical resource for a number of water-dependent mammal species such as zebra and kudu • Seasonal effect of ephemeral springs will be important determinant of space use by zebra	• Seasonally or permanently available water • Lush vegetation is attractive to birds and insects • Seasonal supply of critical resource

4.5.3.2 Discussion of species and communities

Plants

As a general comment the linear infrastructure forms part of the Husab Mine study area. This study area and its surroundings appear to form an 'island' of unusually high plant diversity in the context of the central Namib Zone. Moreover, plant vigour was generally good because on a three-point scale from poor to good none of the plots were scored as anything else but "good".

Although there is significant overlap, the location of plants and plant communities does not strictly adhere to the defined habitats that have been observed in the study area. It follows that the plants in the study area should be divided into 13 basic plant communities (see Table 4-3).

TABLE 4-3: PLANT COMMUNITIES IN THE STUDY AREA

	Community Name	Description
1	***Acacia erioloba-Faidherbia albida* community**	Plant community of sandy riverbed habitat.
2	***Acacia erioloba-Petalidium variabile* community**	Plant community of broad sandy drainage corridor habitat.
3	***Zygophyllum stapffii-Acacia erioloba- Petalidium pilosi-bracteolatum* community**	Plant community strongly associated with three broad sandy drainage line habitats that incise the grassy plain and converge near the road to the old Husab mine.
4	***Commiphora oblanceolata-Stipagrostis dinteri* community**	Plant community of very rugged ridges and gullies forming the Khan River canyon.
5	***Commiphora saxicola-Petalidium canescens* community**	Plant community associated with the very dark, rough and steep metasediments that make up the Black Gramadoelas habitat.
6	***Zygophyllum stapffii-Petalidium variabile* community**	Plant community of the rounded gneiss hillocks incised by narrow sandy gullies with strongly weathered sides.
7	***Arthraerua leubnitziae-Zygophyllum stapffii* community**	Plant community of a sandy-gravelly zone dominated by *Stipagrostis* spp. at the top of the grassy plains, often with subsurface gypsite and small, shallow depressions.
8	***Stipagrostis* spp community**	Plant community associated with flat sandy-gravelly plain sloping upwards from southwest to northeast with *Stipagrostis* spp dominant.
9	***Zygophyllum stapffii-Welwitschia mirabilis* community**	Plant community on a series of dark grey sparsely vegetated gravelly ridges with *Stipagrostis* spp. and *Zygophyllum stapffii* dominant. Foot slopes carry numerous *Welwitschia mirabilis.*
10	***Euphorbia virosa-Commiphora oblanceolata* community**	Plant community of the prominent koppie and ridges and gorges, characterised by *Euphorbia virosa and Commiphora oblanceolata.*
11	***Zygophyllum stapffii-Commiphora oblanceolata* community**	Plant community of the smaller marble ridges on the plains.
12	***Stipagrostis* spp-*Petalidium pilosi-bracteolatum* community**	Plant community found on the hard, undulating plain with stony surface incised by sandy gullies.
13	***Stipagrostis* spp-*Salsola* sp community**	Small low-lying area of saline soil limited to the southernmost part of the study area and dominated by *Stipagrostis* spp. and *Salsola* sp.

As part of understanding the plant communities a list of 248 plant species was compiled for quarter degree grid squares 2215CA and 2215CD, which includes the linear infrastructure sites. Of the 248 species, 177 have been collected or observed in the study area, or are expected to occur based on their habitat affinities. A full list of species is included in the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010).

Of the 48 endemic and 37 near-endemic (to Namibia) species thought to occur in the study area, 28 and 19 respectively have already been collected or observed and another 9 and 7 respectively are expected to occur (AWR 2010). Table 4-4 provides a summary of the more significant endemic, near endemic and protected plant species found, or expected to be found, within the study area.

TABLE 4-4: SUMMARY OF RESTRICTED-RANGE ENDEMIC PLANT SPECIES, PROTECTED PLANT SPECIES AND NEAR-ENDEMIC PLANT SPECIES OF CONSERVATION CONCERN FOUND, OR EXPECTED TO OCCUR, IN THE HUSAB STUDY SITE.

Listing is in alphabetical order within four categories of endemism. Categories were similar to Burke (2007) and Burke et al. (2008), with the only difference being that Mendelsohn et al.'s (2002) vegetation zones were used instead of regional boundaries. Distribution of endemics is based on records from the National Herbarium database (SPMNDB). Conservation status, Red Data Categories: LC = least concern; NT = near threatened; VU = vulnerable; NA = not assessed (Loots 2002, 2005). Recorded on site (R). Expected on site (E).

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
Species that are only known from the central Namib or have only occasionally been recorded elsewhere					
Aizoanthemum galenioides	Annual	Plains, drainage lines, hills, rocky outcrops, inselbergs	LC	R	Most commonly recorded along the central Namib coast, however reasonably common on sandy plains in the study area, possibly due to fog carried inland by river courses.
Cleome carnosa	Annual	Sandy drainage lines, shallow depressions on plains, hills, rocky outcrops and inselbergs	LC	R	Usually only found in drainage lines, occasionally on plains.
Helichrysum marlothianum	Annual	Sandy watercourses		E	Known from only a few collections in four quarter-degree squares centred on the general Rössing area.

Species known from the central Namib and one other vegetation zone					
Aloe namibensis (Namib Aloe)	Perennial, long-lived	Prefers sandy pockets on rocky slopes and ridges, also occurs on sides of gneiss/granite gullies	Protected LC Cites II	R	Occurs as far east as the escarpment zone. Potentially impacted by several uranium developments.
Crotalaria colorata subsp. *Colorata*	perennial	Drainage lines, gullies, rivers		E	Previously recorded from southern Namib also, but that record an incorrect determination.
Lithops ruschiorum	Perennial, long-lived	Reasonably restricted habitat preferences, usually occurring on rocky slopes on hills and ridges	Protected LC	R	Has been reliably reported in the vicinity of the Giant Welwitschia site (G. Erb pers. comm.) and the gneiss hillocks north west of the Khan River. Recent work (Loots In prep) has confirmed its presence as far north as the Khumib River. It is a cryptic species with typically widely scattered sub-

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
		composed of quartz, pegmatite, calcrete, calcite and marble substrates.			populations. Although it has been assessed as ‘least concern (LC)’ by the Red Data list it is a formally protected species that has been impacted by the Rössing mine in the past; this should be factored in when the sensitivity of habitats is being considered.

Species known from the central Namib and more than one other vegetation zone					
Aloe asperifolia (Kraal Aloe)	perennial, long-lived	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	Protected LC	R	Slow-growing.
Arthraerua leubnitziae	perennial, long-lived	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	Fog-dependent, potentially impacted by several uranium developments.
Commiphora saxicola (Rock Corkwood)	perennial, long-lived	Depressions, drainage lines, gullies, hills, rocky outcrops and inselbergs	LC	R	Potentially impacted by several uranium developments but reasonably widespread.
Commiphora virgata (Slender Corkwood)	perennial, long-lived	Hills, rocky outcrops and inselbergs	LC	R	Potentially impacted by several uranium developments but very few were recorded during fieldwork. This is the far western edge of its distribution range; it is more common on the escarpment.
Dauresia alliariifolia	perennial	Hills, rocky outcrops and inselbergs	LC	R	Reasonably widespread.
Euphorbia giessii	perennial	Only occurs on rocky ridges, commonly seen on marble ridges in study area	LC	R	Possibly fog-dependent, virtually restricted to the desert biome. Only known from rocky ridges, which form a relatively small proportion of the central Namib.
Petalidium canescens	perennial	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	Reasonably widespread.
Petalidium pilosi-	perennial	Drainage lines, marble	LC	R	Fragmented population across its range. Common in large washes and on

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
bracteolatum		ridges			marble ridges in the study area, which may represent its western-most limit in the central Namib. Not recorded in recent work at Langer Heinrich, Rössing or Goanikontes.
Zygophyllum cylindrifolium	perennial	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	Most common on marble ridges.
Zygophyllum stapffii	perennial, long-lived	Drainage lines, rivers, rocky slopes, shallow depressions on plains	LC	R	Fog-dependent, potentially impacted by several uranium developments.

Near-endemic and protected species not mentioned above					
*Acacia erioloba (*Camel Thorn Tree*)*	perennial, long-lived	Drainage lines, rivers, hills, inselbergs	Protected	R	Increasing threats countrywide.
*Combretem imberbe (*Leadwood*)*	perennial, long-lived	Drainage lines, rivers	Protected	E	Considered a sacred tree by the Herero people, threatened by illegal harvesting for fuel.
*Commiphora oblanceolata (*Swakopmund Corkwood*)*	perennial, long-lived	Marble ridges, hills, rocky outcrops, inselbergs, gullies.	NT	R	Disjunct distribution, central Namib population appears to be centred on Husab EPL. Not found at Langer Heinrich, very few at Rössing, low numbers at Goanikontes. Of concern because thought to possibly be a distinct taxon from the Northern Namib and Angolan populations.
*Euclea pseudebenus (*Wild Ebony*)*	perennial, long-lived	Drainage lines and rivers	Protected	R	Widespread in Namibia.
*Faidherbia albida (*Ana tree*)*	perennial, long-lived	Rivers	Protected	R	Widespread in Namibia.
*Hoodia currorii (*Hoodia*)*	perennial	Marble and other rocky ridges and slopes, plains	LC	R	Illegal collecting a threat.
*Hoodia pedicellata (*Hoodia*)*	perennial	Marble and other rocky ridges and slopes	VU	R	Main threat thought to be illegal collection.
Larryleachia marlothii	perennial	Marble and other rocky ridges and slopes	Protected	O	Often collected illegally.

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
Maerua schinzii (Lamerdrol*)*	Perennial, long-lived	Riverbanks, rocky slopes	Protected	R	Widespread in Namibia.
Sterculia Africana *(*Tick Tree*)*	Perennial, long-lived	Rocky slopes	Protected	R	Reasonably widespread in Namibia.
Tamarix usneoides *(*Wild Tamarisk*)*	Perennial	Riverbeds and large drainages	Protected	R	Widespread in Namibia.
Welwitschia mirabilis	Perennial, long-lived	Depressions, drainage lines, plains, rocky slopes	Protected LC	R	Large proportion of central Namib population appears to be concentrated in the study area (Kers 1967, Cooper-Driver 1994)
Ziziphus mucronata *(*Buffalo Thorn*)*	Perennial, long-lived	Riverbanks and large drainage lines	Protected	R	Widespread in Namibia.

Invertebrates

Approximately 194 invertebrate species or morphospecies are expected to occur in the study area. Of these 132 (all Phylum Arthropoda) were actually recorded. From the perspective of trophic guilds, very few flower-feeders or fruit-feeders were encountered during the survey, because these trophic resources are only available for a short time following rain. No wood-eaters, whose adult forms are usually also flower-feeders, were encountered. No primary grass-eaters were recorded, but secondary grass-eaters included the harvester ants and the harvester termite. No dung feeders were seen, but microfloral feeders like the tiny booklice were found. A full list of species is included in the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010).

At least 45 invertebrates endemic to Namibia occur in the study area of which 21 (47%) are endemic to the central Namib only, 13 (29%) are endemic to a wider area, but still found only within the borders of Namibia, while the remaining 10 (22%) are near-endemic. The central Namib endemics comprise six solifuges, three scorpions, seven beetles, two flies, two silverfish and one grasshopper.

The endemic invertebrates (both observed on site and expected on site have been assigned to habitat types that (as for the plants) do not exactly correlate to the defined habitats of the project study area because the vegetation and invertebrates are not confined by definite boundaries in all cases. The number of endemic invertebrates provides an indication of the importance of the habitat types for vertebrates (Table 4-5).

TABLE 4-5: INVERTEBRATE ENDEMICS PER INVERTEBRATE HABITAT TYPE

Invertebrate groupings per invertebrate habitats	Number of endemic invertebrates
Khan and Swakop River	6
Rock valley drainage	24
Dry plain wash	25
Pink Gramadoelas	13
Black Gramadoelas	13
Gneiss gullies	29
Succulent shrub watershed	29
Grassy plains	27
Khan ridges	28
Limestone marble ridges	15
Marble ridges	16
Undulating Gneiss plains and gullies	25
Saline community	4
Welwitschia plains	4

Five of the invertebrate species are considered Critically Endangered, four are Endangered and two are Vulnerable. These are described in Table 4-6.

TABLE 4-6: ENDANGERED INVERTEBRATES PER INVERTEBRATE HABITAT TYPE

Abbreviations for vegetation types: BLGR – Black Gramadoelas; DWOP – Dry washes on plains; GNGU – Gneiss Gullies; GRPL – Grassy Plains; KHAN – Khan and Swakop River; KHMR – Khan Metasediment Ridges; LIMA – Limestone-Marble Ridges; MARI – Marble Ridges; PIGR – Pink Gramadoelas; ROVD – Rocky valley Drainages; SALC – Saline Community; SSWS – Succulent Shrub Watershed; UGPG – Undulating Gneiss Plains and Gullies; WELW – Welwitschia-specific site. E – expected. O – observed.

Species	**Common name**	**Red Data status**	**Invertebrate habitat type**													
			KHAN	**ROVR**	**DWOP**	**PIGR**	**BLGR**	**GNGU**	**SSWS**	**GRPL**	**KHMR**	**LIMA**	**MARI**	**UGPG**	**SALC**	**WELW**
Blossia planicursor	Solifuge	Critically Endangered						E	E	E	E			E		
Ctenolepisma occidentalis	Silverfish	Critically Endangered		E	E			E	E	E	E			E		
Metaphilhedonus swakopmundensis	Flower beetle	Critically Endangered		E	E	E	E					E	E			
Nothomorphoides irishi	Jewel beetle	Critically Endangered		E	E			E	E	E	E			E		
Pteraulacodes hessei	Bee fly	Critically Endangered						E	E	E	E			E		E
Julodis namibiensis	Jewel beetle	Endangered						E	E	E	E			E		
Lawrencega longitarsis	Solifuge	Endangered						E	E	E	E			E		
Lawrencega solaris	Solifuge	Endangered						E	E	E	E			E		
Zophosis (Z.) cerea	Toktokkie	Endangered			O						O	O	O			
Acmaeodera liessnerae	Jewel beetle	Vulnerable		E	E	E	E	E	E	E	E	E	E	E		
Zophosis (Z.) dorsata	Toktokkie	Vulnerable			O			O	O	O	O		O			
Number of Threatened species:			**0**	**4**	**6**	**2**	**2**	**9**	**9**	**9**	**10**	**3**	**4**	**8**	**0**	**1**

Overall the findings from the survey confirmed the central Namib (including the study area) as an important area for invertebrate biodiversity, particularly in terms of endemics. Invertebrates showed highest levels of diversity and number of threatened and endemic species in the Succulent Shrub Watershed plant community (part of the Gypsite Plain habitat).

Mammals

A list was compiled containing 45 mammal species that have either been recorded on the study area, or are expected to occur based on their habitat affinities. About 12% of the 41 species listed (a full list of species is included in the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010)) are endemic or near-endemic to the sub-continent, approximately 8% to Namibia, and approximately 9% to the Namib. Four of the species are considered near-threatened, and one, Hartmann's mountain zebra, is considered vulnerable. Table 4-7 provides details on the species of conservation concern. This table should be read in the context of the habitats depicted on figure 4-8.

Species that are particularly relevant to the current study are the large herbivores springbok, gemsbok, kudu *Tragelaphus strepsiceros*, and Hartmann's mountain zebra and the small mammals rock hyrax *Procavia capensis*, dassie rat *Petromus typicus*, tree rat *Thallomys nigricauda*, Namibian pygmy rock mouse *Petromyscus collinus*, and the reddish-grey musk shrew *Crocidura cyanea*. The larger herbivores may primarily be affected through disturbance of their normal behaviour and interference of movements, while the smaller mammals may suffer from direct loss of habitat and disturbance. Another species that may be affected through direct loss of habitat or disturbance is the klipspringer *Oreotragus oreotragus*.

TABLE 4-7: MAMMAL SPECIES OF CONSERVATION CONCERN

Habitat codes are: r: Khan and Swakop River, rvd: Rocky Valley Drainages, pdc: Plains Drainage Channels; pg: Pink Gramadoelas, bg: Black Gramadoelas, mg: Marble in Gramadoelas, gp: Gypsite Plain, grp: Grassy Plain, hup: Hard Undulating Plain, krp: Koppies and Ridges on Plains, Wp: Welwitschia Plain. Endemic status indicates whether the species is restricted to a specific geographic area: central Namib refers to the region between the Kuiseb and Ugab Rivers; Namib refers to the Namib desert;. Conservation status refers to IUCN status: CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near threatened

Order/ family	Species (common name) Status notes	Recorded (Y)	Habitat											Endemic	Conservation status
			R	rvd	pdc	pg	Bg	mg	gp	grp	hup	krp	Wp		
Hyaenidae	*Crocuta crocuta* (spotted hyena) Occasionally roam the area, scats were recorded	Y	X	X	X	X		X	X	X	X	X	X		NT
	Proteles cristatus (aardwolf) Unlikely to occur in study area, being at very edge of its range, but was recorded at Langer Heinrich		X	X	X				X	X	X		X		NT
Procaviidae	*Procavia capensis* (rock hyrax) Found in Pink and Black Gramadoelas, but more common closer to Khan River. Widespread but has close	Y	X	X		X	X	X				X			NT

Order/ family	Species (common name) Status notes	Recorded (Y)	Habitat											Endemic	Conservation status
			R	rvd	pdc	pg	Bg	mg	gp	grp	hup	krp	Wp		
	association with rocky terrain.														
Vespertilionidae	*Cistugo seabrai* (Angolan hairy bat) Poorly known, may be synonymous with *C. Lesueri*		X?											Namib (near)	NT
Equidae	*Equus zebra hartmannae* (Hartmann's mountain zebra) Near-endemic sub-species with fragmented population in Namibia. Tinkas-Khan population is largest in protected area. Important functional role as only large grazer that occurs in any numbers in central Namib.	Y	X	X	X	X	X	X	X	X	X	X	X	Namib	VU

Birds

A detailed list of bird species is included in Appendix 1 of the biodiversity report attached in Appendix F (AWR 2011). Of the 66 species that are endemic or near-endemic to the subcontinent, nine are near-endemic to Namibia including one species that is also endemic to the Namib, namely Gray's Lark. The other Namibian near-endemics are Rüppell's Parrot, Rosy-faced Lovebird, Bradfield's Swift, Rüppell's Korhaan, White-tailed Shrike, Carp's Tit, Rockrunner and Herero Chat. Twenty-five species within the study area are threatened (see Table 4-8).

Some species are considered to be especially at risk of impacts caused by the linear infrastructure. These species can be divided into aquatic/semi-aquatic species, raptors, large terrestrial species and other, sedentary species. Further discussion on each is provided below.

Aquatic and semi aquatic bird species

Lesser Flamingo and Greater Flamingo are classed as aquatic/semi aquatic species. They are nomadic and migrate on a sub-continental scale. They appear to use watercourses as flight paths between the coast and inland, aligned from the northeast to the southwest. There is a strong possibility that these flamingos make use of the Khan and Swakop rivers as a flight path, although this is not confirmed. Because flamingos fly at night, and in groups, they are prone to collisions with electricity structures, especially the thinner, less visible earth/optic wires above the larger conductor wires. The situation may be aggravated by adverse weather conditions associated with wind, dust and fog. During these conditions the birds appear to fly lower for shelter. In such situations, the canyons of large river systems such as the Khan would provide significant shelter, but they may also be conduits for fog, which would reduce visibility. If these are migration routes, new power lines would present an unforeseen threat.

Other aquatic/semi aquatic species of conservation concern that are nomadic and prone to collisions with overhead lines, include Great White Pelican (recorded in the western parts of the study area), Black Stork, Abdim's Stork, White-Breasted Cormorant, South African Shelduck, Maccoa Duck, Cape Shoveler, Cape Teal, Red-billed Teal, Hottentot Teal and Southern Pochard.

TABLE 4-8: BIRD SPECIES OF CONSERVATION CONCERN

Movmt *= Movement: Res: resident, Sed: sedentary, Nom: nomadic, Migr: migratory; Rare; Vagrant*

Prob *= Probability (occurrence in 1-9 bird atlas grids): H: High (6-9), L: Low (0-4).*

Habitat codes *are: r: Khan River, rvd: Rocky Valley Drainages, pdc: Plains Drainage Channels; pg: Pink Gramadoelas, bg: Black Gramadoelas, mg: Marble in Gramadoelas, gp: Gypsite Plain, grp: Grassy Plain, hup: Hard Undulating Plain, krp: Koppies and Ridges on Plains, Wp: Welwitschia Plain.*

Endemic status *indicates whether the species is restricted to a specific geographic area: Namib refers to the Namib desert; Namibia to the country's geopolitical boundaries and subcontinent to the southern African region (with the Zambezi and Kunene Rivers as northern borders).*

Conservation status *refers to IUCN status: CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near threatened, LC: Least Concern, LR: Lower Risk, NE: Not Evaluated, DD: Data Deficient, GT globally threatened.*

Family	Species (common name)	Movmt	Prob	Habitat in Project Area											Endemic status	Cons. status
				r	rvd	pdc	pg	bg	mg	gp	grp	hup	krp	Wp		
Anatidae	*Oxyura maccoa* Maccoa Duck	Sed, Nom	3	X												NT
Phoeniculidae	*Phoeniculus damarensis* Violet Wood-Hoopoe	Sed	1	X	X											E
Psittacidae	*Poicephalus rueppellii* Rüppell's Parrot	Sed, Nom	4	X	X										Near-endemic (Namibia)	NT
Strigidae	*Bubo capensis* Cape Eagle-Owl	Sed	2	X	X								X			NT
Otididae	*Neotis ludwigii* Ludwig's Bustard	Nom	7							X	X				Near-endemic (subcontinent)	V
	Ardeotis kori Kori Bustard	Sed,Nom	3	X	X	X				X	X	X				V
Charadriidae	*Charadrius pallidus* Chestnut-banded Plover	Sed, Nom,	1	X												NT

Family	Species (common name)	Movmt	Prob	Habitat in Project Area											Endemic status	Cons. status
				r	rvd	pdc	pg	bg	mg	gp	grp	hup	krp	Wp		
		Mig														
Laridae	*Larus hartlaubii* Hartlaub's Gull	Sed, Nom	1	X											Endemic (subcontinent)	V
	Sterna caspia Caspian Tern	Sed, Nom	1	X												NT, V
Accipitridae	*Gyps africanus* White-backed Vulture	Sed, Nom	2	X	X	X	X	X	X	X	X	X	X	X		V, NT
	Gyps coprotheres Cape Vulture	Rare, Nom	1	X	X	X	X	X	X	X	X	X	X	X	Near-endemic (subcontinent)	CE in Namibia, CE, GT
	Aegypius tracheliotos Lappet-faced Vulture	Sed, Nom	1	X	X	X	X	X	X	X	X	X	X	X		V, V, GT
	Aquila rapax Tawny Eagle	Sed	2	X	X							X	X			V, E
	Aquila verreauxii Verreauxs' Eagle	Sed	6	X	X		X	X	X							NT
	Aquila pennatus Booted Eagle	Sed, Nom, Mig	3	X	X		X	X	X			X	X			E
	Polemaetus bellicosus Martial Eagle	Sed	3			X				X	X	X		X		V, E
Sagittariidae	*Sagittarius serpentarius* Secretarybird	Sed, Nom	3			X				X	X	X				NT
Falconidae	*Falco naumanni* Lesser Kestrel	Mig	1			X				X	X	X		X		V, NT, GT
	Falco biarmicus	Sed,	4	X			X	X		X	X	X	X			NT

Family	**Species (common name)**	**Movmt**	**Prob**	**Habitat in Project Area**											**Endemic status**	**Cons. status**
				r	**rvd**	**pdc**	**pg**	**bg**	**mg**	**gp**	**grp**	**hup**	**krp**	**Wp**		
	Lanner Falcon	Mig														
	Falco peregrinus Peregrine Falcon	Sed, Mig	4	X	X		X	X	X							NT, NT
Phalacrocoraci-dae	*Phalacrocorax coronatus* Crowned Cormorant	Rare	1	X											Endemic (subcontinent)	NT, NT, GT
Phoenericopteri-dae	*Phoenicopterus ruber* Greater Flamingo	Sed, Nom, Mig	2	X												NT, V
	Phoenicopterus minor Lesser Flamingo	Sed, Nom, Mig	2	X												NT, V, GT
Pelicanidae	*Pelecanus onocrotalus* Great White Pelican	Sed, Nom	5	X												NT, V
Ciconiidae	*Circonia nigra* Black Stork	Sed, Nom	1	X	X											NT, E

Birds of prey

Being wide-ranging, birds of prey are vulnerable to mortality due to poisoning, persecution, electrocution from perching or nesting on electrical infrastructure, collisions with overhead lines, disturbance of breeding sites and habitat loss. As they are slow-breeding with low fecundity, the recovery from population decreases is low, rendering them highly vulnerable to this type of unnatural mortality. The Lappet-faced Vulture is *Vulnerable* with an estimated global population of only 8 500. The Namib-Naukluft National Park may harbour one of two largest populations of these birds where an estimated 40-50 pairs are known to occur. Vultures are extremely sensitive to disturbance during the breeding season. The core nesting area at Ganab is only about 150 km southeast of the study area, and it is likely that both adult and juvenile birds use most parts of the study area for foraging, roosting and possibly nesting. White-backed Vulture is less common in the study area but also at risk from electrocution. While the Globally Threatened Cape Vulture has been recorded in the easternmost part of the study area, it is very rarely encountered in Namibia, and is unlikely to be affected by the linear infrastructure of the current project.

Large eagles are also prone to electrocution and collisions on power lines. These include Martial Eagle Black-chested Snake Eagle (Short-toed Snake-eagle *Circaetus gallicus*), the Tawny Eagle Verreaux's Eagle, the nomadic Booted Eagle, Steppe Eagle, African Hawk-Eagle, Secretary Bird, Augur Buzzard, and Jackal Buzzard.

Nesting by Rock Kestrel and Greater Kestrel on electricity structures, including substations, is a potential cause of outages. These birds frequently use old crows' nests.

Electrocutions of owls on transformer boxes and other structures are reported fairly regularly in Namibia. In the study area owl species at risk would include Spotted Eagle-Owl, Cape Eagle-Owl, and Barn Owl.

Terrestrial bird species

Ludwig's Bustard is *Endangered* and near-endemic to South Africa and Namibia, extending partly into Angola. It has been recorded in most of the study area, particularly on the plains in the eastern and southern parts. The bustard group as a whole is currently experiencing population declines, with Ludwig's Bustard amongst the most threatened. Specific threats include high mortalities as a result of collisions with overhead power lines, which are considered to have reached unsustainable levels. Recent research indicates that restricted binocular vision is likely to be a key factor in Ludwig's Bustard collisions on power lines. Kori Bustard is regarded as *Vulnerable* and may be similarly at risk, although less common in the area. Rüppell's Korhaan is near-endemic to Namibia, with its distribution extending only marginally to south-western Angola. This species is very well represented in all the study area. In attempting to escape from (vehicle) disturbance, these birds have been observed to fly upwards in a confined space, such as the old Khan Mine valley or the proposed permanent road valley, where power line structures (including stay wires) would constitute a threat to this type of behaviour. Northern Black Korhaan may be found on the plains, where there is probably less threat from collision.

Although rated of *Least Concern*, the genetic identity of the wild population of Common Ostrich is threatened throughout its southern African range by the translocation of domesticated 'Oudtshoorn' ostriches from South Africa. There are no data on the size of the southern African wild population of Common Ostrich, but it is likely to be small, hence the protection of the wild population, especially in parks, is critical. Common Ostrich is thus at risk because of its conservation status and ecology. The species is nomadic and widespread throughout the study area. Because of its habit of running blindly, especially in confined spaces such as the valleys mentioned above, the species may be prone to collisions with stay wires on power line structures, or to road kills.

Smaller terrestrial species such as Red-billed Spurfowl, Namaqua Sandgrouse and Double-banded Sandgrouse may also be prone to collisions especially with stay wires and vehicles. Helmeted Guineafowl is locally a common resident, but decreases in numbers have been recorded in some areas since the 1980s. This species may also be susceptible to electrocution on power lines as well as collisions with stay wires, and road kills.

<u>Other sedentary species</u>

Gray's Lark is endemic to the Namib Desert and is locally fairly common. However, it is resident, sedentary, and locally nomadic. All populations within the linear infrastructure footprint are thus at risk from being displaced by disturbance resulting from construction activities. Although fairly numerous, the species has a relatively low fecundity. It forages around zebra and antelope droppings and entrances of rodent burrows, and may thus depend on these organisms for food. Gray's Lark is at risk because of its conservation status and ecology, but the risk is probably relatively small.

Both Freckled Nightjar and Rufous-cheeked Nightjar are likely to roost on roads at night, and would then be at risk from road kills.

One more group of birds that could be implicated in causing nest-induced faults on electrical systems includes crows. Both Pied Crow and Cape Crow are ubiquitous and nest freely on human-made structures, often using pieces of scrap wire which can cause shorts. Nesting by the Sociable Weaver on power line structures is also a potential problem, as this species is the cause of widespread outages elsewhere in the country.

Reptiles

In many respects, the study area is an ecotone for reptile assemblage (an area that has overlapping reptile distributions). Most importantly, it is located at the core of the known range of a lizard that has a particularly small geographic distribution, the Husab Sand Lizard. Altogether, the above makes the study area of high significance for reptiles.

The most common species are the coastal Namib day geckos, common barking geckos, Namaqua chameleons, short-headed sand lizards and the Western three-striped skink. Husab sand lizards appear to be common on marble ridges, most notably on the marble ridge located in the Gramadoelas. It may favour patches of light rock on dark rock, possibly for the thermal range.

The most abundant snake species are the horned adder and the Namib sand snake. The Koppies and Ridges on Plains was the most diverse, but the Welwitschia Plains, the vegetated Plains Drainage Channels, and the Khan's tributaries also have a high diversity. The Grassy Plains habitat is intermediate, while the Black Gramadoelas and Gypsite Plains have relatively low reptile diversity. The highest numbers of chameleons was recorded in the canopies of *Arthraerua leubnitziae* shrubs.

A list of 23 reptile species was compiled from observations in the study area, and it is expected that a further 30 species might occur. A full list of species is included in the biodiversity report that was compiled for the Husab Mine EIA (AWR 2010). All but seven of the 53 species are endemic to the sub-continent, approximately 53% to Namibia, approximately 21% to the Namib, and approximately 9% to the central Namib. Two species are considered vulnerable and four species are data-deficient, to be treated as vulnerable. One species is considered to be potentially at high risk from the project, namely, the Husab Sand Lizard.

TABLE 4-9: REPTILE SPECIES OF CONSERVATION CONCERN

Habitat codes are: r: Khan River, rvd: Rocky Valley Drainages, pdc: Plains Drainage Channels; pg: Pink Gramadoelas, bg: Black Gramadoelas, mg: Marble in Gramadoelas, gp: Gypsite Plain, grp: Grassy Plain, hup: Hard Undulating Plain, krp: Koppies and Ridges on Plains, Wp: Welwitschia Plain. Endemic status indicates whether the species is restricted to a specific geographic area: central Namib refers to the region between the Kuiseb and Ugab Rivers; Namib refers to the Namib desert; Namibia to the country's geopolitical boundaries and sub-Region to the southern African region (with the Zambezi and Kunene Rivers as northern borders). Conservation status refers to IUCN status: VU: Vulnerable, NT: Near threatened, DD: Data Deficient.

ORDER Family	Species (common name) • Status notes	Recorded (Y)	Habitat in Project Area											Endemic status	Conservation status
			R	Rvd	pdc	pg	Bg	mg	gp	grp	hup	krp	wp		
CHELONIA (TORTOISES)															
Testudinidae (tortoises)	*Stigmochelys pardalis* (leopard tortoise)		X	X											VU
SERPENTES (SNAKES)															
Atractaspididae (African burrowing asps)	*Atractaspis bibronii* (Bibron's burrowing asp) • Soft ground, washes • Presumably local population with small distribution around Arandis could be nov.sp. (J.D.Visser pers.comm.) • conservation status sensitive, following precautionary principle		X	X	X								X	central Namib	DD
	Telescopus nov.sp. (Damara tiger snake) • Rocks, hills • Unnamed species, locally distributed					X	X	X			X	X	X	Namib Desert	DD
LACERTILIA (LIZARDS)															
	Pedioplanis husabensis	Y				O	O	O				O		central	DD

ORDER Family	Species (common name) • Status notes	Recorded (Y)	Habitat in Project Area											Endemic status	Conservation status
			R	Rvd	pdc	pg	Bg	mg	gp	grp	hup	krp	wp		
	(Husab sand lizard) • among boulders and on koppies • species confined to core of Uranium Province, high potential of cumulative impacts • possibly VU													Namib	
	Pedioplanis nov.sp. cf. *inornata* (Northern plains sand lizard) • rocky plains • species being described • study area is thought to be near the southern boundary of wider distribution between Swakop and Ugab rivers, probably LC	Y									O		X	central Namib	DD
	Pedioplanis namaquensis quadrangularis (poss.nov.sp.) quadrangular Namaqua sand lizard) • sandy hummocks around vegetation • northern subspecies of Namaqua sand lizard likely to be elevated to species level • this subspecies is widespread in northern Namibia, probably LC		X	X	X				X				X	Namibia	DD
Varanidae (monitors)	*Varanus alibgularis* (rock monitor) • Khan riparian enables it to intrude desert • High risk of poaching makes this species vulnerable		X	X											VU

Amphibians

In the Namib, living conditions for frogs occur only in the form of springs and ephemeral pools. Four amphibian species have ranges that overlap with the study area. A full list of species is included in the biodiversity specialist study that was done as part of the Husab Mine EIA (AWR 2010). None were recorded during field surveys for this project, but all were previously recorded by the authors in nearby areas of the Namib Desert. Although none of these species have a special conservation status, the occurrence of amphibians in this hyper-arid area is considered to be of special significance, and their habitats worthy of special attention. This is because living conditions for frogs occur only at a few small pools, and these are usually temporary in nature. Management of amphibians will simultaneously benefit many other aquatic organisms, most of which have dormant phases tolerant of drought.

4.5.3.3 Ecological functions and processes relevant to the study area

In a desert the surface flow and capture of water is one of the most important factors that determine the presence and spatial distribution of organisms. Water, in the study area, flows on and below the surface in washes on the plains and in the Khan and Swakop Rivers and associated tributaries and springs. This water source supports a wide range of fauna and flora which is relevant when considering the proposed temporary abstraction of water from the Swakop River for construction purposes. Fog is the second major source of moisture for desert organisms, and the regular occurrence of fog is therefore an important ecological process.

As in any ecosystem, the primary source of energy is the capture of solar energy through photosynthesis by plants. The consumption of plants by herbivores, and the subsequent consumption of the herbivores by predators and later by decomposers, as well as the consumption of herbivores' faeces by detritivores constitute a chain of energy flow through the ecosystem. The health and continued pollination of the plant community is therefore of primary importance in laying the foundation for a healthy ecosystem. Nutrient sources are the atmosphere, base material, and organic material. Erosion supplies minerals such as phosphate and magnesium, while nitrogen is primarily fixed by micro-organisms from free nitrogen molecules in the air. Most of the nutrients are made biologically available by the actions of plants and micro-organisms. The flow of these nutrients through the ecosystem is therefore primarily a function of how herbivores and carnivores consume and re-constitute the nutrients into different forms, and then re-distribute these across space through their droppings and, eventually, their rotting carcases.

Shelter is a key function for breeding in particular. In this regard, certain plant species such as large camel thorn (*Acacia erioloba*) trees in the drainage lines form key habitats for a range of invertebrate and vertebrate species, and provide nesting space for iconic and threatened bird species such as the Lappet-faced Vulture. Both the shelter provided by certain plants and the shelter provided by physical habitat are important. A number of small mammal species (dassie rat, Namibian pygmy rock mouse, etc.) are rupicolous (living on rocky habitats) and require the specific small-scale complex physical geography that provides the appropriate types of shelter. Both forms of shelter can be destroyed during the construction of the linear infrastructure.

One of the most important issues concerning mammals is the concept of linkages and free movement which can be threatened by man-made barriers such as pipelines and elevated roads. Food sources of especially large herbivores, being a function of variable rainfall, will be variable within and between seasons and years. These species therefore need to be able to move freely across large areas to obtain enough food. The Rocky Valley Drainages and certain parts of the Grassy and Gypsite Plains are probably key areas where significant movement occurs. Carnivores, being secondary consumers, likewise need disproportionately large areas to obtain their food. Savanna species require unfettered access to the length of the river courses. Water-dependent species (kudu, zebra) require access to a suite of water points. All medium to large mammals critically need to be able to move over large areas to maintain social cohesion among often widely scattered individuals.

The occurrence of point resources, such as springs, and the spatial separation of food sources dictate that topographical linkages (‘corridors’) will exist. In the study area these linkages comprise topographical features like valleys and parts of the plains.

A particularly important issue related to the linear infrastructure and Husab Mine is the movement of large mammals between the Welwitschia Plain and the Khan and Swakop Rivers, and further south from the Swakop River. Hartmann’s mountain zebra may be considered a key species, both because of its conservation status and its potential functional role in the flow of nutrients through the arid ecosystem. All the larger herbivores may in fact contribute to the flow of nutrients (although their roles may be smaller than that of the zebra), while smaller mammals may play important roles in maintaining productivity and creating nooks and crannies to be utilised by other species in the rocky areas. Gerbils may play the role of ecosystem engineers, facilitating higher grass productivity on the otherwise bare plains.

Birds (like other reptile and mammal predators and scavengers) also play important functional roles in the study area. Birds of prey and large terrestrial predator birds, including vultures, eagles, owls, korhaans and bustards that are found in many of these habitats are likely to be important predators and thus regulators of the large gerbil populations that occur on the plains. Both Lappet-faced Vulture and White-backed Vulture are important scavenging birds of prey, cleaning up carcasses and preventing the spread of diseases. Cape Crow and Pied Crow are omnivores that also scavenge, e.g. from road kills. Specialized pollinators include three nectivorous sunbird species. The threats to birds from traffic and power supply infrastructure have been discussed above.

4.5.3.4 Habitat sensitivity

The final integration of sensitivity ratings across all taxa was based on a qualitative assessment of how the mammal, bird, reptile, amphibian and invertebrate communities should alter the original habitat ratings based mainly on plants. Habitat sensitivities are presented on Figure 4-9. Most importantly for the linear infrastructure, part of the Welwitschia Plain is a No Go Area and the Khan and Swakop River valleys are considered extremely sensitive.

FIGURE 4-9: SENSITIVITY OF COLLECTIVE HABITATS

4.5.4 CONCLUSION

The study area is important for the central Namib biodiversity because it is situated in a triangular area in close proximity to two significant rivers (the Khan River to the northwest and the Swakop River to the south). It is the view of the biodiversity team that these rivers and associated valleys allow water and nutrients to reach into the desert from the wetter hinterland and fog to reach further into the desert from the coast than would be expected. Given that water and nutrients are key ecological drivers in the desert this is an important and unique aspect that drives the habitats, floral life and faunal life in, and adjacent to, the study area.

Moreover, on the plains there is surface geological complexity that underpins the diversity of ecological conditions and habitats. In addition, the system of surface washes that channel sheet run-off across the plains to the south and south west (and possibly recharge shallow perched aquifers) appear to support a significant population of the well-known and much publicised *Welwitschia mirabilis.*

The contrasting habitats associated with the plains, the river valleys and the transitional zones in-between provides a range for many taxa of conservation importance some of which are endangered, data deficient, vulnerable, near threatened and/or protected.

In conclusion, it follows that the study area hosts significant biodiversity composition, structure and processes. The development of the linear infrastructure has the potential to threaten all three of these parameters and therefore project layout, process design and on-going management must take this into account. In particular, the more sensitive areas must be avoided, linkages between habitats must be maintained and processes such as water and nutrient flows must be impeded as little as possible.

4.6 SURFACE WATER BASELINE

This information in this section was sourced from the specialist hydrology study attached in Appendix G (Metago 2011).

4.6.1 INTRODUCTION AND LINK TO IMPACTS

In the context of the desert environment most surface water either evaporates or percolates into the ground. In some instances strong rainfall leads to temporary pools or flowing surface water resources. Regardless, water is a key driver in the desert environment both in terms of consumption and use by humans and biodiversity in the broadest sense.

The permanent road in particular has the potential to change surface flow patterns and to pollute surface water resources from spillages in the construction, operational and decommissioning phases. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.6.2 DATA COLLECTION

The following activities took place for data collection:

- Site inspections.
- Sourcing and review of rainfall data from Rössing mine and Langer Heinrich mine.
- Interpretation of elevation survey information.
- Flood hydrology calculations and analysis.

4.6.3 RESULTS

4.6.3.1 Surface drainage and catchments

All the rivers in the area are non-perennial, with flow only taking place after major rainfall events. The rainfall event data has been included in Section 4.1.3.

The most significant rivers in the study area are the Khan and Swakop Rivers. Both are incised into rugged valleys. The Khan is approximately 3km to the west of the Husab Mine site and the Swakop is approximately 20km to the south of the Husab Mine site. The confluence of these two rivers is approximately 23 km southwest of the Husab Mine site, still some 45km from the coast. Both river systems have subsurface stream flow in the river alluvium.

The plains area, to the north and south of the Swakop River, drain gently to towards the Swakop River in a number of washes. To the west of the Husab Mine site there is a catchment divide (which forms a surface flow divide) and surface water flow to the west of the divide flows into the Khan River. Surface water catchments and flows for the plains area on and upstream of the Husab Mine site were calculated for the purpose of designing mine infrastructure to cater for a minimum of the 1:100 year flood event as part of the Husab Mine EIA (Metago, 2010). This information will not be repeated in this report.

Additional work has been done to determine catchments and flows in the Khan River system which is particularly relevant to the proposed new permanent road and associated river culverts and crossings. In this regard, three catchments have been delineated for the side tributaries along the road route. Flows and flood lines for the 1:100 year storm event have been calculated for water courses along the road route. The predicted flood lines are all contained within the valley and canyon walls. The predicted flow rates for the side tributaries (catchments 1, 2 and 3) range between 1.5m^3/second to 5m^3/second. The predicted flow rate in the main Khan River is 275m^3/second. This is shown on Figure 4-10.

FIGURE 4-10: CATCHMENTS AND FLOWS ALONG THE PERMANENT ROAD ROUTE

4.6.3.2 Surface water use

The term surface water in the context of a desert environment covers both water that is found on the surface (albeit temporarily in most cases) and water that is found in the upper parts of the ground water regime. The most apparent surface water users are fauna, flora and humans. Detailed discussion on these uses is provided in Sections 4.5 and 4.7 respectively.

4.6.3.3 Surface water quality

No surface flow was available at the time of the field investigations. Information on sub surface water quality is provided in Section 4.7.

4.6.4 CONCLUSION

Project design and implementation must be done in a way that pollution of water resources is prevented. This is particularly relevant for infrastructure construction in the Khan and Swakop drainage systems. Moreover, care is required to ensure that surface run-off patterns are disturbed as little as possible to promote the continued flows of water and nutrients.

An added issue is the design of flood protection measures for the permanent road in particular. These measures will be needed to maintain infrastructure integrity in flood events and to safeguard road users.

4.7 GROUNDWATER BASELINE

The information in this section was sourced from the specialist hydrogeology study attached in Appendix HH (BIWAC, 2011).

4.7.1 INTRODUCTION AND LINK TO IMPACTS

Water is a key driver for fauna, flora and humans in the desert environment. It is therefore significant that the project may impact on both groundwater quantity and quality. The linear infrastructure is not expected to materially impact on groundwater save for the risk of isolated pollution events from spillages during construction, operation and decommissioning. The main activity that can influence groundwater is the abstraction of water from the Swakop River alluvial aquifer.

4.7.2 DATA COLLECTION

The groundwater baseline information was obtained from:

- A desktop study of existing groundwater information. Two important reference sources are the Uranium Rush SEA (SAIEA, 2010) and the Husab Mine EIA (Metago, 2010).
- A review of available geological data.

- Sampling, testing and analysing of boreholes in the Ida Dome Compartment (IDC) of the Swakop River.

4.7.3 RESULTS

4.7.3.1 Identified aquifers and water depths

The Swakop River can be described in compartments of approximately 25km in length. These compartments are separated by basement highs covered by shallow alluvial deposits of 5m maximum depth. All basement highs are characterised by a shallow water table and dense vegetation which results in high evapotranspiration rates. Water levels in the compartments between the basement highs are found at depths of between 23m to 26m. The compartment that has been targeted for possible use by Swakop Uranium is the IDC (see Figure 4-11).

Similar alluvial aquifer descriptions are associated with the Khan River. There are no plans to abstract water from the Khan River, but pollution impacts from spillages are possible.

Perched aquifers are thought to occur on the plains in association with the washes. In addition, bedrock aquifers exist at depths of approximately 60m below the plains that are located to the north and south of the Swakop River. No impacts are expected on these aquifers from the linear and related infrastructure.

4.7.3.2 Existing groundwater use

At and downstream of the Khan and Swakop River confluence (the confluence is more than 10km from the closest proposed abstraction borehole), land users and farmers abstract water for unspecified and unmetered domestic/irrigation uses (see Figure 4-11). More than 20km upstream of the IDC Langer Heinrich Mine abstracts water from a series of boreholes to supply a portion of its operational requirement. An obvious related concern is the impact of abstraction on vegetation and human users, particularly the IDC and downstream users.

The hydrocensus undertaken as part of the Husab Mine EIA did locate 23 borehole to the east of the mine site, only six of which are currently used for domestic purposes and livestock watering. The closest of these is approximately 19kms from the Husab Mine site and is on the eastern side of the mountain range to the east of the site (Metago 2010). Given that there is a geological disconnect between the Swakop River alluvium and the bedrock boreholes, and that the proposed Swakop Uranium abstraction boreholes are located more than 20km downstream of the closest bedrock borehole no impacts are expected on these groundwater users.

4.7.3.3 Groundwater Recharge

With a rainfall of under 100mm per annum, recharge to most aquifers (especially bedrock aquifers) is expected to be very low (under 1% of total rainfall). Where surface water runoff is concentrated (ie alluvial aquifers in rivers) recharge to the aquifer systems can be enhanced. The Khan and Swakop Rivers are recharged after all large flood events, although surface runoff generated in the higher rainfall inland areas seldom reaches the coast, resulting in lower recharge to the alluvial aquifers in the coastal areas.

4.7.3.4 Groundwater quality

A summary table of the baseline water quality in and around the project site is provided in Table 4-10. Sampling locations are presented on Figure 4-11. In most cases, the samples indicate that the groundwater does not comply with either the drinking water guidelines of WHO or the Namibian class A and B guidelines.

TABLE 4-10: BASELINE WATER QUALITY IN THE ALLUVIAL AQUIFER OF THE SWAKOP RIVER AND DOWNSTREAM OF THE KHAN RIVER

Single set sample data from SEA (SAIEA 2010) and quarterly monitoring by Biwac (Biwac 2011)

	Total dissolved solids (TDS)mg/l	Ph	Chloride (Cl) - mg/l	Sulphate (SO_4) - mg/l	Uranium (U) - mg/l	Calcium (Ca) -mg/l	Magnesium (Mg) – mg/l	Sodium (Na) – mg/l	Potassium (K) – mg/l
WHO Guideline & Namibian Group A & B Guideline	1000 No Guideline	6.5 to 8.5 6 to 9	250 250 to 600	250 250 to 600	0.015 1 to 4	no guideline 150 to 200	no guideline 70 to 100	200 100 to 400	no guideline 200 to 400
SW1	3465	7.2	1614	354	0.038	314	83	786	37
SW2	4354	7.1	1908	513	0.038	424	109	919	43
SW3	5306	7.2	2397	591	0.042	444	121	1249	54
SW4	3953	7.2	1651	362	-	310	78	804	38
SW5	4221	7.3	1774	369	-	346	85	839	39
SW6	4428	7.2	1749	523	-	397	94	862	43
HH1	4290	7.2	1276	280	-	204	51	656	33
HH2	7514	6.9	3807	952	-	1048	182	1487	56
PMH	6256	7.1	2454	1082	-	514	170	1328	54
WW41075	5345	6.9	2187	1010	-	394	163	1290	51
BH1	4678	7.0	2049	452	-	367	91	970	42

FIGURE 4-11: MONITORING BOREHOLES

4.7.4 CONCLUSION

In the context of the linear infrastructure project, dewatering of the IDC and Swakop River alluvial aquifer will always be a sensitive issue in the context of the desert environment.

Although the baseline water quality of most samples exceeds the WHO and Namibian drinking quality guidelines, the project design and implementation should aim to prevent pollution of this valuable resource.

4.8 AIR QUALITY BASELINE

Information in this section was sourced from the specialist study done for the Husab Mine EIA (Airshed, 2010).

4.8.1 INTRODUCTION AND LINK TO IMPACTS

The linear infrastructure will introduce new air emission sources into the environment. The more significant sources include dust entrainment from vehicle movement, and the exposure of soils and materials handling during construction. Depending on the concentration of the emissions and their related dispersion this may reduce air quality which can impact on third parties, flora and fauna.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.8.2 DATA COLLECTION

On site meteorology was obtained from the on site Husab weather station. This has been discussed and presented in Section 4.1.

A dust fallout network comprising eight single dust fallout buckets was installed on site in August 2009. The American Society for Testing and Materials (ASTM) standard method for collection and analysis of dust fall was used. Analysis was done by SGS laboratories in Swakopmund.

A desktop review of known emission sources in the region was also undertaken.

4.8.3 RESULTS

4.8.3.1 Sources and types of emissions

Source types present in the area and the pollutants associated with such source types were noted with the aim of identifying pollutants which may be of importance in terms of cumulative impact potentials. Sources identified as possibly impacting on air quality in the region include, but are not limited to:

- Fugitive and gaseous emissions from mining operations.
- Vehicle tailpipe emissions from national and main roads.
- Various miscellaneous fugitive dust sources (wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

Each of these is discussed below in more detail.

Existing Mining Operations

Current operating mines in the Erongo region include Rössing Uranium Mine, Langer Heinrich Uranium and Navachab Gold Mine. Valencia Uranium and Trekkopje mines are approved proposed uranium mines in the region. Of these operations the only one that is expected to influence the ambient air conditions around the Husab Mine and linear infrastructure is Rössing. In addition, the possible mining operations at the Etango Project could also add to the cumulative load in future. There are a number of small scale stone operations throughout the region with two large salt works located north of Swakopmund and south of Henties bay. These sources are however located too far away to have a significant influence on the air quality at the Husab Mine and linear infrastructure.

Fugitive dust sources associated with mining activities include drilling and blasting operations, materials handling activities, vehicle-entrainment by haul vehicles and wind-blown dust from tailings impoundments and stockpiles. Mining operations represent potentially the most significant sources of fugitive dust emissions (PM2.5, PM10 and TSP) with small amounts of oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), methane, and carbon dioxide (CO_2) being released during blasting operations and from mine trucks.

Vehicle Tailpipe Emissions

There are a number of main roads within the region. The B2 between Swakopmund and Usakos, and Swakopmund and Henties Bay is probably the busiest road in the area. Other roads within the immediate vicinity of the Husab Project include the unpaved C28 through the Namib Naukluft National Park (linking Swakopmund and Windhoek), the D1991 and the gravel road between the C28 and the big Welwitschia (tourist attraction).

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The significant primary pollutants emitted by vehicles include CO_2, CO, hydrocarbons (HCs), SO_2, NO_x, particulates and lead. Secondary pollutants include: nitrogen dioxide (NO_2), photochemical oxidants (e.g. ozone), HCs, sulphur acid, sulphates, nitric acid, nitric acid and nitrate aerosols. Toxic hydrocarbons emitted include benzene, 1.2-butadiene, aldehydes and polycyclic aromatic hydrocarbons (PAH).

Benzene represents an aromatic HC present in petrol, with 85% to 90% of benzene emissions emanating from the exhaust and the remainder from evaporative losses.

Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads, and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and on the silt loading on the roadways. The areas prone to wind erosion within the relevant region are significant. The extent, nature and duration of windblown dust is a function of the moisture and silt content of soils, the wind speed, and the extent of exposed areas. A distinct thin crust on the surface binds the material reducing the potential for wind erosion when undisturbed. When disturbed however, very fine loose materials are exposed to wind erosion. Aside from the roads and the tracks adjacent to the demarcated roads, mining activities in the area are the main source of dust generation.

4.8.3.2 Ambient air quality

As indicated, Swakop Uranium implemented a dust fallout monitoring network in the second week of August 2009 (see Figure 4-12). The monitoring will continued by the mine throughout the life of mine. Data from the monitoring campaign is provided in the sections below.

FIGURE 4-12: DUST FALLOUT AND PM10 MONITORING NETWORK

Dust deposition levels at Husab Mine

Available dust fallout results are depicted in Table 4-11. On average, dust deposition levels recorded over the twelve months were low and well within the German dust fallout category of 350 mg/m²/day and the SANS limit for residential areas of 600 mg/m²/day (Airshed, 2010). The highest levels were generally recorded at site EXT08 located close to the access road and near the public road to the Welwitschia area. The single highest level recorded was 256 mg/m²/day during Dec/Jan period at site EXT02 located downwind (southwest) from the exploration activities. The lowest dust fallout levels were recorded at EXT06, located near the northeastern boundary where there is not much activity at the moment. Drilling activities are generally expected to have contributed to the instances of higher recordings.

TABLE 4-11: DUST DEPOSITION LEVELS FOR THE MONTHS OF AUGUST 2009 TO JUNE 2010

Bucket ID	Dust Deposition levels (mg/m²/day)										
	Aug '09	Sep '09	Oct '09	Nov '09	Dec '09	Jan '10	Feb '10	Mar '10	Apr '10	Jun '10	Jul '10
EXT 01	30	49	22	11	31	24	4	27	10	104	16
EXT 02	34	51	13	5	256	21	2	12	6	145	14
EXT 03	39	47	9	17	7	19	8	14	8	100	14
EXT 04	38	48	16	21	7	20	15	13	6	138	8
EXT 05	31	45	13	21	2	19	1	30	5	159	13
EXT 06	33	28	22	6	7	21	7	10	7	136	11
EXT 07	47	50	19	0	3	23	1	19	5	187	10
EXT 08	40	56	22	15	17	30	11	25	12	108	16

Ambient PM10 concentrations

The SEA (SAIEA, 2010) Air Quality section provided background PM10 concentrations for the Etango site located approximately 30 km southwest of the Husab Mine. The results over the period March to November 2009 resulted in a period average PM10 concentration of 40 µg/m³ for the nine-months. The highest daily concentration recorded is 329 µg/m³ and the World Health Organisation's (WHO) IT-3 of 75 µg/m³ was exceeded 11% of the time. The simulated PM10 concentrations for the SEA correlated well with the measured concentrations where available. Based on this information, Table 4-12 shows the ambient PM10 concentrations that apply to the potential receptors around the linear infrastructure.

TABLE 4-12: AMBIENT PM10 CONCENTRATIONS

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	242	610	550
PM10 annual (µg/m³)	65	160	90

In the context of the above baseline data, the background is already in excess of the evaluation criteria of 75 µg/m³ and 30 µg/m³, for highest daily and annual averages respectively.

4.8.4 CONCLUSION

While dust deposition levels are generally low and well within relevant guidelines and standards, PM10 levels are already in excess of the WHO evaluation criteria. Once the linear infrastructure commences there will be increased emission sources that will contribute additional dust fallout and PM10. Related impacts will require consideration and management, particularly if the effects of dust can influence third parties and sensitive biodiversity.

4.9 NOISE BASELINE

This information in this section was sourced from the specialist noise study that was done for the Husab Mine EIA (Acusolv 2010) and the opinion that was compiled for the linear EIA, and is attached in Appendix J (Acusolv 2011)

4.9.1 INTRODUCTION AND LINK TO IMPACTS

The linear infrastructure will introduce a number of noise sources into the study area. In the short term there will be construction noises, but the more significant noise sources are associated with vehicle movements in the operational phase in particular. The study area is considered to be relatively quiet with wilderness characteristics. Science has not progressed to the point that the impact of noise on biodiversity is understood so the potential for noise impacts is mentioned in the context of third parties only. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.9.2 DATA COLLECTION

4.9.2.1 Test equipment

For purposes of assessing baseline conditions in the study area, a survey was carried out during February 2010 at three points in the study area.

Noise measurements were carried out using the following equipment: Brüel & Kjaer Type 2260 Modular Precision Sound Analyser (Ser no. 1875497), Brüel & Kjaer Type 4189 Measurement Microphone (Ser no. 1858498), and Brüel & Kjaer Type 4231 Sound Calibrator (Ser no. 2606011).

4.9.3 RESULTS

As is expected in such a remote region the survey results indicate that daytime and night-time levels are 30 dBA. Moreover, ambient levels are practically the same everywhere. The exception is the area to the north and northwest where noise levels are influenced by traffic on the B2, Rössing Uranium mine and Husab's exploration activities.

The nearest inhabited location relative to the proposed development is Arandis village. It is situated not far from the B2 main road and at a distance of about 18 km from the Husab Project development, with an existing mining operation in-between. As such Arandis is estimated to be completely outside audible reach of noise originating from the proposed development. Hence no sample was taken in that area. Acceptable ambient level ratings for such a small village would be 50 dBA daytime and 40 dBA night-time, respectively.

In areas where the ambient level is determined predominantly by human activity and road traffic, the night-time ambient level is typically 10 dB lower than the daytime level. This includes typical rural residential districts. The implication of this is that the environment becomes considerably more sensitive to intrusive noise at night. In wilderness areas, such as the DNP and NNNP and in most of the study area under consideration, lack of human activity and road traffic results in this 10 dB difference falling away.

4.9.4 CONCLUSION

Ambient noise levels are low and represent a wilderness type environment. An increase in noise levels due to the linear infrastructure and related traffic in particular will increase ambient noise levels, which could have impacts on the visitor experience to the tourist and recreation attractions in the study area.

4.10 ARCHAEOLOGY BASELINE

Information in this section was sourced from the specialist study included in Appendix K (QRS 2011).

4.10.1 INTRODUCTION AND LINK TO IMPACTS

The proposed project has the potential to damage the land surface and associated archaeological resources through physical disturbance of the land. The main activities that could cause this disturbance are the placement of linear infrastructure and construction and decommissioning related activities and facilities. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.10.2 DATA COLLECTION

The field survey was carried out on foot using parallel compass transects. All archaeological finds were logged in the field using a hand-held GPS (error 3m) as described according to standard criteria. Field notes were augmented with photographs and field sketches where necessary. The survey also determined the archaeological or cultural affinity of each site, noting this as to the specific activity that was carried out there or the type of remains observed.

4.10.3 RESULTS

The most notable archaeological resources that could be affected by the linear infrastructure and related construction activities are the remains of the old Khan Mine, the remains of the narrow gauge railway line - particularly the Welwitschia siding, and the high density archaeological area of mainly second millennium AD hunter-gatherer activity with a single specimen of the !nara *Acanthosicyos horridus* around the Husab Spring.

The other findings are isolated scatterings, seed diggings and shelters from the Middle Stone Age (MSA), Later Stone Age (LSA) and the second millennium AD. Together these isolated findings provide an overview of the general archaeological landscape.

Table 4-13 provides a list of the archaeological sites that were identified and documented. Figure 4-13 and Figure 4-14 indicate the distribution of archaeological sites in relation to the linear infrastructure.

TABLE 4-13: LIST OF ARCHAEOLOGY SITES PRESENTED ON FIGURES 4-13 AND 4-14

Site	Description
QRS 72/1	Surface scatter later stone age (LSA) yellow chert
QRS 72/2	Surface scatter LSA yellow chert
QRS 72/3	Isolated core fragment
QRS 72/4	Earth embankment part of the narrow-gauge track
QRS 72/5	Earth embankment dump
QRS 72/6	Earth embankment
QRS 72/7	Stone post anchors of hut/windbreak
QRS 72/8	Surface scatter 19th/early 20th century green glass
QRS 72/10	Dispersed surface scatter yellow-brown chert
QRS 72/15	Shuttered concrete bridge supports for narrow gauge railway
QRS 72/16	Endpoint of narrow gauge railway embankment
QRS 72/20	Thin scatter flaking debris
QRS 72/21	Possible chert quarry
QRS 72/22	Dispersed flaking area, yellow-brown chert
QRS 72/23	Localized scatter flaked yellow-brown chert
QRS 72/24	Localized scatter of flaked yellow-brown chert
QRS 72/25	Thin surface scatter ostrich eggshell
QRS 72/26	Surface scatter artefact debris, yellow-brown chert.
QRS 72/27	Localized flaking scatter yellow-brown chert, 500m2 25 objects/m2.
QRS 72/28	Dense localized scatters
QRS 72/29	More or less continuous artefact flaking scatter.
QRS 72/30	Localized artefact debris scatter, chert and hydrothermal vein quartz

QRS 72/41	Narrow gauge railway siding
QRS 72/81	seed digging
QRS 72/83	seed digging
QRS 72/84	seed digging
QRS 72/85	seed digging
QRS 72/86	seed digging
QRS 78/ 18	Khan Mine historical infrastructure
QRS 78/ 19	Khan Mine historical infrastructure
QRS 78/ 25	Khan Mine historical infrastructure
QRS 78/ 38	Khan Mine historical infrastructure
QRS 78/ 39	Khan Mine historical infrastructure
QRS 78/ 40	Khan Mine historical infrastructure
QRS 78/ 41	Khan Mine historical infrastructure
QRS 78/ 42	Khan Mine historical infrastructure
QRS 78/ 43	Khan Mine historical infrastructure
QRS 105/1	shelter LSA, pebble tool Overlooking saline spring
QRS 105/2	scatter LSA yellow chert core
QRS 105/3	seed digging 2nd millennium (mill) none caliche
QRS 105/4	scatter LSA dispersed
QRS 105/5	scatter LSA yellow chert 10x10m
QRS 105/6	seed digging 2nd mill manuports
QRS 105/7	scatter LSA yellow chert on southern slope
QRS 105/8	scatter LSA yellow chart
QRS 105/9	seed digging 2nd mill
QRS 105/10	seed digging 2nd mill manuports
QRS 105/11	seed digging 2nd mill low ridge
QRS 105/12	shelter LSA manuports low, south facing
QRS 105/13	scatter LSA vein quartz eastern slope 10x20m <25pcs/m2
QRS 105/14	seed digging 2nd mill 3-4 diggings in group c50mdiam
QRS 105/15	scatter LSA yellow chert 50x50m >25pcs/m2
QRS 105/16	shelter LSA vein quartz
QRS 105/17	scatter LSA hornfels
QRS 105/18	scatter LSA yellow chert <2pcs/m2
QRS 105/26	earthworks historical embankment of narrow gauge railway
QRS 105/27	earthworks historical coal, cinders, scrap iron
QRS 105/28	seed digging 2nd mill none
QRS 105/33	seed digging 2nd mill 4 diggings in 60m dia
QRS 105/34	seed digging 2nd mill 3-4 diggings
QRS 105/35	stone feature 2nd mill 2 hut circles
QRS 105/36	seed digging 2nd mill
QRS 105/44	shelter LSA manuports
QRS 105/45	seed digging 2nd mill
QRS 105/54	stone feature LSA 2 hunting blinds 0.9x1.8m facg 230deg in saddle
QRS 105/55	seed digging 2nd mill
QRS 105/56	seed digging 2nd mill
QRS 105/57	seed digging 2nd mill
QRS 105/59	scatter MSA chert flake
QRS 105/60	seed digging 2nd mill
QRS 105/61	seed digging 2nd mill
QRS 105/62	seed digging 2nd mill
QRS 105/63	seed digging 2nd mill
QRS 105/64	seed digging 2nd mill
QRS 105/82	Miscellaneous finds
QRS 132/ 336	Historical dump site
QRS 132/ 342	Historical dump site
QRS 132/ 343	Historical dump site

QRS 132/ 90	Historical survey cairn
QRS 132/ 92	Historical survey cairn

FIGURE 4-13: ARCHAEOLOGICAL SITES - NORTH

FIGURE 4-14: ARCHAEOLOGICAL SITES - SOUTH

4.10.4 CONCLUSION

Archaeological sites in Namibia are protected under the National Heritage Act (27 of 2004) which makes provision for archaeological assessment of large developments such as this. A survey of the study area located a number of archaeological sites, representing a discontinuous sequence of human occupation from the late Pleistocene to the early colonial era. The variety of archaeological sites found in the project area is similar to that found in adjacent parts of the Namib, reflecting a number of highly specific human adaptations to this environment.

The remains of the Welwitschia siding of the early colonial narrow gauge railway, the remains of the Khan Mine, and the remains of around the Husab Spring are considered to be of high significance. The remaining sites are isolated finds of low archaeological significance. However, despite their low individual significance, the sites form part of an archaeological landscape that will be impacted by the linear infrastructure. This applies especially to the narrow gauge railway line and related earthworks.

Potential impacts and mitigation measures relating to these resources must be taken into consideration in the project layout, design and implementation.

4.11 VISUAL BASELINE

Information in this section was sourced from the specialist study included in Appendix L (NLA 2011).

4.11.1 INTRODUCTION AND LINK TO IMPACTS

The aboveground linear infrastructure will change the visual environment. To understand the basis of this potential impact, a baseline situational analysis is described below.

4.11.2 DATA COLLECTION

The visual baseline was collected by field investigations, photographs and map interrogation.

4.11.3 RESULTS

The various aspects of the visual baseline are set out below. The relevant boundaries and features of the visual study area are presented in Figure 4-15.

4.11.3.1 Landscape character

The landscape character of the study area is defined by: plains and the Swakop River valley in the south; and by plains, mountains and the Khan River valley in the north. In addition, it is important to provide the study area context as follows:

- Most of the study area is located within the undeveloped NNNP, some in the DNP and the rest in the Khan River valley and areas to the north that falls outside of these protected areas.
- In the northern most part of the study area there are existing roads, power lines, railway lines, the old Khan Mine, Rössing Mine, Arandis airport, Arandis town and granite quarries.
- In the central and southern part of the study area, there are fewer man-made structures. In this regard, there are some NNNP campsites, prospecting camp and rigs, gravel roads, pipelines and power lines. Further afield to the east and west there are guesthouses and residences that are located on private land.

4.11.3.2 Visual Resource Value / Scenic Quality

With reference to Figure 4-15, the background visual resource of the study area is considered to have high value. The highest value resources are the hills, mountains, koppies, river canyons, natural vegetation and washes. Even though there are some man-made structures in the study area, these do not detract from the scenic beauty and dominant natural features of the total landscape. Further to the north in the area between the B2 and the Khan River valley, the visual resource value is reduced because of the concentration of mining and linear infrastructure activities.

4.11.3.3 Sensitivity of Visual Resource

It follows that the highest value visual resources described above are also the most sensitive to changes associated with the proposed project. In contrast, the areas with the highest concentrations of man-made structures are the least sensitive to these changes. As a whole, the total visual resource is considered sensitive to project related change.

FIGURE 4-15: VISUAL RESOURCE

4.11.3.4 Sense of Place

The sense of place results from the combined influence of the landscape on all of the viewers' subjective senses. When viewed from the perspective of a tourist, the natural landscape is associated with a serene sense of place. The tourist attractions and guest/farm houses further afield evoke excitement and anticipation. The exploration and mining activities are associated with a sense of disenchantment, particularly to people not involved with the mines in question. In this regard, the people who get jobs at the mines may not experience this disenchantment but rather see the mines with a sense of excitement and anticipation. Given the dominance of the natural landscape, the overall sense of place for the majority of the study area is considered tranquil.

4.11.3.5 Visual receptors

In broad terms, two types of visual receptors have been identified. Sensitive tourist and recreation oriented viewers and less sensitive mine workers. It follows that the sensitive viewer locations are situated on tourist routes and at tourist attractions. These include inter alia: the Khan River Valley and associated old Khan Mine and German railway line, the big tourist Welwitschia, the Welwitschia and Swakop River camping sites. The less sensitive viewer locations are from within the mining areas, on the B2 and on roads that service the mines.

4.11.4 CONCLUSION

The current visual environment in the visual study area is considered to be of high value as a visual resource. The linear infrastructure will change the current visual environment. The impact thereof is largely dependent on the sensitivity of the views and related visual receptors. These issues must be incorporated into the infrastructure design and operation.

4.12 SOCIO-ECONOMIC

Information in this section was sourced from the socio-economic specialist study included in Appendix L (Metago Strategy4Good 2010), the traffic specialist study in Appendix N (Siyazi 2011), the Uranium Rush SEA (SAIEA, 2010) and the Husab Mine EIA (Metago 2010).

4.12.1 INTRODUCTION AND LINK TO IMPACTS

The socio-economic baseline and impacts associated with the development of the Husab Mine and related infrastructure (including the construction, operational, decommissioning and closure phases) were described and assessed in detail in the Husab Mine EIA (Metago 2010). This information will not be repeated here. Therefore the focus of this section is on the additional socio-economic issues that were not previously assessed and which are associated with the development of the linear infrastructure. These are: impacts on tourism and traffic.

To understand these potential impacts, a baseline situational analysis is described below.

4.12.2 DATA COLLECTION

Information in this section was primarily gained through field investigations, interrogation of government databases, key stakeholder meetings and document review.

4.12.3 RESULTS

This section focuses on land use and road use issues and should be read with reference to Figure 1-2 and Figure 1-1.

4.12.3.1 Land ownership/rights

A deeds search by attorneys Theunissen, Louw & Vennote revealed that all land over which the linear infrastructure will be routed is owned by the Namibian government under the custodianship of MET Directorate of Parks and Wildlife.

4.12.3.2 Tourism and recreation

Tour operators, self-drive tourists and members of the public frequent a range of unique places within the study area. One of the key related attractions to all these groups is that the places of tourism and recreational interest are in close proximity to the towns of Swakopmund and Walvis Bay, which have excellent accommodation and hospitality amenities. It is this combination that makes these two towns obvious tourism gateways into parts of Namibia.

Tour operators take tourists into the Swakop River between Swakopmund and the Khan/Swakop confluence. This tourism resource is used both for day and night time activities including site seeing, wildlife tours and various functions like dinners, weddings and conferences. Namibians also frequent this area for weekend recreation activities including camping.

Tour operators take tourists on a daily site seeing trip that covers the big tourist Welwitschia and the Moon Valley. This trip is also popular with self-drive tourists and Namibians that sometimes also make use of the Swakop River, Moon Valley and Welwitschia camp sites

A smaller number of tour operators take tourists into the Khan River valley and Dorob National Park upstream of the Khan Swakop confluence. Some of these tour operators include the old Khan Mine in their tours and Namibians also frequent the Khan River valley for weekend recreation activities including camping.

4.12.3.3 Mining and prospecting

A licence search by attorneys Theunissen, Louw & Vennote revealed that the study area has been divided into a number of exclusive prospecting licences (EPLs) and mining licences (MLs) which are held by a number of companies (pending applications have not been included) including:

- Swakop Uranium (Pty) Ltd;
- Rössing Uranium Limited;
- Bannerman Mining Resources Namibia (Pty) Ltd;
- Reptile Uranium (Pty) Ltd);
- Langer Heinrich Uranium (Pty) Ltd;
- Zonghe Resources (Namibia) Development (Pty) Ltd;
- Nova Energy (Namibia) (Pty) Ltd;
- Africa Range Group of Companies;
- Oshilathingo Mining cc; and
- Olunddjinda Trading cc.

4.12.3.4 Communities

The communities in the study area are:

- Arandis – approximately 17km north of the Husab Mine;
- farmers and landowners – approximately 20km east of the Husab Mine;
- farmers and landowners – approximately 20km south west of the Husab Mine; and
- the Topnaar Nama community. The Topnaar is one of the oldest inhabitants of the Namib desert and earliest records date back to 1670. Traditionally the Topnaar Nama (currently located in the lower Kuiseb Valley) lived by herding cattle, gardening and gathering the nara (*Acanthosicyos horridus*). They were nomadic, restricted only by the availability of waterholes and the nara distribution. In 1907 the NNNP was declared and the presence of the Topnaar within the NNNP has been controversial ever since.

4.12.3.5 Roads

A network of roads exists in the study area:

- The tarred B2 from Walvis Bay via Swakopmund to Windhoek;
- The gravel and tarred C28 from Swakopmund to Windhoek;
- The salt D1984 from Swakopmund to Walvis Bay;
- The D1991/D4570 gravel road; and
- The gravel road (D1903) to the south that runs between the C28, the big Welwitschia and the farms to the east of the proposed project site (referred to as the Welwitschia drive).

Of these the three key roads from a Husab Mine access perspective are the B2, the C28 and the Welwitschia drive (D1903). The results of traffic counts at key proposed intersection points on these roads are presented in detail in the specialist traffic assessment in Appendix N (Siyazi 2011). A summary of the results are included in Table 4-14.

TABLE 4-14: ACCESS ROAD BASELINE CONDITIONS

	B2 (proposed intersection point for permanent mine access)	**C28 (proposed intersection point for temporary mine access)**	**Welwitschia drive (D1903)**
Daily vehicles – measured between 06h00 and 18h00 on Friday 22 October 2010.	2608 vehicles used the B2.	316 vehicles used the C28.	90 vehicles used the gravel road.
Road classification	Major Provincial Road	Minor Provincial Road	Local gravel road
Configuration	Tarred road with single lane per direction.	Partially tarred with a single lane in each direction.	Graded gravel road allowing traffic flow in both directions
Design and safety issues	The basic design is acceptable but upgrade recommendations relating to two additional lanes have been made in the Uranium Rush SEA (SAIEA 2010).	The undulating nature of this road significantly reduces lines of sight and recommendations to tar additional sections of this road have been made in the Uranium Rush SEA (SAIEA 2010).	The basic design is acceptable provided that the road is routinely maintained.
Intersections	There is no intersection currently in place for the permanent mine access road. A new intersection is required.	There is an intersection between the C28 and the gravel road to the Welwitschia plains. This requires upgrading if it is to be used for temporary mine access.	The gravel road runs past the Welwitschia plains to the Husab Mine. No additional intersection is required.

4.12.3.6 Power lines and pipelines

The study area is mostly devoid of pipelines and power lines save for the north western and southern extremities. To the northwest there is a regional power line and a water supply pipeline between Swakopmund and Rössing Uranium Mine on the plateau between the B2 and the Khan River valley. To the south there is a NamWater pipeline between Swakopmund and Langer Heinrich that runs in parallel to the C28. This pipeline will soon be augmented with another pipeline that forms part of NamWater’s southern supply scheme to a range of mining operations. There is also a southern power line that supplies power to Langer Heinrich.

4.12.4 CONCLUSION

The installation and use of the linear infrastructure will add to the type and range of mine related activities and land uses that can conflict with conservation and tourism. The traffic introduced by the Husab Mine will add increased pressure on the existing road network which may introduce additional capacity and safety issues.

5 ALTERNATIVES CONSIDERED

5.1 CURRENT AND FUTURE LAND USE ALTERNATIVES

In the area where the linear infrastructure is proposed, current land use comprises conservation and ecotourism (in the NNNP and DNP in particular), mining at Rössing Uranium Mine, dimension stone quarrying and prospecting on various EPLs. The development of the linear infrastructure will not change this land use. Instead it will modify parts of the land surface for a period of time that is directly linked to the operation of the Husab Mine.

5.2 PROJECT ALTERNATIVES

During the course of the definitive cost study process during 2010, the project access road, possible rail, water and power other infrastructure route options were investigated in detail. The main infrastructure access that was discussed in the Scoping Report (Metago, 2009) routed from the south of the site, through the NNNP along the Welwitscia drive (D1903). Apart from the Husab Uranium Project's technical and financial considerations, the requirements of the SEA and SEMP for the "Uranium Rush" were also noted. In this, recommendations were made to keep the infrastructure in corridors, and to avoid potential impacts to the tourism industry. This provided impetus to Husab to take as much linear infrastructure out of the NNNP as was possible.

Consequently, the Husab Uranium Project decided to access the mine site from the B2 in the north across the Khan River. The intention was that other utilities would parallel this route as well. As has been described in the EIA for the Husab Mine (Metago 2010), the mine site infrastructure layout went through a couple of iterations to avoid areas of bio-diversity sensitivity and to minimise its footprint. As a result, the processing plant and administrative areas were moved to the west of the pits. This had implications for the power supply and rail routes which are discussed in more detail below.

5.2.1 WATER SUPPLY OPTIONS

There is no sustainable water source at the Husab Mine site and therefore water for construction and for mine operation has to be sourced from elsewhere. The permanent water supply will be provided by NamWater and will be available towards the end of 2013. The temporary construction water requirement will come preferentially via NamWater's Central Namib reservoir (commonly referred to as the Rössing reservoir). The fall back option will be that a percentage of the temporary water will come from the Swakop River.

5.2.1.1 Temporary water supply

Two options have been considered for temporary construction related water supply. The preferred option is to take water from NamWater's Central Namib reservoir (commonly referred to as the Rössing reservoir) and pipe it in a corridor with the temporary power line past the old Khan Mine to site. Should this option not provide the requisite amount of water for construction, then the Project's fall back additional option is the extraction of a maximum of 0,5 Ml per annum for approximately 30 months from the Ida Dome Compartment (IDC) in the Swakop River. This equates to approximately 40% of the total water requirement for construction.

Two alternative temporary pipeline routes (Routes A and B) from the boreholes in the Swakop River were considered (see Figure 5-1). Route A follows an easterly route from the Swakop River parallel to an existing exploration track and NNNP internal road. Route B is the western route along the Swakop River that emerges near the Swakop River campsites and then parallels, on surface, the Welwitschia drive road (D1903) before turning north along the temporary access road to site.

Route A was chosen as the preferred route as it has the shortest length of pipeline in the river; it follows existing roads/track all the way to the mine site, and is not situated on a major tourist route. This is the option evaluated in this EIA report. Route B was discarded as it has a longer length of pipe in the river, making it potentially more vulnerable to flooding and would be visible for a greater distance along the tourist route.

5.2.1.2 Permanent water supply

NamWater has proposed that water for the Husab Mine be supplied via the shared Swakop South Water Supply Scheme (SSWSS) that will also supply desalinated water to Langer Heinrich Mine and the future Bannerman and Reptile projects. In this scheme, water from a desalination plant will be pumped to the Swakopmund reservoir from where it will be pumped in a new pipeline (that runs parallel to the existing Langer Heinrich pipeline and the C28) from which point it will T off to each of the new mine sites. The costs for this pipeline are to be shared proportionately between the different mines. A separate environmental assessment for this shared section of the pipeline route is being undertaken by an independent EIA consultant, under the auspices of NamWater.

The Husab specific pipeline will T off from the SSWSS pipeline and run parallel to the existing Welwitschia drive. The only possible deviation to this relates to the first section of the pipeline that may follow the EPL boundary (see Figure 6-2) instead of the road. This deviation eliminates the possibility of the pipeline traversing any possible future mining operation in either of the separately owned EPLs. The preferred route and possible deviation have both been assessed as part of the project.

Three pipeline route alternatives have been considered for the section of permanent pipeline between the Swakop River and the mine (see Figure 5-1). In order to use the SEA and SEMP as intended, and to make the best decision for this component of the project, a workshop was held between relevant stakeholders to determine the best permanent pipeline route for the identified alternatives. The results of the workshop are included in Table 5-1 and the minutes are included in Appendix B.

FIGURE 5-1: ALTERNATIVE TEMPORARY AND PERMANENT PIPELINE ROUTES

TABLE 5-1: PERMANENT PIPELINE ALTERNATIVES ANALYSIS

The three alternative permanent pipeline routes are shown on Figure 5-1. A relative score between 1 and 3 is allocated to the alternative pipeline routes for each factor. The best score is 1 the worst score is 3. The alternative with the lowest score is preferred.

Relevant factors to consider	Alternative 1 (west)	Alternative 2 (central)	Alternative 3 (east)	Discussion
Length – capital expense, operational expense, carbon footprint	1	2	3	The shorter the route the lower the capital cost, the lower the operational cost, the lower the energy usage and the associated carbon footprint. Alternative 1 is the shortest route and alternative 3 is the longest route. The difference between these routes is approximately 2.5km. This translates into a capital cost difference in the order of N$20 million.
Geology	1	2	3	Alternative 3 is positioned on potential uranium ore deposit that may be mineable. Locating the pipeline on this route carries the risk of a future pipeline diversion and associated costs and disruption to the permanent water supply for Husab Mine. The further the alternatives are located to the west the further they are from this potential ore deposit. Alternative 1 is preferred because it is further to the west than alternative 2.
Land disturbance – is it pristine wilderness or already disturbed	3	2	1	Alternative 3 is located adjacent to the gravel access road to the Husab Mine site. This road will continue to be used during the Husab construction phase until the permanent road located to the north is constructed. Thereafter the gravel road will only be used in emergencies. Although the land within the immediate road extent is disturbed, the pipeline would be located up to 15m from the road which implies that undisturbed land will be affected even though it is within a corridor configuration with the road. Alternative 2 is located partially on previously disturbed land (the access track to the Welwitschia campsite and the old airstrip) and partially on undisturbed land. Alternative 1 is located primarily on undisturbed land.
Biodiversity Impact-Fauna	1	2	2	The preferred alternative is the one that will present the least physical barriers to the movement of animals and ground bird species. Preliminary observations indicate that the ground conditions associated with alternative 1 will enable the pipeline to be buried along most of its length. The same is not possible for alternatives 2 and 3 because of near surface rock outcrop.
Biodiversity Impact Flora	1	3	3	Alternative 1 is located on grassy gravel plains. There are reportedly no plant species of concern in this area and although the SEA and EIA maps indicate that the route traverses the Welwitcschia plains, no Welwitschia

Relevant factors to consider	Alternative 1 (west)	Alternative 2 (central)	Alternative 3 (east)	Discussion
				plants were observed on or near to this route. Alternative 2 and 3 are least favourable because they are located in a more densely populated part of the Welwitschia plains.
Archaeology impact	1	3	1	Alternatives 1 and 3 would be the most favourable routes as this is where the lowest concentrations of archaeological sites and associated landscapes are found.
Visual and tourism impact	2	3	3	Despite the fact that the pipeline will be buried where possible, the visual environment and associated sense of place for tourists may still be impacted by the presence of aboveground associated infrastructure including a pump station, pressure valves and an 11kV power line. The main views of the pipeline routes are from the Welwitschia drive (views from the Welwitschia campsite have been discounted on the basis that this campsite will be relocated). The more that the infrastructure is aligned with this tourist route, the greater the impact on the visual environment and tourism sense of place. Given this, alternative 1 is preferred. In addition, alternative 2 climbs up an incline which makes it more visible from Welwitschia drive. Alternative 3 is aligned with the Welwitschia drive for the longest section.
Disturbance of SEA/SEMP Red Flag biodiversity area	3	3	3	All three alternatives are located within a red flag area. It is noted made that the delineation of this red flag area is not absolute and is largely focussed on the iconic Welwitschia plants. In this context it could be argued that the western extent of the red flag area is not accurate and that alternative 1 is the best option because it crosses an area beyond the western extent of the actual Welwitschia plant distribution (see biodiversity discussion above). Despite this argument, the current red flag delineation has been taken into account and all three routes have been equally scored.
Adherence to SEA/SEMP corridor recommendation	3	2	1	Alternative 3 follows an existing access road. Alternative 2 partially follows an existing track and the old airstrip. Alternative 1 does not follow any existing infrastructure routes.
TOTAL	**16**	**22**	**20**	**Alternative 1 is the preferred alternative.**

5.2.2 POWER SUPPLY OPTIONS

At an early stage in the power supply planning process two conceptual options were considered by NamPower for permanent power supply.

The one option was to construct the proposed new north-south regional power line to the east of the Husab Mine between Valencia and the Kuiseb substation. This line has been the subject of an EIA and would have routed through the NNNP. A connecting line and related substation would be required from this regional line to the Husab Mine. The other option was to upgrade the existing regional power line infrastructure that runs parallel to the B2 between the Khan and Walmund substations. As for the former option a connecting line and related substation would be required from this line to the Husab Mine.

Given that the former (Valencia-Kuiseb) option could not guarantee the required power demand of the Husab Mine and that NamPower has existing plans to upgrade the power supply to Arandis, the western (Khan-Walmund) option that is outside of the NNNP and closer to the B2 was selected. This selection meets at least one of the criteria of the Uranium Rush SEA (SAIEA, 2010) which is that existing infrastructure corridors should be used.

The permanent power supply cannot be established in time to meet the construction power and early mining activities electrical load by early 2012. NamPower has accordingly offered a temporary power supply solution that involves the construction of a temporary 220/66kV substation that will be connected to the existing Rossing-Walmund 220kV line using an available 60MVA transformer. This temporary supply will cover the period early 2012 to end 2013.

The selection of a suitable site for the temporary and permanent substations was made on the basis that the substations must be placed on level ground, they should be outside of sensitive environmental and tourism areas, they cannot be placed on marble because they must be earthed, the must fit into the planning for the temporary and permanent power line routes, and they must adhere to the aviation authority restriction on placing the substation outside of the critical zone of the Arandis airport. The latter criteria caused the identification of a second position for the permanent substation from site 1 to site 2 (see Figure 6-1). Both potential permanent substation sites are assessed further in the EIA.

The power line routes from the substations to the Husab Mine site have been selected by NamPower on the technical basis of: minimising the length and footprint of the power lines, having vehicle access to the entire power line for maintenance and construction purposes, and servitude width requirements. In keeping with the principle that linear infrastructure should be placed in corridors where possible, the initial objective was to find a route in which both the temporary and permanent power lines could be constructed. However, the route on the existing road past the old Khan Mine is not wide enough to host the permanent power line and the selected permanent power line route is not wide enough in places to host both the permanent and temporary lines. The end result is two separate substations and associated power line routes for the temporary and permanent power supply (see Figure 6-1).

5.2.3 TRANSPORT

Initially the combination of road and rail were considered as permanent transportation options. The rail option was investigated in some detail and then dismissed because it is unfeasible. The discussion below focuses on the permanent road.

The following road options were considered and assessed by the project team (see colour indications on Figure 5-2):

- a road from the north using the Valencia crossing of the Khan River (yellow line);
- a road from the south following the current Welwitschia drive across the Swakop River (red line); and
- a road from the north west with its own crossing of the Khan River (pink, green, and blue lines).

The road options were analysed on the basis of trip length, new infrastructure requirements, disturbance to the NNNP and DNP, SEA and SEMP recommendations, and specialist findings. These issues are discussed further below.

5.2.3.1 Trip length

The options were analysed on the basis of trip length between labour and material sending areas (assumed to be Swakopmund, Walvis Bay and Arandis) and the Husab Mine. The shorter the road the less the: operational cost (fuel and maintenance), carbon footprint, and length of trips for workers (with associated comfort and safety concerns). The shortest route for all trips is from the B2 to the north west of the mine site (blue, pink and green lines). The southern route via the C28 and Welwitschia drive (red line) is longer for the trip from Walvis Bay and Swakopmund and significantly longer for the trip from Arandis. The northern route (yellow line) via the Valencia crossing is the longest by almost double the distance for the trip from Walvis Bay and Swakopmund. On this basis any of the north western routes are most preferred and the northern route is least preferred.

5.2.3.2 New road infrastructure requirements

The road route options were analysed to determine the capital cost requirement for building new road infrastructure. The routes from the north west (blue, pink and green lines) require approximately 25km of new road infrastructure. The route from the north (yellow line) requires approximately 50km of new infrastructure, and the route from the south (red line) requires approximately 70km of new infrastructure. On this basis any of the north western routes are the most preferred and the southern route is least preferred.

5.2.3.3 Disturbance to NNNP and DNP

The options were analysed to determine the disturbance to land situated within the NNNP and/or DNP. The northern route (yellow line) only enters the NNNP at the Husab Mine site. Two of the north western routes (blue 1 and pink 1 lines) avoid the DNP and only enter the NNNP at the Husab Mine site. The other north western routes (pink 2 and green lines) cross parts of the DNP before entering the NNNP near the Husab Mine site. The southern route (red line) is in the NNNP. On this basis the northern and north western (blue 1 and pink 1) routes are most preferred and the southern route is least preferred.

5.2.3.4 SEA and SEMP recommendations

The main related recommendation from the SEA and SEMP is that access to the Husab Mine site should rather be from the north/ north west than from the south. On this basis all the north and north western routes are preferred but the southern route is not preferred.

5.2.3.5 Specialist input

Specialists did not consider the northern route (yellow line), the green and pink 2 north western routes or the southern route(red line) as permanent road options because by the time the specialists were briefed to do their investigations the project team had discarded these options on the basis of the abovementioned issues. The most significant specialist findings in relation to the blue and pink 1 options from the north west relate to archaeology and the requirement for blasting by road construction engineers. In this regard, the blue option is least preferred because:

- it runs through the significant archaeological resources associated with the old Khan Mine and related landscape; and
- It runs through narrow valleys with steep cliff sides that would require significant and intrusive blasting to provide a space that is wide enough for the permanent road.

5.2.3.6 Conclusion

The preferred route for the permanent road is route pink 1 from the north west. It should be noted that temporary access to the site will be required while this permanent road is being constructed and therefore the temporary access road will be via the existing southern route (red line).

As is evident on Figure 6-1 and Figure 6-2, both the permanent access road and the temporary access road have route variations at the starting sections. In both cases provision has been made to deviate from the preferred route as the deviation would eliminate the possibility of the infrastructure traversing any possible mining/quarrying operations in either of the separately owned EPLs to the north and south of the Husab EPL. Both of these deviations have been assessed as part of the project.

FIGURE 5-2: ALTERNATIVE ROAD ROUTES

5.3 THE "NO PROJECT" OPTION LINKED TO NEED AND DESIRABILITY

The assessment of this option requires a comparison between the alternative of proceeding with the proposed linear infrastructure development with that of not proceeding.

Proceeding with the linear infrastructure will enable the functioning of the approved Husab Mine and will therefore result in significant positive economic impacts, but it will also result in negative environmental and social impacts as described and assessed in the Husab Mine EIA (Metago, 2010) and in Section 7 below. Not proceeding with the linear infrastructure will prevent Swakop Uranium from mining the Husab deposit and will leave the mineral resource undeveloped. In addition, in this scenario, the relevant areas within the NNNP and DNP will remain undisturbed.

To answer the question of whether there is a need for the linear infrastructure or not, and whether it is desirable, one must understand that the linear infrastructure is necessarily linked to the Husab Mine itself. By approving the Husab Mine the Namibian government has already prioritised positive economic impacts above negative environmental and social impacts, and which in the case of the linear infrastructure can be mitigated to an acceptable level (Section 7).

6 PROJECT DESCRIPTION

The project description has been separated into the following phases: construction, operation, decommissioning and closure. These phases are described below.

6.1 CONSTRUCTION PHASE

The purpose of the linear infrastructure construction phase is to establish the linear infrastructure that is required for the construction and operation of the Husab Mine.

6.1.1 SITE FACILITIES FOR CONSTRUCTION

A number of construction working areas will be established on site during the linear infrastructure construction phase. These work areas will either move within the linear infrastructure footprint as construction progresses, or they will be located at a specific stationary site within the linear infrastructure footprints for the duration of the construction phase. A site layout map is attached in Figure 6-1 and Figure 6-2.

In general, the following facilities will be required at each contractor working area.

- mobile field workshop and maintenance areas;
- mobile stores for storing and handling fuel, lubricants, solvents, paints and construction materials;
- temporary lay-down areas;
- mobile site offices;
- mobile waste collection and storage areas;
- temporary wash bay for washing equipment and vehicles;
- temporary parking area for cars and equipment;
- mobile change rooms; and
- portable toilets that will be serviced regularly.

6.1.2 CONSTRUCTION ACTIVITIES

Construction activities will take place during the establishment and preparation of the temporary and permanent linear infrastructure. A table of construction activities is provided in Table 6-1. The “X’s” in the table indicate which activities may be associated with the construction of the various linear infrastructure components.

FIGURE 6-1: SITE LAYOUT NORTH

FIGURE 6-2: SITE LAYOUT SOUTH

TABLE 6-1: TABLE OF CONSTRUCTION ACTIVITIES

Activity		Temporary access road	Permanent access road	Temporary water supply - Rössing reservoir	Temporary water supply - river	Permanent water supply	Temporary power supply	Permanent power supply	Tele-communications
A1	Earthworks: Drilling and blasting activities		x					x	
A2	Earthworks: Cleaning and grubbing and bulldozing activities	x	x			x	x	x	
A3	Earthworks: Soil excavation	x	x	x	x	x	x	x	
A4	Earthwork: Stockpiling of topsoil and other material	x	x	x	x	x	x	x	
A5	Disposal or treatment of contaminated soil	x	x	x	x	x	x	x	
A6	Backfill of material (specific grade) from borrow pits		x						
A7	Opening and management of borrow pits		x						
A8	Construction and use of new roads – clearing of areas and operation of asphalt plant		x						
A9	Civil works: Foundation excavations	x	x			x		x	
A10	Building activities	x	x	x	x	x	x		x
A11	Storage and handling of material: Sand, rock, cement, chemical additives in cements	x	x	x	x	x	x	x	
A12	Water utilization	x	x			x	x	x	
A13	Mixing of concrete (batch plant) and concrete work (casting)		x	x	x	x	x	x	
A14	Operation and movement of construction vehicles and machinery	x	x	x	x	x	x	x	x
A15	Refuelling of equipment	x	x	x	x	x	x	x	x
A16	Use of cranes					x	x	x	
A17	Erection and destruction of scaffolding		x						
A18	Building of shutters							x	
A19	Installing re-enforcement steel		x				x	x	
A20	Handling, storage and disposal of hazardous waste • Blasting media packing material • Empty paint containers • Cements bags • Chemical additives (for cement) containers • Contaminated PPE and other (with oil, etc).	x	x	x	x	x	x	x	x

Activity		Temporary access road	Permanent access road	Temporary water supply - Rössing reservoir	Temporary water supply - river	Permanent water supply	Temporary power supply	Permanent power supply	Tele-communications
	• Redundant concrete • Earth moving tyres								
A21	Handling, storage and disposal of non-hazardous waste • Steel off-cuts • Domestic waste • Wood off-cuts • Grinding wheels • Other construction waste	x	x	x	x	x	x	x	x
A22	Transportation of hazardous material	x	x	x	x	x	x	x	x
A23	Transportation of non-hazardous material	x	x	x	x	x	x	x	x
A24	Handling and storage of hazardous material • Blasting media • Fuel and lubricants • Paints • Gas (welding) • Cement • Chemical additives for cement for leach tanks only)	x	x	x	x	x	x	x	x
A25	Install pipelines for water and process solutions (above ground)			x	x	x			
A26	Install of electricity lines					x	x	x	
A27	Use of electricity generators	x	x	x	x	x	x	x	
A28	Install transformers						x	x	
A29	Install parking bay for trucks								
A30	Manage construction site	x	x	x	x	x	x	x	x
A31	Painting, grind and welding		x	x	x	x	x	x	
A32	Provision and operation of water washing and toilet facilities	x	x	x	x	x	x	x	x
A33	Slope stabilization and erosion control	x	x					x	
A34	Appointment of contractors, labourers, etc.	x	x	x	x	x	x	x	x

6.1.3 TOPSOIL AND BORROW PIT MANAGEMENT

Topsoil will be stripped from all areas that will be disturbed. This topsoil will be placed in stockpiles and will be considered a future rehabilitation growth medium.

Borrow pits will be developed to source material for the permanent road construction. These will developed as close as possible to the permanent road route subject to the material requirements. Borrow pits will be approximately 5m deep and will be rehabilitated by contouring and replacing topsoil where possible.

6.1.4 CONSTRUCTION TRANSPORT

During the early construction phase of the mine and plant, all construction traffic will use the existing gravel road currently used by Husab Uranium Project exploration vehicles. Construction traffic will therefore travel on the C28 and then branch off northwards on the gravel road that crosses the Swakop River and routes to the Welwitschia plain to the Husab Mine gate (see Figure 6-2). Swakop Uranium will continue to assist MET in maintaining this gravel road (from the C28 to the Husab Mine gate) by grading it on a routine basis. In addition, the intersection between the C28 and the gravel road will be upgraded. The minimum standard for the upgrade design is shown in Figure 6-3. The 3m wide track (that routes through the Welwitschia plains from the gravel road to the Husab Mine gate) that existed before exploration began, and which has since been used for exploration activities, will be widened to 6m and upgraded by adding and grading a soil topping obtained from the preliminary mine site earthworks.

During construction, the volume of trucks, busses, passenger vehicles and other traffic travelling to and from site per day is estimated at 130 vehicles. This figure will increase to approximately 210 vehicles per day during peak periods, specifically on weekends, when workers leave/return to the construction camp on site.

Once the permanent access road from the B2 is complete, all construction traffic will use this road. This is described further in section 6.2.3.1.

Traffic will run primarily between sunrise and sunset. Prior permission is required from MET Directorate of Parks and Wildlife when there is a requirement that traffic runs at night time.

FIGURE 6-3: MINIMUM STANDARD FOR C28 INTERSECTION UPGRADE

6.1.5 EMPLOYMENT AND HOUSING

Construction of the linear infrastructure will be done by contractors. It is anticipated that these contractors will make use of their existing workforces augmented by new recruits where required.

Where linear infrastructure construction workers are not housed in activity specific temporary camps they will either be housed at the Husab Mine construction camp for contractors (Metago 2010) or at accommodation in Arandis, Swakopmund or private facilities rented out by private landowners in the region.

Each of the activity specific camps is described below. As a general rule each of these camps will have the following amenities:

- portable toilets that will be serviced regularly.
- portable showers;
- water bowsers to provide domestic water;
- gas cooking facilities;
- domestic waste collection and storage facilities.

Construction workers associated with both the permanent and temporary power lines will be housed in a small tented camp. These temporary tented camps will move within the power line servitude as work on the power lines progresses. Each camp is expected to house approximately six people. It is noted that the construction of the power lines will be completed by several crews which will follow each other – first to dig holes and set foundations, then the steelwork construction and assembly and finally the group that strings the conductors.

The construction workers associated with the permanent road will likely be housed at a camp adjacent to the quarry just south of the intersection between the B2 and permanent road. In the event that workers are required to stay close to a particular activity, they will make use of tented accommodation along the route.

The construction workers associated with the temporary pipeline from Rössing reservoir to Husab Mine will likely stay in Arandis. There might be a need for a small number of people to stay alongside the line in tents for security reasons.

Construction workers associated with the temporary road, the temporary water supply from Swakop River, permanent water supply and associated 11kV power line will likely stay either in Walvis Bay, Swakopmund or at the drillers exploration camp at the old Husab Mine.

6.1.6 WATER SUPPLY FOR CONSTRUCTION ACTIVITIES

Water quantity requirements for the construction activities associated with both the linear infrastructure and the Husab Mine will be approximately 1.2 million m^3 per annum (pa) for approximately two years. This water will be used for both construction and domestic purposes. The supply options are described further below.

Water supply for linear infrastructure construction

Water for the construction of the roads, pipelines and power infrastructure will be supplied by mobile water bowsers. The bowsers will get construction purpose water from a point on the existing Rössing pipeline, or alternatively from boreholes generally used for drilling activities on site. Potable water will be sourced from Arandis or Swakopmund.

Construction phase water supply for the Husab Mine

Construction phase water will be supplied by NamWater via a temporary overland pipeline. The pipeline will start from NamWater's Central Namib reservoir (commonly referred to as the Rössing reservoir). Initially the pipeline will run parallel to an existing pipeline and the B2 road before it turns to the south and passes to the north east of the Arandis airport. From the airport it will run in a shared corridor with the temporary Husab power line, past the old Khan Mine, and across the Khan River to the Husab Mine site. From the Khan River to the Husab Mine site all northern Husab linear infrastructure will share the same corridor.

The pipeline will comprise a combination of HDPE and steel piping with a diameter of approximately 30cm. The pipeline will be placed directly onto the ground for most of the route except where vehicle crossings are required and where the pipe crosses the Khan River. In these two cases the pipeline will be buried approximately 2m below surface. For the Khan River crossing the pipe will require additional reinforcing with the use of gabions as protection against flood water. Along the pipeline route, the pipe will be anchored at regular intervals by means of pipe brackets, gabions and/or concrete anchor blocks.

A pressure break reservoir will be required between the Arandis airport and the Khan River at a site just to the north of the old Khan mine. This reservoir will comprise a standard shipping container will have sealed doors. The containers are approximately 12m long, 3m high and 3m wide. This arrangement is mobile, and has minimum impact on the surroundings as it can be placed/removed with little effort.

A booster pump station and balancing reservoir will be required between the Khan River and the Husab Mine site reservoir. The pumps will be housed either on a concrete base or in a shipping container. The balancing reservoir has the same specifications as the pressure break reservoir described above. Power for the pump station will be provided directly from the Husab power lines that will run in close proximity to the pipeline and pump station. The backup alternative is a diesel generator.

Backup construction phase water for the Husab Mine

Depending on the consistency of supply from NamWater, this temporary water source may be supplemented (as a backup) by a pipeline from a series of (between two and three) boreholes in the Swakop River. Should this option be pursued, a temporary 200 mm diameter overland pipeline of 28 km length will connect the boreholes in the Swakop River with a reservoir at the Husab Mine The pumping head from the river requires the installation of a booster pumping station and container reservoir midway to between the river and the Husab Mine site.

6.1.7 POWER SUPPLY FOR CONSTRUCTION ACTIVITIES

Power demand during the construction phase of both the linear infrastructure and the Husab Mine will be approximately two megawatt. The supply options are described further below.

Power supply for linear infrastructure construction

Power for the construction of the roads, pipelines and power infrastructure will be supplied by portable diesel fuelled generators as normally used in road construction.

Construction phase power supply for the Husab mine

Construction phase power will be supplied by NamPower via a temporary 66kV power line. The line will run from a temporary substation to the southeast of the Arandis airport, in a shared corridor with the temporary water pipeline from the Rössing reservoir, past the old Khan Mine, and across the Khan River to the Husab Mine site. From the Khan River to the Husab Mine site all northern linear infrastructure will share the same corridor.

The temporary substation will be fenced (2.5m high security mesh) and will comprise a 60MVA 220/66kV transformer station. The substation will be a typical outdoor yard substation. The transformer will be placed on a concrete bunded base to contain transformer oil spillage. The substation footprint will be approximately 40m by 40m.

The temporary power line design will comprise auger planted wood mono-poles with insulators mounted on metallic A frames such that conductors are approximately 12m in height and poles are spaced approximately 100m apart. A service track will be required along the power line length both for construction and maintenance access.

Backup construction phase power for the Husab mine

Back-up power will be supplied by portable generators.

6.1.8 SANITATION FOR CONSTRUCTION

Initially, portable toilets with associated septic tanks will be used. The septic tanks will be emptied on a regular basis and the effluent disposed of at the Swakopmund Municipal sewage treatment works.

The main sewerage treatment works for the Husab Mine will be a package plant modular design, planned to be commissioned in January 2012. The treatment plant will be commissioned prior to most of the construction workers arriving on site, so that it will be available to accommodate sewage from the maximum workforce of 4000 people at the height of the construction phase. The plant will be a bio-filter process divided into the following:

- Primary settlement - receiving of raw sewage and settlement of suspended solids
- Aerobic treatment – aeration system
- Final settlement – prevents ingress of untreated effluent
- Sludge storage – provided in the base unit with 12 weeks capacity. The removed sludge will be placed on settling beds, dried, then buried within the waste rock dump or used for bioremediation.

The treated effluent water will be of 'Namibian General Standards for Wastewater Discharge into a Water Resource' and will be used for dust suppression on site during the construction phase.

6.1.9 NON MINERALISED WASTE MANAGEMENT FOR CONSTRUCTION

Waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment and either recycled or reused where possible. The remainder will be transported off site to appropriate recycling or disposal facilities (Swakopmund for general waste and Walvis Bay for hazardous waste).

Table 6-2 presents the waste management specification that has been developed for the Husab Project and outlines the waste management for all waste types. In summary, the types of non mineralised waste expected to be generated during the construction phase include:

- General waste (domestic waste and other non-hazardous waste).
- Industrial waste.
- Hazardous waste.

TABLE 6-2: WASTE MANAGEMENT FOR CONSTRUCTION PHASE

Waste type	Waste specifics (example of waste types)	Storage facility	End use
Non-hazardous non-radioactive	Pallets and wooden crates, cable drums, scrap metal,	Skips in relevant work areas will be provided for different waste types. A waste management contractor will remove skips	Waste will be sorted further at the WTY. Recyclable waste will be sent to a reputable recycling company. Some items may be distributed

Waste type	Waste specifics (example of waste types)	Storage facility	End use
contaminated solid waste (non-mineralised)	general domestic waste such as food and packaging	regularly to the Waste Transition Yard (WTY).	directly to the community such as pallets and wooden crates. The remainder of the waste will be transported by the waste management contractor to a permitted general landfill facility in Swakopmund for disposal.
	Building rubble and waste concrete	Designated rubble collection points will be determined to which contractors will take rubble and concrete.	The waste management contractor will regularly remove the waste from the designated collection points to the footprint of the waste rock dump.
Non-hazardous and hazardous radioactive contaminated solid waste (non-mineralised)	Contaminated sand, drill chips, old PPE, pipes etc.	Radioactive waste will be stored in sealed drums in the relevant work areas. These drums will be taken to the WTY on a regular basis.	Waste will be further sorted at the WTY. Recyclable waste will be decontaminated (high pressure washing) and if successfully decontaminated will be sent to a reputable recycling company. There is no appropriate disposal site in Namibia for radioactive waste. All radioactive waste will therefore be disposed of in the mineralised waste facility.
Hazardous non-radioactive contaminated solid waste (non-mineralised).	Treated timber crates, printer cartridges, batteries, fluorescent bulbs, paint, solvents, tar, empty hazardous material containers etc.	Hazardous waste will be separated at source and stored in designated containers in bunded work areas. The waste management contractor will remove these drums regularly to the WTY.	Hazardous waste will be disposed of at the permitted hazardous disposal site in Walvis Bay by the waste management contractor.
	Hydrocarbons (oils, grease)	Used oil and grease will be stored in drums in bunded areas at key points in work areas. The bunds will be able to accommodate 110 % of the container contents and include a sump and oil trap. The waste management contractor will remove these drums regularly to the WTY. The yard will have a dedicated used oil storage area which will include a concrete slab, proper bunding and an oil sump. The appointed bulk fuel supplier will collect used oil for recycling.	The yard will have a dedicated used oil storage area that will include an impermeable concrete slab, bunding, an oil trap and sump. Used oil will be sent to a reputable recycling company for recycling.
	Sewage	Sewage will be treated at a sewage treatment plant (STP) with a capacity of 0.5 Ml per day.	Sewage effluent will be used for dust suppression. Sewage sludge will be dried and buried in the STP area.
Medical waste	Syringes, material with blood stains, bandages, etc.	Medical waste will be stored in sealed containers at the clinic. A waste management contractor will remove these drums regularly to the WTY.	Medical waste will be transported by the waste management contractor to a permitted incineration facility in Swakopmund for incineration.

6.1.10 TIME TABLE

Subject to authorisation, the construction phase will commence in quarter three 2011 or early 2012 and continue to quarter four 2013 or early 2014.

6.2 OPERATIONAL PHASE

6.2.1 FACILITIES FOR OPERATION

The operational phase will consist of the following facilities most of which are indicated on Figure 6-1 and Figure 6-2:

- Permanent access road.
- Utilisation of the temporary access road as a permanent backup access road if a situation arises that makes the permanent road impassable (eg. flooding of the Khan River valley).
- Permanent power supply infrastructure.
- Permanent water supply infrastructure.
- Permanent telecommunications infrastructure.

6.2.2 OPERATION PHASE ACTIVITIES AND INFRASTRUCTURE

6.2.3 OPERATIONAL TRANSPORT

6.2.3.1 Roads

Permanent access will be on an asphalt road that runs between the B2 and the Husab Mine across the Khan River. For a portion of the route between the B2 and the Khan River, the road and the permanent power line will share the same corridor. From the Khan River to the Husab Mine site, all northern linear infrastructure will share the same corridor.

A new purpose-built intersection is required to join the permanent access road to the B2. The minimum design standards are shown in Figure 6-4. On the flat plateau areas the road will be a single carriageway two-lane asphalt road with a total width of 11m. The road will comprise two lanes of 3.5m each, two asphalt shoulders (yellow line sections) of 0.3m each, and two gravel shoulders of 1.7m each on the outside of the asphalt shoulders. Speed limits on these flat plateau sections will be restricted to 100km/hour. For sections in the steeper valley areas the road will be equipped with additional asphalt passing lanes of 3.5m in width. Speed limits on these steeper valley sections will be 80km/hour.

FIGURE 6-4: MINIMUM STANDARD FOR THE NEW B2 INTERSECTION

In order to manage water flows in the various river channels and to keep these flows as close to natural flows as possible, a specialist study was conducted by Metago to recommend requirements for elevations, culverts and bridges. Conceptual design specifications for these items are included in the specialist report in Appendix G (Metago Australia 2011). Key related issues are: the recommendation for the road to be elevated by 1-2m in the tributary channels and 2-3m in the Khan River, the recommendation for water flow culverts to allow water to move beneath the road, and the recommendation for one or more bridges to cross the main Khan River.

The former recommendations are being incorporated into the detailed road design, but two options are being planned for the road crossing of the main Khan River. The one option is a single concrete bridge and the other is a low level concrete drift. The bridge will have the following approximate dimensions: between 4-6m high, 7.5m wide and 120m long. The drift will be placed onto the riverbed and will have the following approximate dimensions: 7.5m wide and 120m long. The need for additional bridges is being avoided by keeping the road close to the north western bank of the Khan River before routing it over the Khan River and up to the Husab Mine site.

In the event that the permanent asphalt road is impassable (eg. flooding of the Kahn River valley) the temporary construction road to the south of the Husab Mine will be used as the backup. This road will be maintained by the Husab Mine for as long as it remains the backup road access.

Traffic will run primarily between sunrise and sunset. Prior permission is required from MET Directorate of Parks and Wildlife when there is a requirement that traffic runs at night time.

6.2.3.2 Transportation of employees

Approximately 190 private vehicles and 18 buses will travel to and from Husab Mine daily to deliver shift and office workers to and from site.

6.2.3.3 Transportation of goods and materials

Approximately 65 trucks will deliver goods and materials to Husab Mine per day.

6.2.3.4 Transportation of product

Approximately 8 trucks will deliver product from Husab Mine to the Walvis Bay harbour per day.

6.2.4 WATER SUPPLY FOR OPERATION PHASE

NamWater has proposed that water for the Husab Mine be supplied via the shared Swakop South Water Supply Scheme (SSWSS) that will also supply desalinated water to Langer Heinrich Mine and the future Bannerman and Reptile projects. In this scheme, water from a desalination plant will be pumped to the Swakopmund reservoir from where it will be pumped in a new pipeline that runs parallel to the C28 to T off to each of the new mine sites. The costs for this pipeline are to be shared proportionately between the different mines. A separate environmental assessment for this shared section of the pipeline route is being undertaken by an independent EIA consultant, under the auspices of NamWater.

The required Husab Mine operational potable water requirement is 6.5Mm^3/a. Water for the operational phase will be piped to site in a new pipeline that runs from the C28 T off point, adjacent to the existing gravel access road to the Husab Mine site. This pipeline will be approximately 60cm in diameter and will be constructed from cast iron. The project preference is to place the pipeline below ground. There may be sections where this is not possible and the related determining factor is whether the ground is soft enough to be excavated with a front end loader in order to create a trench for the pipe. Where the pipe is aboveground it will be placed on concrete plinths. The height from the ground to the top of the pipe will be a maximum of 1m. Where the pipe is underground it will be approximately 1m below surface. The crossing of the Swakop River will be approximately 2m below surface and for this section the pipe will be made of a welded steel section.

As part of the pipeline configuration there is a requirement to locate maintenance valves, pump station(s) with enclosed balancing tanks, and an 11kV power line along the pipeline route. The exact position of these items has not been determined yet but the pump station is likely to be north of the Swakop River with the power line likely to be from the Husab Mine substation. The placement of the pump station is subject to technical requirements.

6.2.5 POWER SUPPLY FOR OPERATION ACTIVITIES

Power during the operation phase will be supplied to Husab Mine via a permanent 220 kV NamPower line. The line will run from the permanent substation located to the south of the Arandis airport or from an alternate site (the Lithops substation) identified near the existing 200 kV line just inside the DNP. Both options are included in the project description although the Lithops substation is the preferred option. The power line will be erected along a remote valley where it parallels the permanent access road corridor for a few kilometres before veering off to the east along a separate route to cross the Khan River in a single span before joining the other infrastructure in the narrow valley leading up to the Husab Mine site.

The line will comprise steel pylons approximately 35m high and spaced apart at distances ranging from 300m to 700m. The pylons will be erected with concrete bases set in purpose built holes. The line and service track that is required for construction and maintenance will run in a servitude of approximately 44m in width.

The permanent substation will be fenced (2.5m high security mesh) and will comprise a switching station (circuit breakers, isolators and busbars) in typical outdoor yard configuration with a footprint of 500m by 500m.

The pump stations located on the permanent water supply line will require power. This will be supplied by an 11kV overhead line routed either from NamPower's existing power line that runs parallel to the C28, or from the Husab sub-station at the mine. This line will be carried on a wooden monopole.

6.2.6 TELECOMMUNICATIONS

Telecommunication connectivity will be established by installing fibre optic cables. The primary fibre optic cables will be either be placed on wooden monopoles or placed within the permanent access road foundation in 110mm pvc sleeves. The Husab telecommunication cables will T off from the current network that runs along the B2.

6.2.7 NON-MINERALISED WASTE MANAGEMENT FOR THE OPERATION PHASE

Once the permanent linear infrastructure is operational no routine waste stream is expected. In the event that waste is generated it will be handled in accordance with the Husab Mine waste management system which requires that waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment, and either recycled or reused where possible. On site facilities will be provided at the waste transition yard (WTY) for sorting and temporary storage prior to removal and disposal to off site appropriated recycling or disposal facilities (Swakopmund for general waste and Walvis Bay for hazardous waste).

Domestic waste will be disposed of at a licensed waste disposal site in Swakopmund. On site facilities will be provided at the WTY for sorting and temporary storage prior to removal and disposal.

Industrial waste will be sorted on site, at the WTY, and either disposed of within the waste rock dumps or sent to the municipal waste sites with the domestic waste.

Hazardous waste (non radioactive) includes inter alia: fuels, chemicals, lubricating oils, hydraulic and brake fluid, paints, solvents, acids, detergents, resins, brine, solids from sewerage and sludge. Hazardous waste will be disposed of at the Walvis Bay hazardous waste disposal site.

Disposal sites for radioactive contaminated material/waste will be established within the waste rock dump as part of the mineralised waste facility. This radioactive contaminated waste will include inter alia: old personal protective equipment, drums, pipes, etc

A waste specification has been developed for the Husab Project and details waste management on site. A summary of this is provided in Table 6-3.

TABLE 6-3: NON MINERALISED WASTE MANAGEMENT FOR OPERATIONS

Waste type	Waste specifics (example of waste types)	Storage facility	End use
Non-hazardous non-radioactive contaminated solid waste (non-mineralised)	Pallets and wooden crates, rubber, cardboard, paper, cable drums, metal cut-offs. scrap metal, general domestic waste such as food and packaging	Skips in relevant work areas will be provided for different waste types. A waste management contractor will remove skips regularly to the Waste Transition Yard (WTY).	Waste will be sorted further at the WTY. Recyclable waste will be sent to a reputable recycling company. Some items may be distributed directly to the community such as pallets and wooden crates. The remainder of the waste will be transported by the waste management contractor to a permitted general landfill facility in Swakopmund for disposal.
	Building rubble and waste concrete	Designated rubble collection points will be determined to which rubble and concrete will be taken.	Building rubble will be disposed of to a designated area in the waste rock dump as part of the mineralised waste facility.
Non-hazardous and hazardous radioactive contaminated solid waste (non-mineralised)	Contaminated sand, drill chips, old PPE, pipes etc.	Radioactive waste will be stored in sealed drums in the relevant work areas. These drums will be taken to the WTY on a regular basis.	Waste will be further sorted at the WTY. Recyclable waste will be decontaminated (high pressure washing) and if successfully decontaminated will be sent to a reputable recycling company. There is no appropriate disposal site in Namibia for radioactive waste. All radioactive waste will therefore be disposed of in the mineralised waste facility.
Hazardous non-radioactive contaminated solid waste (non-mineralised).	Treated timber crates, printer cartridges, batteries, fluorescent bulbs, paint, solvents, tar, empty hazardous material containers etc.	Hazardous waste will be separated at source and stored in designated containers in bunded work areas. The waste management contractor will remove these drums regularly to the WTY.	Hazardous waste will be disposed of at the permitted hazardous disposal site in Walvis Bay by the waste management contractor.
	Hydrocarbons (oils, grease)	Used oil and grease will be stored in drums in bunded areas at key points in work areas. The bunds will be able to accommodate 110 % of the container contents and include a sump and oil trap. The waste management contractor will remove these drums regularly to the WTY. The yard will have a dedicated used oil storage area which will include a concrete slab, proper bunding and an oil sump. The appointed bulk fuel supplier will collect used oil for recycling.	The yard will have a dedicated used oil storage area that will include an impermeable concrete slab, bunding, an oil trap and sump. Used oil will be sent to a reputable recycling company for recycling.
	Sewage	Sewage will be treated at a sewage treatment plant (STP) with a capacity of 0.5 Ml per day.	Sewage effluent will be reused in the process water circuit. Sewage sludge will be dried and either buried in the mineralised waste facility or used for bio-remediation.
Medical waste	Syringes, material with blood stains,	Medical waste will be stored in sealed containers at the clinic. A	Medical waste will be transported by the waste management contractor to

Waste type	Waste specifics (example of waste types)	Storage facility	End use
	bandages, etc.	waste management contractor will remove these drums regularly to the WTY.	a permitted incineration facility in Swakopmund for incineration.

6.2.8 ADDITIONAL SITE FACILITIES

6.2.8.1 Lighting

No lighting will be provided on the roads, pipelines or power lines. The permanent asphalt road will be equipped with reflective cat's eyes. The temporary and permanent substations will be equipped with lights that will be only be used for maintenance purposes or for security purposes if operational experiences so dictate.

6.2.9 DUST CONTROL (ROADS)

Dust emissions on the permanent access road will be minimised because the road will be surfaced with asphalt. Dust emissions on the temporary construction gravel access road (which remains a backup access road for the mine life) will be controlled through the application of water sprays or a dust suppressant.

6.2.10 TIME TABLE

The linear infrastructure will remain operational for at least as long as the Husab Mine which is at least until 2028. The temporary power and water infrastructure will be decommissioned once the permanent arrangements have been commissioned.

6.3 DECOMMISSIONING AND CLOSURE PHASE

At a conceptual level, decommissioning can be considered a reverse of the construction phase as the demolition and removal of the majority of infrastructure has activities very similar to those described for the construction phase. The closure phase occurs after the cessation of all decommissioning activities. Relevant closure activities are those related to the after care and maintenance of remaining structures.

6.3.1 CLOSURE OBJECTIVES

The conceptual planning stage for decommissioning and closure has commenced. Closure objectives have been developed against the background of the project location in the Namib Desert, within the NNNP, and immediately adjacent to DNP, the Welwitschia Plains and major ephemeral rivers: the Khan and Swakop Rivers. In broad terms, the main objective will be to rehabilitate the routes to resemble the pre project land state as closely as possible unless stakeholders agree otherwise in the detailed closure panning process. The end land use will be conservation and wilderness.

The above principles and concepts will be refined as part of on-going detailed closure planning and costing during the life of mine as an operations function.

6.3.2 DECOMMISSIONING ACTIVITIES

At a conceptual level this is a reverse of the construction phase with infrastructure and activities very similar to those described in section 6.1. The conceptual decommissioning plan is as follows:

- Surface infrastructure will be demolished and removed.
- Areas where infrastructure has been removed will be levelled and restored in terms of soils horizons, vegetation and drainage.

The temporary water and power supply infrastructure will be removed approximately six months after the Husab Mine receives permanent power and water supply.

6.3.3 CLOSURE ACTIVITIES

If all linear infrastructure is removed there will be no closure related activities other than monitoring of the rehabilitated areas in accordance with the post closure monitoring plan.

7 ENVIRONMENTAL IMPACT ASSESSMENT

Potential environmental impacts were identified by Metago in consultation with IAPs, regulatory authorities, specialist consultants and Swakop Uranium. In case of people related impacts, the assessment focused on third parties only (third parties include members of the public and occupants of the contractors camp after working hours) and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

The impacts are discussed under issue headings in this section. Impacts are considered in a cumulative manner where possible such that the impacts of the proposed linear infrastructure are seen in the context of the baseline conditions described in Section 4, in the context of the Husab Mine development as a whole, and where relevant in the context of the development of other mines.

The discussion and impact assessment for each sub-section covers the construction, operational, decommissioning and closure phases where relevant. This is indicated in the table at the beginning of each sub-section. Included in the table is a list of project activities/infrastructure that could cause the potential impact per mine phase. The activities/infrastructure that are summarised in this chapter, link to the description of the proposed project (see Section 6 of the EIA report).

Mitigation measures to address the identified impacts are discussed in this section and included in more detail in the EMP report that is attached in Appendix O. In most cases (unless otherwise stated), these mitigation measures have been taken into account in the assessment of the significance of the mitigated impacts only.

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7-1. This method complies with the method provided in the Namibian EIA Policy document and the draft EIA regulations. Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Both mitigated and unmitigated scenarios are considered for each impact. In addition, a comment on Metago's confidence in the significance rating is provided for each impact. The confidence options range from high, to moderate to low and must be read in the context of the assumptions, uncertainties, and limitations set out in section 8.

EXAMPLE SHOWING HOW THIS CHAPTER HAS BEEN STRUCTURED

5.2 TOPOGRAPHY

Environmental component heading

5.2.1 ISSUE: HAZARDOUS EXCAVATIONS

Issue heading

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
			N/A*
Activity/infrastructure 1 Activity/infrastructure 2	Activity/infrastructure 1 Activity/infrastructure 2	Activity/infrastructure 1	-

** N/A – not applicable.*

Bars showing phase of operation in which impacts could occur, and link to project activities

Assessment of impact

Description of the issue and associated impact in terms of severity, duration, spatial scale, consequence, probability and significance – considering all phases of project including any cumulative impacts

Tabulated summary of the assessed impact

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	L	M	L	M	M	M
Managed	L	L	L	L	L	L

Conceptual description of mitigation measures

Identification of mitigation objectives and conceptual description of mitigation actions

Emergency situation

Description of any emergency situations where relevant with reference to relevant procedures

TABLE 7-1: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
			SEVERITY = L		
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
			SEVERITY = M		
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
			SEVERITY = H		
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

7.1 TOPOGRAPHY

The topography (as described in Section 4.2) will be changed by the linear infrastructure. The following related issues have been identified and are discussed further in the sections highlighted in brackets:

- hazardous excavations and infrastructure and the dangers they present to animals and humans (Section 7.1.1);
- changes to surface water flow and related impacts (Section 7.4); and
- visual impacts (Section 7.9).

7.1.1 ISSUE: HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE

The information in the section was sourced from the project team and the specialist study in Appendix F (AWR 2011).

7.1.1.1 Introduction

With reference to Table 7-2, hazardous excavations and infrastructure include all structures into or off which third parties and animals can collide, fall and be harmed. It also includes all electrical structures which can result in electrocution. Hazardous excavations and infrastructure occur from construction through operation to decommissioning. Until closure planning indicates otherwise, it is assumed that at closure no linear infrastructure will remain. In the construction and decommissioning phases these hazardous excavations and infrastructure are usually temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term hazardous infrastructure.

TABLE 7-2: HAZARDOUS EXCAVATIONS & INFRASTRUCTURE - LINK TO PHASE & ACTIVITIES

Construction	Operational	Decommissioning	Closure
Trenches Borrow pits Scaffolding Temporary substation and power line	Bridge(s) crossing the Khan River and elevated road sections Steel pylons located along permanent power line Permanent substation and power line Power line along permanent pipeline Elevated sections of the permanent water pipeline Reservoirs along water pipelines	Trenches Piles of rubble Piles of scrap	N/A

7.1.1.2 Assessment of impact

Severity

In the unmitigated scenario, most of the identified hazardous excavations and infrastructure will by their physical nature change the current topography and landscape and as such they will present a potential risk of injury and/or death to animals, birds and humans.

In the case of humans and animals, the borrow pits, trenches, scaffolding, bridge and pylons all present opportunities for falling to harm. The reservoirs present a risk of drowning. The electrical infrastructure presents the risk of electrocution.

In the case of birds there are two issues. The power lines and associated infrastructure present a risk of collisions to both flying and running birds. Species of conservation concern that are nomadic and prone to collisions with overhead lines, include Flamingos, Great White Pelican, Black Stork, Abdim's Stork, White-Breasted Cormorant, South African Shelduck, Maccoa Duck, Cape Shoveler, Cape Teal, Red-billed Teal, Hottentot Teal and Southern Pochard. Terrestrial species that are prone to collisions include Ludwigs Bustard, Kori Bustard, Rüppell's Korhaan and common Ostrich. In addition, all live wires (particularly at poles and pylons) present a risk of electrocution for roosting and nesting birds. Species of concern that face this risk include Lappet-faced Vulture, White-backed Vulture, and various eagles, buzzards, owls, Guineafowl, crows, kestrels and hawks.

This is a potential high severity. With mitigation, the severity reduces to medium.

Duration

In the context of this assessment, death or permanent injury is considered a long term, permanent impact.

Spatial scale

For the most part, the direct impacts will be located within the infrastructure footprint, but the indirect impacts will extend to the communities to which the people/animals belong.

Consequence

In both the unmitigated and mitigated scenario, the consequence of this potential impact is high.

Probability

In the unmitigated scenario, it is probable that the hazardous excavations and infrastructure present a risk to humans, birds and animals.

In the case of humans, this is particularly relevant to the infrastructure that will route from the north across the Khan River, because these areas are outside of the regulation and controls of the MET

Directorate of Parks and Wildlife and are frequented by tourists and members of the public. Moreover, people are by nature curious and bold which can get them into difficult situations.

In the case of animals, any infrastructure in or close to the Khan River valley presents a risk because the concentration of animals is higher in these areas than in the desert plains. While animals may also be curious, they are also wary of humans and related activities particularly during the day. In the early morning and late afternoon they will be more active and bold especially if there is less human activity around the linear infrastructure.

In the case of birds, when they fly at night and in groups (like flamingos do), they are prone to collisions with electricity structures, especially the thinner, less visible earth/optic wires above the larger conductor wires. The situation may be aggravated by adverse weather conditions associated with wind, dust and fog. During these conditions the birds appear to fly lower for shelter. In such situations, the canyons of large river systems such as the Khan would provide significant shelter, but they may also be conduits for fog, which would reduce visibility. On these probably ancient migration routes, new power lines would present collision threat. Terrestrial birds are also prone to collisions when they are disturbed and/or alarmed by humans and related activities and attempt to escape. In these situations they have been observed to run or fly into wires. Moreover, the experience in Namibia is that pylons and stand poles are frequently used for roosting and nesting which presents a probable risk of bird electrocutions.

The proposed mitigation measures will focus on infrastructure safety, limiting access by third parties, animals and birds, and warning/diversion mechanisms for flying birds. Together these mitigation measures will reduce the probability of the impact occurring to possible.

Significance

In the unmitigated scenario, the significance of this potential cumulative impact is high. In the mitigated scenario, the significance of this potential impact is medium because there will be a reduction in probability that the impact occurs. The Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed impact – hazardous excavations and infrastructure

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**M**	**H**
Mitigated	**M**	**H**	**M**	**H**	**L**	**M**

7.1.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the mitigation measures is to prevent physical harm to humans, animals and birds from hazardous excavations and infrastructure.

Actions

During the construction, operation and decommissioning phases, barriers and warning signs will be used to keep people and animals away from the hazardous excavations and infrastructure. In this regard:

- the substations will be equipped with fences and warning signs;
- the reservoirs will be enclosed to prevent drowning;
- the bridge(s) and elevated sections of the permanent road will be equipped with barrier railings and warning signs to deter people and prevent animals from falling off the sides;
- the borrow pits, trenches and stockpiles will be cordoned off as appropriate until they are decommissioned; and
- the pylons will be equipped with base barriers to deter people from climbing up these structures.

Measures to limit bird fatalities associated with the temporary 66kV and 11kV power supply infrastructure will be incorporated into the planning and construction phases in a proactive manner as follows:

- the 66kV line should be routed along the western side of the Khan Mine valley, where practical, to avoid the spring and eastern cliffs;
- with due consideration of technical constraints, attempts will be made to minimise the length of the crossing span of the Khan River crossing;
- all wooded areas should be avoided as far as possible; in particular the eastern section of the Khan River valley, which has many trees;
- A-frame structures will be used for the 66kV temporary line and the 11kV permanent line rather than H-frame structures; however, H-frame structures will be used for straining;
- the use of stay wires should be minimised on both lines;
- all stay wires on both lines should be fitted with black / yellow guy markers will be installed at road crossings only
- spiral double loop flight diverters (alternating black and white) should be fitted to top conductors on the 66kV line where it routes in and through the Khan River valley;
- to increase the visibility of the line at night, in addition to spiral double loop flight diverters, fluorescent double loop flight diverters manufactured from “glow in the night material” should be fitted to top conductors on the 66kV line where it routes in and through the Khan River valley;
- top conductors of both the 11kV line and the 66kV line in the Khan Mine Valley should also be fitted with spiral double loop flight diverters, to mitigate against korhaan collisions;

- the top conductors of areas that were identified during the monitoring as being bird flight paths should be retrofitted with spiral double loop flight diverters and where necessary with fluorescent double loop flight diverters manufactured from "glow in the night material";
- raptor protectors (or some suitable alternative) could be installed on all top insulators on the 66kV A-frame line in the vicinity of vulture roosting sites; this applies in particular to camel thorn trees in the Khan River and its tributaries; and
- each earth wire on both lines, if used, should have an air space safety gap wide enough to avoid being permanently active, but close enough to allow lightning strikes to bridge it.

Measures to limit bird fatalities associated with the permanent 220kV power supply infrastructure will be incorporated into the planning and construction phases in a proactive manner as follows:

- with due consideration of technical constraints, attempts should be made to minimise the length of the crossing span of the Khan River crossing
- the eastern section of the Khan River valley, which has many trees, should be avoided;
- to increase the visibility of the line at night, fluorescent double loop flight diverters manufactured from "glow in the night material" should be installed on the earth-optic wires where the line crosses the Khan River valley and related tributaries; and
- the top conductors of areas that were identified during the monitoring as being bird flight paths should be retrofitted with spiral double loop flight diverters and where necessary with fluorescent double loop flight diverters manufactured from "glow in the night material".

Information will be provided at stakeholder information meetings to educate the public about the dangers associated with hazardous excavations and infrastructure.

Monthly monitoring will be performed along the power lines to identify and record any bird fatalities. The reports will record the fatality position, a photograph of the carcass, and a photograph of the surrounding habitat. The report will be copied to the NamPower/NNF strategic partnership for further investigation and action.

Emergency situations

If people or animals sustain injuries as a result of the linear infrastructure, the Husab emergency response procedure will be followed.

7.2 SOILS AND LAND CAPABILITY

The information in this section was sourced from the soil specialist study in Appendix E (ESS, 2011).

Soils are a significant component of most ecosystems. As an ecological driver, soil is the medium in which most vegetation grows and a range of vertebrates and invertebrates exist. In the context of mining and related infrastructure, soil is even more significant if one considers that mining is a temporary land use where-after rehabilitation (using soil) is the key to re-establishing post closure land capability that will support post closure land uses.

7.2.1 ISSUE: LOSS OF SOIL RESOURCES FROM POLLUTION

7.2.1.1 Introduction

With reference to Table 7-3, there are a number of sources in all phases that could pollute soils particularly in the unmitigated scenario. In the construction and decommissioning phases these potential pollution sources are temporary in nature, usually existing for a few weeks to a few months. Although the sources are temporary in nature, the potential related pollution can have long term effects. The operational phase will present more long term potential sources. No pollution is expected in the closure phase because all linear infrastructure will have been removed.

TABLE 7-3: SOIL POLLUTION – LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
General construction activities Cement mixing Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	Servicing equipment Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Transportation of product and input chemicals	General building activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	N/A

7.2.1.2 Assessment of impact

Severity

In the unmitigated scenario, pollution of soils from numerous incidents can result in a loss of soil functionality as an ecological driver because it can create a toxic environment for vegetation, vertebrates and invertebrates that rely on the soil. It could also negatively impact on the chemistry of the soils such that current growth conditions are impaired. This is a high severity. In the mitigated scenario, the number of pollution events should be significantly less which reduces the potential severity to medium.

Duration

In the unmitigated scenario, most pollution impacts will remain until long after closure. In the mitigated scenario most of these potential impacts should either be avoided or be remedied within the life of the mine. Important related issues are the reaction time of the clean-up team and the chosen remediation methods, which need to be carefully considered in the desert environment because it has different underlying processes in the soil when compared to wetter environments.

Spatial scale

Potential soil pollution will be restricted to the linear infrastructure sites.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to medium because the severity and duration of the impact is reduced.

Probability

Without any mitigation the probability of impacting on soils through pollution events is high. With mitigation, the probability will be significantly reduced to low because emphasis will be placed on preventing pollution events and on quick and effective remediation if pollution events do occur.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance reduces to low because with mitigation the severity, duration and probability associated with the potential the impact all reduce. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – soil pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
unmitigated	**H**	**H**	**L**	**H**	**H**	**H**
mitigated	**M**	**L**	**L**	**L**	**L**	**L**

7.2.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to prevent pollution of soils.

Actions

In the construction, operation and decommissioning phases all hazardous chemicals and materials (new and used), dirty water, and non-mineralised wastes will be handled in a manner that they do not pollute soils. This will be implemented through the EMP and one or more procedure(s) covering the following:

- pollution prevention through basic infrastructure design and through education and training of workers (permanent and temporary);

- safe transportation of chemicals and materials that have the potential to pollute soils;
- the required steps to enable fast reaction to contain and remediate pollution incidents. In this regard the remediation options include in situ treatment or disposal of contaminated soils as hazardous waste. The former is generally considered to be the preferred option because with successful in situ remediation the soil resource will be retained in the correct place. The in situ options include bioremediation at the point of pollution, or removal of soils for washing and/or bio remediation at a designated area after which the soils are replaced; and
- specifications for post rehabilitation audit criteria to ascertain whether the remediation has been successful.

Emergency situations

Major spillage incidents will be handled in accordance with the Husab emergency response procedure.

7.2.2 ISSUE: LOSS OF SOILS RESOURCE THROUGH PHYSICAL DISTURBANCE

Introduction

With reference to Table 7-4, there are a number of activities/infrastructure in all phases that have the potential to disturb soils through removal, compaction and/or erosion. In the construction and decommissioning phases these activities are temporary in nature, usually existing for a few weeks to a few months. The operational and closure phase will present more long term activities.

TABLE 7-4: PHYSICAL DISTURBANCE OF SOILS – LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Soil stripping Cleaning, grubbing and bulldozing Preparation of foundations Material and equipment movement Compacting bases Opening borrow pits and trenches Vehicle movement	Vehicle movement Servicing equipment Soil stockpile management	Soil stripping Cleaning and grubbing Material and equipment movement Slope stabilization Vehicle movement	Erosion of rehabilitated areas

7.2.2.1 Assessment of impact

Severity

In the unmitigated scenario, physical soil disturbance can result in a loss of soil functionality as an ecological driver. In the case of erosion, the soils will be lost to the area of disturbance, and in the case of compaction the soils functionality will firstly be compromised through a lack of rooting ability and aeration, and secondly the compacted soils are likely to erode because with less inherent functionality there will be little chance for the establishment of vegetation and other matter that naturally protects the soils from erosion. This amounts to a high severity.

In the context of the soil horizons that have been identified by the specialist, this issue is further complicated because of the occurrence of the upper soil crust on the plains and the calcrete layer beneath many of the soils. Both of these features are considered to be important aspects of the ecosystem functionality. In the case of the calcrete layer, the key issue is its impermeable nature which retains moisture and nutrients in the lower part of the upper soil horizon. In the case of the crust, it prevents erosion of the underlying soils and may also retain moisture and nutrients in those soils.

In the mitigated scenario, the soils can be conserved and reused, but it is not yet clear whether the calcrete and crust layers can be effectively re-established with the same or similar material. If successful, these mitigation measures reduce the high unmitigated severity to medium.

Duration

In the unmitigated scenario the loss of soil and related functionality is long term and will continue after the life of the linear infrastructure. In the mitigated scenario, the soil is conserved and replaced in all areas which reduces the duration of the impact to the life of the linear infrastructure.

Spatial scale

Physical disturbance of the soil will be restricted to the area of direct influence of the linear infrastructure and related activities. This is a localised spatial scale.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario this reduces to medium because the severity and duration of the impacts are reduced.

Probability

Without any mitigation the probability of losing soil and its functionality is definite. With mitigation, the probability will be reduced because emphasis will be placed on soil conservation and re-establishment. In this regard, there remains some uncertainty about the chances of effectively rehabilitating the calcrete and crust layers (with the same or similar material) and the role they play as ecological drivers.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance is expected to reduce but the success of the management measures remains untested. Metago's confidence level is therefore moderate for this significance rating.

Tabulated summary of the assessed cumulative impact – physical disturbance of soils

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	**H**	**H**	**L**	**H**	**H**	**H**
Managed	**M**	**M**	**L**	**M**	**M**	**M**

7.2.2.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to minimise the loss of soil resources and related functionality through physical disturbance, erosion and compaction.

Actions

In the construction, operation and decommissioning phases a soil management plan will be implemented. The key components are:

- limit the disturbance of soils to what is absolutely necessary both in terms of site clearing and in terms of on-going maintenance (servicing equipment) and use of vehicles;
- where soils have to be disturbed the soil will be stripped, stored, maintained and replaced in accordance with the specifications of the soil management plan (conservation procedure); and
- if required, pilot studies will be undertaken during the operation phase of the linear infrastructure to determine the best method of re-creating the subsurface impermeable layer (in its natural form this is calcrete but it may be possible to recreate it with similar material) and crust layers, and restoring their role as ecological drivers.

As part of closure planning, the rehabilitation plans and interventions will take into consideration the requirements for long term erosion prevention and confirmatory monitoring.

Emergency situations

None identified.

7.3 BIODIVERSITY

The information in this section was sourced from the biodiversity specialist study in Appendix F (AWR, 2011) and the Uranium Rush SEA (SAIEA, 2010).

7.3.1 INTRODUCTION

The section is intended to be a high level assessment of biodiversity impacts. Therefore, readers must be aware of the content of the baseline description (Section 4.5), the content of the specialist report (Appendix F) and the content of the EMP (Appendix O) when reading this section.

The assessment covers the following broad topics: physical destruction of biodiversity and related functions, impacts on sub-surface water resources as an ecological driver, and general disturbances to biodiversity. Each of these topics is individually assessed below.

It must also be noted that the collision and electrocution impacts of power supply infrastructure have been assessed in Section 7.1 and secondary impacts on biodiversity associated with soil erosion, soil compaction, and physical disturbance and pollution of soils have already been assessed in Section 7.2. None of these assessments will be repeated below.

7.3.2 ISSUE: PHYSICAL DESTRUCTION OF BIODIVERSITY

7.3.2.1 Introduction

With reference to Table 7-5, there are a number of activities/infrastructure in all phases that have the potential to destroy biodiversity in the broadest sense. In this regard, the discussion relates to the physical destruction of specific biodiversity areas, of linkages between biodiversity areas and of related species which are considered to be significant because of their status, and/or the role that they play in the ecosystem.

TABLE 7-5: PHYSICAL DESTRUCTION OF BIODIVERSITY - LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Soil stripping Cleaning, grubbing and bulldozing Preparation of foundations Material and equipment movement Compacting bases Opening borrow pits and trenches Vehicle movement	Vehicle movement Servicing equipment Soil stockpile management Elevated permanent road Bridge(s) Above ground pipeline	Soil stripping Cleaning and grubbing Material and equipment movement Slope stabilization Vehicle movement	Erosion of rehabilitated areas

7.3.2.2 Assessment of impact

Severity

It must be noted that in the context of the Uranium Rush SEA (SAIEA, 2010) there are no feasible route alternatives for the Husab Mine linear infrastructure that do not cross the red flag biodiversity areas associated with the Khan and Swakop Rivers and the Welwitschia plain. This in itself is a highly significant issue, but it cannot be avoided if the approved Husab Mine is to function. This issue raises the question of biodiversity offsets which are dealt with under mitigation measures below.

With reference to the combined biodiversity habitats and sensitivity map (Figure 4-9), the proposed activities and infrastructure will traverse a range of sensitivities from the No-Go Welwitschia plains to the, to the very sensitive river beds and tributaries to the least sensitive areas on the Grassy and Gypsite Plains and Khan Mine road through the Black Gramadoelas. This has negative implications for the biodiversity of the area in general, but particularly for:

- mammals including the gerbils, ground squirrels, and rupicolous species such as the dassie rat;
- reptiles including the Husab sand lizard;
- some endangered and vulnerable invertebrates;
- birds including nightjars, owls, korhaans, Ostrich, vultures, eagles and crows; and
- plants including *Welwitschia mirabilis, Aloe aspeifolia, Lavrania marlothii, Hoodia spp, Commiphora saxicola, Lithops ruschiorum*, and riparian trees especially *Acacia erioloba.*

The relatively thin disturbance width but long disturbance length associated with the linear infrastructure means that there is some concern about the direct destruction of specific habitats and species as described above, but there is probably more concern about the fragmentation of habitats and obstructions and disturbances to the movement of key species, energy and water.

For example, the zebras and Ostriches are important because they migrate significant distances in and around the study area. Other larger mammals perform a similar role. In this process they transfer nutrients and connect different populations, habitats and regions. There is already concern that the Husab Mine infrastructure and related disturbances may cause the zebras in particular to vacate the study area which has implications for the sustainability of the zebra population in the area, for the role they play in the nutrient dispersion cycle and the effect they have in providing invertebrates with required habitat (eg. dung feeders). By adding the linear infrastructure to the landscape, the impact could be worsened by:

- physical obstructions to fauna movement caused by linear infrastructure in general, but by the elevated road and permanent pipeline in particular. This includes the obstructions that may be caused if channelled run-off water adjacent to the permanent road forms erosion gulleys in the Khan and tributary riverbeds;
- Physical obstruction of water and nutrient flows by constructing the elevated road in the Khan River and associated tributaries;
- disturbance obstructions caused by the influx of people, equipment and vehicles. The activity and noise associated therewith can frighten animals and prevent them from using established game paths and can disturb breeding patterns; and
- physical disturbance caused by destroying important parts of previously contiguous habitat patches.

Given the above discussion, the unmitigated cumulative severity is high which may reduce to somewhere between medium and high depending on the successful implementation of the mitigation measures.

Duration

In the unmitigated scenario the cumulative loss of biodiversity and related functionality is long term and will continue after the life of the mine (and associated linear infrastructure). In the mitigated scenario the biodiversity and related functionality may be partially restored during the operational and decommissioning phases, but given the long term nature of ecological processes in the desert, it is unlikely that full restoration will occur before closure. The duration is therefore high in both the unmitigated and mitigated scenarios.

Spatial scale

Given that biodiversity processes are not confined to the infrastructure sites, the spatial scale of impacts will extend beyond the site boundary in both the mitigated and unmitigated scenario. Key related issues are the migration of species, the flow of nutrients and linkages between biodiversity areas. The spatial scale is therefore medium in both the unmitigated and mitigated scenarios.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. Even though the severity may be reduced with mitigation, the duration and spatial scale remain high and therefore the mitigated consequence remains high.

Probability

Without any mitigation the probability associated with the impacts is definite. With mitigation, the probability may be reduced because emphasis will be placed on designing and constructing the linear infrastructure in a manner that reduces the significance of the disturbance footprint and in a manner that presents limited obstructions to natural processes. In addition, rehabilitation and restoration of the disturbance footprints will be a focus going forward although the possibility of full restoration is uncertain. In the scenario where restoration is not successful, the option of offsets is still available if deemed necessary.

Significance

The significance of this potential impact is high in the unmitigated scenario and medium to high in the mitigated scenario. Metago's confidence level is moderate to high for this significance rating.

Tabulated summary of the assessed impact – destruction of biodiversity

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M-H**	**H**	**M**	**M-H**	**M-H**	**M-H**

7.3.2.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the mitigation measures is to prevent, as far as is possible, the unacceptable loss of biodiversity and related functionality through physical destruction and disturbance.

Actions

The following design and planning recommendations will be implemented.

It is acknowledged that the permanent water pipeline will be buried as a preference. Where this is not possible, over and underpasses will be provided at regular intervals. The design specifications of these passes and the intervals will be obtained from an ecology specialist and will be included in the final detailed engineering design for the pipeline. Access along this route will be controlled.

It is acknowledged that the permanent road will either have a high level bridge or a level crossing over the Khan River and both of these designs are sufficient in concept to allow free movement of fauna, particularly after sunset and before sunrise when the road will not normally be used. In addition, it is acknowledged that the planned culverts beneath the permanent road will allow water and nutrient flows to continue. In addition to these commitments energy dissipaters will be used to prevent water flows from channelling and eroding the river bed adjacent to the road and culverts. In the case of the elevated road in the Khan River and tributaries, underpasses and overpasses will be provided at regular intervals. The design specifications of these passes and intervals will be obtained from an ecology specialist and will be included in the final detailed engineering design for the road.

Because linear infrastructure is routed through the SEA red flag areas, specific care will be taken to avoid both vegetation species of concern and highly sensitive habitats. In the case of the Welwitschia plain, specific care will be taken to prevent harm or destruction of *Welwitschia mirabilis* individuals. In the case of the Swakop and Khan Rivers specific care will be taken to prevent harm or destruction of all vegetation species of concern including all riparian trees, and to try to limit any development any access to the eastern side valleys and associated springs of the Khan River and the side valleys and springs associated with the Swakop River. This will be achieved by appointing an ecologist to work with the planners and designers (before construction commences) to mark out all vegetation and habitat sensitivities so that these can be avoided. Where damage cannot be avoided the ecologist will advise on the possibilities for rescue and trans-relocation and applications will be made for the necessary permits in terms of the Nature Conservation Ordinance 14 of 1975 and the Forest Act, 12 of 2001 for the destruction and/or removal of protected vegetation.

In the construction, operation and decommissioning phases a biodiversity management plan will be implemented. The key components are:

- to generally limit linear infrastructure, activities and related disturbance to those specifically identified and described in this EIA report. As part of this commitment the size of development areas including tracks will be kept to an absolute minimum;
- Construction activities in the Khan River, Swakop River and tributaries will preferentially start after sunrise and finish before sunset so that the disturbance at dusk and dawn for animal and bird movement is reduced;
- to audit the activities of construction teams in the red flag areas on a routine basis. Where the construction teams have not complied with the relevant plans contractual penalty clauses will apply;
- to initiate rehabilitation and restoration initiatives as soon as possible. This will include follow up audits and monitoring in the short and long term to determine the success of the rehabilitation and restoration activities in terms of a range of performance indicators;
- implementation of an alien/invasive/weed management programme to control the spread of these plants onto and from disturbed areas;
- if irreplaceable biodiversity will be permanently lost and restoration is not possible, a biodiversity offset will be investigated. This is a deviation from the recommendations in the Uranium Rush SEA which requires an offset whenever infrastructure routes through red flag areas. The modified approach is considered justified on the basis that should all the mitigation measures be successfully implemented then the level of impact should be acceptable (reducing to medium significance in the range of medium to high). Issues that will be considered in the investigation are as follows:
    - the size of the potentially affected area;
    - the conservation/sensitivity status of the potentially affected area;
    - the offset ratio (in terms of the required size of the offset site) to be applied;
    - evaluation of alternative offset sites on the basis of: no net biodiversity loss, compensation for the mine's negative impact on biodiversity, long term functionality, long term viability, contribution to biodiversity conservation in the Namib including linkages to areas of conservation importance, acceptability to key stakeholders, distances from other mines in relation to dust fallout and other impacts, and biodiversity condition scores as compared to that at the mine site;
    - land ownership now and in the future;
    - status/security of the offset site, ie. will it receive conservation status;
    - measures to guarantee the security, management, monitoring and auditing of the offset;
    - capacity of Swakop Uranium to implement and manage the offset;
    - identification of unacceptable risks associated with the offset; and
    - the start-up and on-going costs associated with the offset for the life of the project.

Provision will be made for post closure monitoring to assess the effectiveness of rehabilitation and restoration and to implement additional measures where required.

As an on-going contribution to the knowledge and conservation of biodiversity in the NNNP, Swakop Uranium will contribute towards resourcing additional biodiversity studies. A recommended priority in this regard is a study to understand more about the movement and associated processes of large mammals and possibly the Common Ostrich.

Emergency situations

None identified.

7.3.3 ISSUE: IMPACTS ON SUB SURFACE WATER RESOURCES

7.3.3.1 Introduction

Abstraction of Swakop River water presents two possible impacts. The one impact is on downstream human users. The other impact is on riparian habitat and related functions and processes.

Modelling shows that potential dewatering impacts will not be noticed further than 3km of the proposed abstraction boreholes. Given that the distance between the closest downstream third party borehole and the closest proposed abstraction borehole is more than 10km, no impacts are expected on human users and this issue will not be discussed further.

In the Swakop River a key ecological driver (an element that is important for the functioning of that habitat and related ecosystem) is sub surface water. The abstraction thereof presents the possibility of impacts on riparian vegetation and associated functions and processes. This issue is assessed further below.

TABLE 7-6: IMPACT ON SUBSURFACE WATER RESOURCES – LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Possible abstraction of sub surface water from the IDC	N/A	N/A	N/A

7.3.3.2 Assessment of impact

Severity

A key variable that influences riparian tree survival in the Swakop River is sub surface water depth. In general, the deeper the sub surface water level the closer a riparian tree gets to water induced survival thresholds. Available research indicates that a drop in sub surface water levels of more than 10cm per month will cause trees to struggle for survival. In the early stages of this struggle some trees will lose leaves and seed pods (by the time this first criteria is reached it is probable that the trees are too stressed to recover in the same growing season). If the water decline increases the trees will lose branches. With continued dewatering above the 10cm per month the trees are expected to die. The indigenous trees of concern include ana tree *Faidherbia albida*, camel thorn *Acacia erioloba* and umbrella thorn *Acacia tortilis.* The death of riparian trees will have knock on effects for the ecological functions and processes associated with these trees particularly in regard to food sources and shelter for invertebrates and vertebrates. Moreover, some of these vertebrates and invertebrates play a key role in assisting the trees with seed germination, so by reducing the number of trees through dewatering, the ecosystem functionality will be reduced which will further reduce the propagation and related number of trees in the long term. One positive of dewatering induced stress is that it will impact the exotic invasive *Prosopis* sp which is considered an ecological problem species in the Swakop River.

In the unmitigated scenario, the impact severity will be high when abstraction from the IDC causes the sub surface water level to drop by more than 10cm per month. With mitigation the drop in water levels can be controlled and the severity should reduce to low.

Duration

The construction phase of the linear infrastructure and Husab Mine will be approximately 30 months. It follows that in the most conservative scenario that abstraction from the IDC will occur for 30 months.

In the unmitigated scenario, the duration of the impacts will extend beyond the 30 months for an unknown period. One of the critical factors in this scenario is the natural recharge from rainfall and runoff. This cannot be predicted with certainty and the possibility of extended drought periods is as plausible as an extended wet period which results in significant recharge of the sub surface water levels. By adopting a conservative approach the duration is expected to be long term because some of the riparian trees in question are older than 100 years and to time required to replace them with new trees will extend beyond the life of the Husab Mine.

In the mitigated scenario, if the abstraction activities have been controlled and the drop in sub surface water levels has been less than 10cm per month it is possible that the impact duration will be short term, if at all.

Spatial scale

Given that biodiversity processes are not confined to the project site, the spatial scale of impacts will extend beyond the site boundary in both the mitigated and unmitigated scenario. The related spatial scale is medium.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario this reduces to low.

Probability

Without any mitigation it is probable that the impact will occur. With mitigation, the impact is unlikely.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance reduces to low. It must also be noted that although some research has been done on this issue, it is considered to be insufficient to predict the impact with complete confidence. Issues that remain questionable are the water dynamics of all riparian trees and the limit thresholds of extraction rates and water depths. Metago's confidence level is therefore moderate for this significance rating.

Tabulated summary of the assessed impact – water resource as an ecological driver

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**L**	**L**	**M**	**L**	**L**	**L**

7.3.3.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the mitigation measures is to prevent the loss of riparian vegetation (trees in particular) and related ecosystem functionality.

Actions

In order to ensure that sub surface water levels do not drop by more than 10cm per month, the abstraction limit is calculated at a maximum amount of 0.5Mm^3/annum (Biwac 2011). If the maximum amount is abstracted, three boreholes will be used and these boreholes will be spaced at least 2km apart to prevent cumulative abstraction impacts on sub surface water levels.

A permit will be obtained from the Ministry of Agriculture, Water and Forestry prior to abstraction.

For each abstraction borehole, a downstream monitoring borehole will be installed to enable monthly monitoring of the sub surface water levels. Given the uncertainties around the 10cm limit, monitoring of riparian tree health by a botanist will also be done on a monthly basis by using physiological parameters (such as xylem pressure). If monitoring shows that either the water levels have dropped by more than 10cm or that the trees are struggling to survive then on the advice of both a groundwater specialist and botanist:

- abstraction rates will be adjusted down or stopped; or

- alternative measures will be identified and implemented to water the affected trees.

The monitoring data will assist with the understanding of the water dynamics of riparian trees and the limit thresholds of extraction rates and water depths.

The competition for sub surface water between the indigenous trees and the exotic invasive *Prosopis* sp may be reduced by the clearing of the exotic trees from certain sections the IDC. If implemented, this will require a specific and monitored management plan.

Emergency situations

None identified.

7.3.4 ISSUE: GENERAL DISTURBANCE OF BIODIVERSITY

7.3.4.1 Introduction

With reference to Table 7-7, there are a number of activities/infrastructure that have the potential to directly disturb vegetation, vertebrates and invertebrates in all mine phases, particularly in the unmitigated scenario. In the construction and decommissioning phases these activities are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term occurrences and the closure phase will present final land forms that may have pollution potential through long term seepage and/or run-off.

TABLE 7-7: GENERAL DISTURBANCE OF BIODIVERSITY –LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
General construction activities Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Servicing equipment Use of vehicles and equipment that may leak lubricants and fuel Security lights Contractors camps Vehicle movement on access roads and off road	Servicing equipment Vehicle movement on access roads and off road Use of vehicles and equipment that may leak lubricants and fuel and that carry hazardous loads Security lights	General construction activities Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Servicing equipment Use of vehicles and equipment that may leak lubricants and fuel Security lights Contractors camps Vehicle movement on access roads and off road	N/A

7.3.4.2 Assessment of impact

Severity

In the unmanaged scenario, biodiversity will be disturbed in the following ways:

- white light attracts large numbers of invertebrates which become easy prey for predators. This can upset the invertebrate population balances;
- people may kill various types of biodiversity for food, for sport, for fire wood etc;
- people may illegally collect and remove vegetation, vertebrate and invertebrate species;
- river sand may be collected from the Swakop and Khan Rivers for building purposes;
- excessive dust fallout from various dust sources may have adverse effects on the growth of some vegetation, and it may cause varying stress on the teeth of vertebrates that have to graze soiled vegetation;
- the increase in traffic in the area can cause road kills especially if drivers speed;
- open reservoirs may lead to drowning of fauna; and
- pollution emissions and general litter may directly impact on the survival of individual plants, vertebrates and invertebrates.

Taken together, the disturbances will have a high severity in the unmitigated scenario. In the mitigated scenario, many of these disturbances can be prevented or mitigated to acceptable levels, which reduces the severity to low.

Duration

In both the mitigated and unmitigated scenarios, the impacts are long term because where biodiversity is compromised, killed or removed from the area this impact is likely to exist beyond the life of mine.

Spatial scale

Given that biodiversity processes are not confined to the proposed project site, the spatial scale of impacts will extend beyond the infrastructure site boundary in the unmitigated and mitigated scenario. Key related issues are the migration of species and linkages between biodiversity areas. This is a medium spatial scale.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to somewhere between medium and high because the severity of the impact is reduced.

Probability

Without any mitigation the probability of negatively impacting on biodiversity through multiple disturbance events is high. With mitigation, the probability will be reduced to medium because most of the disturbances can be controlled through implementation and enforcement of practices, policies and procedures.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance is reduced to medium - high because the associated severity and probability are reduced. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact- general biodiversity disturbance

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M-L**	**H**	**M**	**H-M**	**M**	**H-M**

7.3.4.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the management measures is to prevent unacceptable disturbance of biodiversity.

Actions

In the construction, operation and decommissioning phases the following will be implemented:

- disturbance footprints will be minimised through appropriate planning;
- training will be provided to all workers about the impacts associated with biodiversity disturbances;
- to prevent high insect mortality, the use of light is kept to a minimum, and where it is required, yellow lighting is used where possible: vertebrates should be kept away from the lighted areas with appropriate fencing where feasible;
- there is zero tolerance to the killing or collecting of any biodiversity (including the collection of wood). In this regard, the locations of species of concern will not be marked or advertised;
- collection of sand for building and other purposes will be minimised from the Swakop and Khan Rivers in the vicinity of the linear infrastructure;
- occupants of the temporary accommodation camps within the DNP and NNNP will be required to remain within the camp after working hours;
- all camps will be supplied with sufficient cooking equipment so that the collection of fire wood is not required for this purpose;
- strict speed control measures are used for any Husab Mine related vehicles driving within the NNNP and DNP boundaries. Appropriate speed limit reductions will be implemented for the permanent access road in the Khan River and associated tributaries where animal and bird concentration is highest. No off road driving will be allowed;
- noisy equipment will be well maintained to control noise emission levels;

- the new linear infrastructure reservoirs will be enclosed containers that will prevent access by birds and animals;
- dust control measures are implemented (see 7.5.1) and
- pollution prevention measures are implemented (see Section 7.2.1).
- Routine monitoring will be performed and an incident and action report compiled on a weekly basis during construction and decommissioning and on a monthly basis during operations.

Emergency situations

Major spillage incidents will be handled in accordance with the Husab emergency response procedure.

Certain instances of injury to animals may be considered emergency situations. These will be managed in accordance with the Husab emergency response procedure.

7.4 WATER

7.4.1 ISSUE: ALTERING SURFACE DRAINAGE PATTERNS

The identified impacts associated with altering and obstructing surface water drainage have been addressed in Section 7.3.2. In this regard, the key issues are the change to surface water and nutrient flow as an important ecological driver and gully erosion of the river beds from channelling of water. These issues will not be repeated here.

7.4.2 ISSUE: DEWATERING IN THE IDA DOME COMPARTMENT OF THE SWAKOP RIVER

The identified impacts associated with dewatering have been addressed in Section 7.3.3. In this regard, the key issues are impacts on downstream human users and impacts on riparian vegetation and associated functions and processes. These issues will not be repeated here.

7.4.3 ISSUE: POLLUTION OF SURFACE AND GROUND WATER

7.4.3.1 Introduction

With reference to Table 7-8, there are a number of pollution sources in all project phases that have the potential to pollute surface and groundwater, particularly in the unmitigated scenario. In the construction and decommissioning phases these potential pollution sources are temporary in nature, usually existing for a few weeks to a few months. Although these sources may be temporary, the potential pollution may be long term. The operational phase will present more long term potential sources.

TABLE 7-8: WATER POLLUTION SOURCES–LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
General construction activities Cement mixing Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	Servicing equipment Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Transportation of product and input chemicals	General building activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	N/A

7.4.3.2 Assessment of impact

Severity

Surface water flow occurs infrequently and for short durations after rainfall events. Most of this water seeps into the topsoil and shallow sandy zones and flows in the near surface zones. Therefore the surface and shallow groundwater systems, and the related impact assessment, are necessarily linked.

In the unmitigated scenario, surface water may collect contaminants from numerous diffuse sources. At elevated pollution concentrations these contaminants can result in water concentrations that are above recommended drinking water guidelines. (note that the impacts on biodiversity have been assessed in Section 7.3.4 and will not be reassessed in this section). The dilution effect of the flood water has not been studied in detail but it will reduce the concentration of any contaminants.

In the mitigated scenario, most surface water run-off should be relatively clean and the severity reduces to low because systems and procedures can be implemented to contain pollution at source and isolate it from potential water resources.

Duration

If humans consume contaminated water the related health impact can extend beyond the life of the Husab Mine and linear infrastructure so the duration is high in the mitigated and unmitigated scenarios.

Spatial scale

The spatial scale of the potential unmitigated impacts will be off site, downstream of the pollution incidents, in the Swakop or Khan Rivers. This is a medium spatial scale in both the mitigated and unmitigated scenarios.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to medium because the severity of the impact is reduced.

Probability

In the unmitigated scenario, even if pollution occurs in the rivers, the impact points are in remote areas where the alluvial aquifer water is not utilised by humans. Although no project specific modelling has been done for this EIA, once the polluted water seeps into the river alluvium, it is expected that it will not migrate to downstream users because of the limited volumes in question, and the compartmentalised nature of the alluvial aquifers in the rivers (SAIEA, 2010) that is expected to limit downstream flow between compartments. With mitigation the pollution of the rivers will be prevented.

This translates into a low impact probability in the unmitigated and mitigated scenarios.

Significance

In the unmitigated scenario, the significance of this potential impact is medium. In the mitigated scenario, the significance is reduced to low because of the reduction in severity and probability. Metago's confidence level is moderate to high for this significance rating.

7.4.3.3 Tabulated summary of the assessed cumulative impact – surface water pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**L**	**M**
Mitigated	**L**	**M-L**	**L**	**L**	**L**	**L**

7.4.3.4 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the mitigation measures is to prevent pollution of surface water run-off and related health impacts on downstream users of surface and sub-surface water.

Actions

In the construction, operation and decommissioning phases the mine will ensure that all hazardous chemicals (new and used), dirty water, non-mineralised wastes, and product are handled and transported in a manner that they do not contaminate surface water run-off or near surface water flow. Further detail is provided in the soils mitigation section 7.2.1 ;

On-going water quality monitoring in the Swakop and Khan Rivers will be done to track pollution trends and related risks. If pollution is detected, remediation steps will be implemented with the input of a groundwater specialist and the relevant government departments.

Emergency situations

Major spillage incidents that can contaminate water resources will be handled in accordance with the Husab emergency response procedure.

7.5 AIR

The information in this section was sourced from the air specialist assessment in Appendix I (Airshed, 2010) and the EIA for the Husab Mine (Metago 2010).

7.5.1 ISSUE: AIR POLLUTION

7.5.1.1 Introduction

With reference to Table 7-9, there are a number of activities in all phases that have the potential to pollute the air. In the construction and decommissioning phases these activities are temporary in nature. The operational phase will present more long term activities and the closure phase will present final land forms that may have the potential to pollute the air through long term wind erosion. The assessment below presents findings for the construction and operational phase only. Given that the activities during decommissioning are similar to construction, the assessment findings for construction are considered applicable to decommissioning. Modelling and detailed assessment of the closure phase is only possible when the final closure plan is documented, but it is expected that impacts at closure will not be worse than the operational phase.

On their own the impacts from the linear infrastructure and related activities will be localised and of low significance (Airshed 2011). However, the discussion below presents a cumulative assessment in the context of the potential air impacts presented in the Husab Mine EIA (Metago, 2010),

Air pollution related impacts on biodiversity have been discussed in Section 7.3 and therefore this section focuses on the potential for human health impacts.

TABLE 7-9: AIR POLLUTION – LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Soil stripping Cleaning and grubbing Preparation of the foundations Compacting bases Opening borrow pits and trenches Operation of asphalt plant General building activities Vehicle movement and exhaust fumes Diesel generators Limited drilling and blasting	Vehicle movement and exhaust fumes Soil management activities	Removal of infrastructure Vehicle movement and exhaust fumes General material handling Soil management activities Diesel generators	Wind erosion of rehabilitated areas

7.5.1.2 Assessment of impact

Severity

From the assessment results for the Husab Mine EIA (Metago, 2010) the only contaminant of material human health concern is particulate matter less than ten micron in size (PM10). All other contaminants (vehicle fumes, generator fumes, gas emissions from plants) result in negligible impacts. The corresponding evaluation criteria are presented in Table 7-10.

TABLE 7-10: AIR IMPACT EVALUATION CRITERIA

Contaminant	Averaging Period	Evaluation criteria	Source
PM10	Daily	75 microgram/m^3	WHO IT3
	Annual	30 microgram/m^3	WHO IT3
	Eight hourly	10 000 microgram/m^3	WHO

Given the above, this cumulative assessment focuses only on PM10 and in this context, the most relevant off site receptor points are Arandis town, Rössing Mine, and the tourist attractions centred around the Khan Mine, Khan River Valley and Welwitschia plain (including the big tourist Welwitschia, and the Welwitschia and Swakop River camp sites). It must further be noted that people who live in Arandis and work at either Rössing mine or the proposed Husab mine will be exposed to the greatest cumulative impacts because they will be exposed at both work and at home.

Construction (and decommissioning) PM10 predictions

Table 7-11 and Table 7-12 show that in both the unmitigated and mitigated scenarios the incremental contribution from the Husab Mine (excluding the localised contribution from the linear infrastructure construction) is small when considered as a percentage of the current ambient concentrations (as presented in Section 4.8.3).

TABLE 7-11: UNMITIGATED INCREMENTAL CONSTRUCTION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	8	21	40
PM10 annual (µg/m³)	1	1	2

TABLE 7-12: MITIGATED INCREMENTAL CONSTRUCTION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	4	10	20
PM10 annual (µg/m³)	0.6	0.4	1

As small as these incremental contributions are, they will add more PM10 pollution to the baseline which already exceeds the evaluation criteria (Table 7-10). Even though the additional contribution from the linear infrastructure construction is expected to be limited, the cumulative severity in both scenarios is high.

<u>Operational PM10 predictions</u>

Table 7-13 shows that unmitigated incremental contributions from the Husab Mine (excluding the localised contribution from the linear infrastructure construction) generally exceed the evaluation criteria. Table 7-14 shows that in the mitigated scenarios the incremental contribution is small when considered as a percentage of the current ambient concentrations (as presented in Section 4.8.3).

TABLE 7-13: UNMITIGATED INCREMENTAL OPERATION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	75	369	271
PM10 annual (µg/m³)	13	37	42

TABLE 7-14: MITIGATED INCREMENTAL OPERATION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	10	45	48
PM10 annual (µg/m³)	2	4	5

As small as these mitigated incremental contributions are, they will add more PM10 pollution to the baseline which already exceeds the evaluation criteria.). Even though the additional contribution from the linear infrastructure operation is expected to be limited, the cumulative severity in both scenarios is high.

The cumulative impact scenario is carried forward in the rest of the assessment below.

Duration

In both the cumulative unmitigated and mitigated scenarios, if human health impacts occur, these are potentially medium to long term in nature. This is a medium to high duration.

Spatial scale

The spatial scale of the potential cumulative impact is directly related to the spatial scale of the dispersion of any air pollution that in turn has the potential to impact on human health. In both the unmitigated and mitigated scenarios the evaluation criteria will be exceeded off site so the spatial scale is medium. Given that there are localised dispersion zones this is expected to have a negative impact on tourist and recreation activities in the following areas:

- wilderness tours in the affected section of the Khan River and tributary valleys;
- camping activities in the affected section of the Khan River and tributary valleys; and
- camping activities in the Swakop River camp sites.

Consequence

In the unmitigated and mitigated scenario, the consequence of this potential impact is medium to high.

Probability

In both the unmitigated and mitigated scenarios the cumulative PM10 concentrations exceed the evaluation criteria at the off site receptors. In the absence of a health risk assessment, the probability is linked to the probability of exceeding the evaluation criteria. Given this the probability is high in both scenarios.

Significance

In the unmitigated and mitigated scenario, the significance is high. Metago's confidence level is moderate to high for this significance rating.

Tabulated summary of the assessed cumulative impact –air pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**M-H**	**M**	**M-H**	**H**	**H**
Mitigated	**H**	**M-H**	**M**	**M-H**	**H**	**H**

7.5.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective is to limit the mine's contribution to cumulative air pollution impacts.

Actions

In the construction, operational and decommissioning phases, mitigation measures will be implemented for the main dust emission sources. The recommended methods to achieve this are:

- dust suppression on the temporary gravel road through chemical binding agents combined with vehicle speed controls. The alternative dust suppression means is water but preferably not Swakop River water;
- dust controls at the crushing and screening operation (for road building) by water sprays; and
- dust controls at excavation, scraping, and material handling points (loading and offloading) by water sprays where practical.

In addition to the monitoring and auditing programme that is included in the Husab Mine EMP (Swakop Uranium, 2010), Swakop Uranium will implement a source-based dust fallout performance indicator of a maximum of 1200mg/m^2/day in the immediate vicinity of the temporary gravel road, the road material crushing operation, and excavation, scraping and material tipping points. Bucket sites will be selected and moved along with the construction activities with the input of an air specialist. It is acknowledged that after construction the main linear PM10 sources will be removed and because the permanent road will be surfaced with asphalt no additional monitoring will be required on this road.

Quarterly performance audits and inspections will be done to verify that the monitoring is taking place according to specifications and that the Swakop Uranium is adhering to the specified dust fallout indicators.

If used, diesel generators will be operated and maintained according to supplier specifications and the IFC emission limits.

The tourism and recreation offsets as described in Section 7.10 will be implemented. These relate to the relocation of affected campsites in the NNNP, the maintenance of the gravel road that routes between the C28 and the big tourist Welwitschia, the upgrade of the big tourist Welwitschia site, and the preservation of the wilderness Khan River areas.

As part of closure planning the rehabilitation designs will incorporate measures to address long term pollution prevention and confirmatory monitoring.

Emergency situations

None identified.

7.6 NOISE

The information in this section was sourced from the noise specialist opinion in Appendix J (Acusolv, 2011) and the noise assessment in the Husab Mine EIA (Metago, 2010).

7.6.1 ISSUE: NOISE POLLUTION

7.6.1.1 Introduction

Two types of noise are distinguished: noise disturbance and noise nuisance. The former is noise that can be registered as a discernable reading on a sound level meter and the latter, although it may not register as a discernable reading on a sound level meter, may cause nuisance because of its tonal character (eg. distant humming noises). The impacts of both noise types are assessed below. It must be noted that because the main noise receptors associated with the linear infrastructure are located more than 3km from the Husab Mine noise sources, there is little possibility of cumulative noise impacts from the Husab Mine and its linear infrastructure. The reason for this is that insignificant noise impacts were predicted more than 3km from the Husab Mine site (Metago, 2010).

With reference to Table 7-15, there are a range of construction, operation and decommissioning activities that have the potential to generate noise and cause related disturbance and nuisance. No impacts are associated with the closure phase.

Potential noise impacts on biodiversity have been addressed in Section 7.3.4 and so this section will focus on the potential human related noise impacts.

TABLE 7-15: NOISE POLLUTION – LINK TO PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Generators Vehicle movement Earth moving equipment Crushing and screening General building activities Limited drilling and blasting	Vehicle movement	Vehicle movement Earth moving equipment Material tipping Generators	N/A

7.6.1.2 Assessment of impact

Severity

The World Bank performance standards stipulate that noise levels from a development should not cause background noise levels to increase in excess of 3dB, or exceed the following limits for residential, institutional or educational receptors: 55 dBA in the daytime and 45 dBA at night. These evaluation criteria have been used in this assessment of severity with reference to the baseline context described in Section 4.9. In addition, noise pollution will have different impacts on different receptors because some are very sensitive to noise and others are not. For example, workers do not expect a noise free work environment and so they will be less sensitive to environmental noise pollution at work. In contrast, visitors to the NNNP are likely to be sensitive to unnatural noises and so any change to ambient noise levels (even less than 3dBA) will have a negative impact on them and their anticipated wilderness experience.

The noise specialist is of the view that the linear infrastructure and associated activities will increase ambient noise levels by 3dBa between 1km and 2.5km from the noise source in the Khan River valley and between 500m and 1km on the open topography of the plains. This is expected to have a negative impact on tourist and recreation activities in the following areas:

- wilderness tours in the affected section of the Khan River and tributary valleys;
- camping activities in the affected section of the Khan River and tributary valleys; and
- camping activities in the Swakop River camp sites.

This impact will primarily be a daytime impact because neither traffic nor construction activities are expected to occur between sunset and sunrise in normal conditions. Nonetheless, the severity is high in the unmitigated scenario and medium in the mitigated scenario. The latter conclusion is reliant on the success of the Swakop River campsite offsets and the fact that although certain zones in the Khan River and associated tributaries will be negatively impacted, there will still be sufficient alternative options for Khan River wilderness and camping type experiences further downstream.

Duration

The impacts around the temporary access road, permanent pipeline and temporary Swakop River abstraction scheme will be limited to a 30 month construction period. The impacts associated with the construction activities on the northern linear infrastructure will be limited to a similar period but the impacts associated with the permanent road will be linked to the life of the Husab Mine. This translates into a medium term duration in both the unmitigated and mitigated scenarios.

Spatial scale

In both the unmitigated and mitigated scenarios the noise impacts will extend beyond the proposed project site. This is a medium spatial scale.

Consequence

In the unmitigated and mitigated scenarios the consequence is medium.

Probability

The probability of the noise being heard by third parties at the identified tourism and recreation locations is definite in both the unmitigated and mitigated scenarios. Whether this results in a negative impact will depend on the expectations of the third parties and their response to the audible noise. The related probability is assumed to be high in the unmitigated scenario. If however, there is an effective offset for the Swakop River campsites, this component of the impact will be eliminated and the total probability is only influenced by impacts in the Khan River and tributary valleys. While the related noise impact zone will probably reduce the space for wilderness tours and the options for recreational camping, it is fair to conclude that these types of experiences will still be available in the Dorob national Park and therefore the probability reduces to medium.

Significance

The significance of this potential impact is low to medium in both the unmitigated and mitigated scenarios. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – noise impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**M**	**M**	**H**	**H**	**H**
Mitigated	**M**	**M**	**M**	**M**	**M**	**M**

7.6.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to limit noise pollution impacts.

Actions

All registered complaints will be documented, investigated and efforts made to address the area of concern where possible.

The tourism and recreation offsets as described in Section 7.10 will be implemented. These relate to the relocation of affected campsites in the NNNP, the maintenance of the gravel road that routes between the C28 and the big tourist Welwitschia, the upgrade of the big tourist Welwitschia site, and the preservation of the wilderness Khan River areas further downstream.

Construction activities and traffic will primarily be limited to the daylight hours between sunrise and sunset. This is particularly relevant in the NNNP and the Khan River and tributary valleys on the weekends when tourists and members of the public may be camping overnight.

Emergency situations

None identified.

7.7 BLASTING

The information in the section was provided by Metago in conjunction with the Husab Project team.

7.7.1 ISSUE: BLASTING DAMAGE

7.7.1.1 Introduction

With reference to Table 7-15, blast related impacts are an issue during the construction and operational phases. Issues relating to blasting noise and blasting dust have been assessed as part of Section 7.6 and Section 7.5. The impacts assessed in this section related to infrastructure damage and/or harm to third parties.

TABLE 7-16: BLASTING DAMAGE – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Limited blasting for widening valleys on the permanent road and power line routes, establishment of borrow pits and for preparing substation foundations	N/A	N/A	N/A

7.7.1.2 Assessment of impact

Severity

Blast injury to third parties may be caused by fly rock. Blast damage to third party infrastructure may be caused by the following blast related pathways:

- fly rock (that can be thrown up to 1.5km from the blast site),
- ground vibration where the peak particle velocity is above 12mm/s at low frequencies, and
- air blast above 130dB.

If any damage or injury occurs, it is considered a high severity in the unmitigated scenario, which may be reduced to medium in the mitigated scenario because the potential for blast related incidents is expected to decrease.

Duration

Injury or death is considered to be long term in nature. Therefore the unmitigated and mitigated duration is high.

Spatial scale

In unmitigated and mitigated scenarios the potential for blast related impacts is either within, or close to, the blasting sites along the permanent road and permanent power line routes. In this regard, no third party structures are at risk, but this area is accessible by tourists and members of the public. The spatial scale is medium.

Consequence

In both the unmitigated and mitigated scenarios the consequence is high.

Probability

The probability of the blast related damage to third party infrastructure is extremely low because no infrastructure is located within 3km of the proposed blasting site. The probability of blast related injury to third parties is low (even without mitigation) because of the remote setting of the proposed permanent road and power line routes and because limited blasting will be required in a short space of construction time. With mitigation the low probability is reduced even more.

Significance

The significance of this potential impact is medium in the unmitigated and medium to low in the mitigated scenarios. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – blasting impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**L**	**M**
Mitigated	**M**	**H**	**M**	**H**	**L**	**M-L**

7.7.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to prevent blast related damage to third parties and infrastructure.

Actions

The blast design, implementation and monitoring will, as a general rule, ensure that:

- fly rock is contained within 500m of the blast site;
- ground vibration at the closest third party structures (granite quarries, Arandis airport and Rössing Uranium Mine) is less than 12mm/s peak particle velocity; and
- air blast at the closest third party structures (Rössing Uranium Mine) is less than 130dB.

Prior to each blast the area within a 1km radius of the blast site will be cleared of third parties. Prior to each blast an audible warning will be sounded.

All registered complaints will be documented, investigated and efforts made to address the area of concern where possible.

Emergency situations

If a person or animal is injured by fly rock this must be handled in accordance with the Husab emergency response procedure.

7.8 ARCHAEOLOGY

The information in this section was sourced from the archaeology specialist study in Appendix K (QRS, 2011).

7.8.1 ISSUE: DAMAGE TO ARCHAEOLOGICAL SITES AND LANDSCAPES

7.8.1.1 Introduction

With reference to Table 7-17, there are a number of activities/infrastructure in the construction, operation and decommissioning phases that have the potential to damage archaeological resources.

TABLE 7-17: ARCHAEOLOGY IMPACTS – LINK TO PHASES AND ACTIVITIES/INFRASTRUCTURE

Construction	Operational	Decommissioning -	Closure
Soil stripping Cleaning, grubbing and bulldozing Preparation of foundations Material and equipment movement Compacting bases Opening borrow pits and trenches Vehicle movement Limited drilling and blasting	Vehicle movement Servicing equipment and infrastructure Soil stockpile management	Demolition of infrastructure Material and equipment movement Slope stabilization Vehicle movement Stockpiles of scrap and rubble	N/A

7.8.1.2 Assessment of impact

Severity

The assessment focuses on two levels. On the specific archaeological resource level, the impact depends on the physical disturbance of individual sites. On the landscape level there are important archaeological areas that will be compromised by the placement of linear infrastructure in general. The most important landscapes are the remains of the Welwitschia siding of the early colonial narrow gauge railway, the remains of the Khan Mine (and the associated plan to include this into a future heritage park) and the sites around the Husab Spring. The remaining sites are isolated finds of low archaeological significance. However, despite their low individual significance, the sites form part of an archaeological landscape that will be impacted by the linear infrastructure. This applies especially to the narrow gauge railway line and related earthworks.

In the unmitigated scenario the severity is high because both landscapes and individual sites could be compromised and damaged respectively.

With mitigation that focuses on detailed planning and final design prior to construction, measures can be implemented to limit the intrusion into the key landscape areas and to prevent excessive damage to individual sites. This reduces the overall severity to medium and in the case of the siding, which will be reconstructed (subject to MET Directorate of Parks and Wildlife agreement), may even turn the potential negative impact into something positive.

Duration

In the unmitigated and mitigated scenarios, archaeological impacts will be long term in nature.

Spatial scale

The spatial scale is localised within or adjacent to the linear infrastructure sites.

Consequence

The consequence of this potential impact is high in the unmitigated scenario. It reduces to medium in the mitigated scenario because the severity is reduced.

Probability

Even with mitigation the probability that some impacts occur is definite.

Significance

The significance of this potential impact is high in the unmitigated scenario and medium in the mitigated scenario. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – archaeology impacts

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	**H**	**H**	**L**	**H**	**H**	**H**
Managed	**L**	**H**	**L**	**M**	**H**	**M**

7.8.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to prevent the unacceptable loss of archaeological sites and related historical information.

Actions

Prior to construction Swakop Uranium will ensure that:

- An archaeological specialist is included in the final detailed planning and design process for all linear infrastructure components to guide the final routing and placement of infrastructure. In so doing landscapes and finds of archaeological importance can be avoided in most cases.
- The Welwitschia station site will be surveyed in detail to produce documentary evidence of the site as it currently exists. Thereafter it will be reconstructed and preserved as an information centre under the guidance of an archaeological specialist - subject to MET Directorate of Parks and Wildlife agreement.
- Where possible, the historical narrow gauge railway line and the dump at the position of the old Khan station will be demarcated and/or cordoned off from the linear infrastructure and left undisturbed.
- Where any archaeological sites will be disturbed and/or destroyed they will be subjected to detailed survey. This information will be used to apply for the necessary permits that are required in terms of the National Heritage Act 2004.
- All workers (temporary and permanent) will be educated about the importance of preserving archaeological sites.

During all phases prior to closure, the mine will ensure that it limits mine infrastructure, activities and related disturbance.

Emergency situations

If there are any chance finds of archaeological sites that have not been identified and described in the specialist report, Swakop Uranium will follow its chance find procedure. The key component of which is to ensure that the site remains undisturbed until a specialist has assessed the site, assessed the potential damage, advised on the necessary management steps, and advised on the requirements for authority consultation and permitting.

7.9 VISUAL

The information in this section was sourced from the visual specialist study in Appendix L (NLA 2011).

7.9.1 ISSUE: VISUAL IMPACT ON TOURISM AND RECREATION

7.9.1.1 Introduction

With reference to Table 7-18, visual impacts may be caused by activities and infrastructure in most phases. The more significant activities and infrastructure are associated with the construction, operation and decommissioning phases. No linear infrastructure will remain post closure.

The cumulative visual impact is considered in the assessment below. This is determined by assessing the change to the visual landscape as a result of linear infrastructure and activities as they will be seen together with the Husab Mine infrastructure. The latter impacts were discussed in detail in the Husab Mine EIA (Metago 2010). The main conclusion from the Husab Mine EIA is that there will be a high visual impact on the Welwitschia campsite particularly at night when the mine lights are on. The related mitigation measure is to relocate this campsite in conjunction with MET Directorate of Parks and Wildlife.

TABLE 7-18: VISUAL IMPACTS – LINK TO PHASE AND ACTIVITIES/INFRASTRUCTURE

Construction	Operational	Decommissioning -	Closure
Foundations Trenches Stockpiles Scaffolding at bridge crossing Cranes Borrow pits Construction camps Partially built permanent road Temporary and permanent power lines Temporary and permanent pipelines Lights at substations Dust plumes	Above ground components of permanent pipeline Permanent power lines Permanent road Permanent substation and associated lights	Trenches Piles of rubble Piles of scrap Contractor camps Dust plumes	N/A

7.9.1.2 Assessment of impact

Severity

The severity of visual impacts is determined by assessing the change to the visual landscape as a result of linear infrastructure and activities as they will be seen together with the Husab Mine infrastructure.

As discussed in Section 4.11, the visual landscape is determined by considering: landscape character, sense of place, aesthetic value, sensitivity of the visual resource and sensitive views. In this regard, the study area is considered to have a significant visual landscape.

When considering the potential change to the visual landscape the key issues are: visual exposure, visual intrusion, and sensitivity of receptors. Each of these issues is discussed below.

Visual exposure is the extent to which mine infrastructure and activities will appear in the various sensitive views. It follows that the closer the infrastructure and activities, the greater the visual exposure. The visual exposure of the Husab Mine was assessed as moderate because most tourist/recreation views will be more than 7km away. The combined visual exposure is considered to be high because components of the linear infrastructure will be within 1km of tourist and recreation areas as follows:

- The temporary water and power infrastructure near the Khan Mine.
- The permanent power and road, and temporary power and water infrastructure in the Khan River and tributary valleys.
- The above ground components of the permanent water supply infrastructure adjacent to the gravel Welwitschia drive road.

Visual intrusion is the extent to which the infrastructure and activities will contrast with the visual landscape and can/cannot be absorbed by the landscape. The visual intrusion of the Husab Mine will be high especially at night. The visual intrusion of the linear infrastructure is considered to be low near the B2, moderate at the Khan Mine, and high in the Khan River and tributary valleys and adjacent to the gravel Welwitschia drive road that routes to the big tourist Welwitschia and past the Swakop River campsites.

Sensitivity of receptors relates to the way in which people will view the visual intrusion. In this regard, it is anticipated that tourist and recreation receptors will be sensitive but mine related receptors may not be sensitive.

Taken together, the unmitigated severity is high. The severity can be reduced to medium in the mitigated scenario. The latter conclusion is reliant on the success of the mitigation measures in general, but particularly the campsite offsets, and the preservation of sufficient alternative options for Khan River wilderness and camping type experiences.

Duration

In the unmitigated and mitigated scenario the duration is linked to the life of the linear infrastructure which is the life of the Husab Mine. This is a medium to long term duration.

Spatial scale

The linear infrastructure will be visible up to 3km from the linear infrastructure footprints and the Husab Mine infrastructure will be highly visible (in places) up to 7.5km from the mine. This is a medium spatial scale in both the mitigated and unmitigated scenarios.

Consequence

In the unmitigated scenario the consequence is high. This reduces to medium with mitigation.

Probability

The probability of the visual impact occurring is high in the unmitigated scenario and medium in the mitigated scenario.

Significance

The significance is high in the unmitigated scenario. The implementation of the tourism and recreation offsets will reduce this significance to medium. Metago's confidence level is moderate to high for this significance rating.

7.9.1.3 Tabulated summary of the assessed cumulative impact – visual impact

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M**	**M**	**M**	**M**	**M**	**M**

7.9.1.4 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the measures is to limit visual impacts on tourism and recreation activities.

Actions

During construction, operation and decommissioning the following general principles apply:

- land disturbance will be limited to what is absolutely necessary;
- A significant portion of the permanent water supply pipeline will be buried and all associated above ground facilities (pump station, valves, 11kV power line) will be positioned to limit the visual impact;
- rehabilitation of areas will be done as soon as possible after the temporary and permanent infrastructure is no longer in use. If required, a landscape architect will be commissioned to advise on landscaping during rehabilitation in sensitive visual areas;
- where possible all linear dust plume sources will be managed with dust suppressants and water sprays to limit visual intrusion by dust;
- night lights will be used only where necessary and should be designed to illuminate only that which requires illumination. The use of standard high pole flood lights should be avoided where possible;
- litter will be prevented;

- the tourism and recreation offsets as described in Section 7.10 will be implemented. These relate to the relocation of affected campsites in the NNNP, the maintenance of the gravel Welwitschia drive road, and the preservation of the wilderness Khan River areas.

Emergency situations

None identified.

7.10 SOCIO-ECONOMIC – TRAFFIC AND TOURISM

The information in this section was sourced from the socio-economic specialist study in Appendix M (Metago4Good, 2011), the traffic specialist study in Appendix N (Siyazi, 2011), and the Uranium Rush SEA (SAIEA, 2010).

7.10.1 INTRODUCTION

The Husab Mine EIA assessed a range of socio-economic impacts relating to economic impacts in general, inward migration, service and infrastructure and linkages between the Husab Mine and communities. These impacts will not be reassessed because the linear infrastructure components will not materially change the assessment findings. Given this, the assessment below focuses on two specific aspects that are directly affected by the linear infrastructure: impacts on traffic and impacts on tourism. The former being a cumulative regional assessment that takes current and future traffic flows into account and the latter being an assessment of the impacts associated with the Husab Mine plus the linear infrastructure in the context of other mine developments in the region.

7.10.2 ISSUE: TRAFFIC IMPACT

The Husab Mine will introduce additional traffic onto the Erongo road network in the construction, operation and decommissioning phases. In the construction phase the mine will introduce approximately 130 vehicles per day which may increase to 210 on weekends when construction camp workers travel to and from the site. In the operation phase the mine will introduce approximately 280 vehicles per day. The traffic flows for decommissioning are expected to be similar to construction (see sections 6.1.4 and 6.2.3 for additional detail).

The assessment below considers the service and safety impacts of introducing the additional traffic to the existing road networks and traffic flows. Provision is also made for future growth in traffic.

The Husab Mine related traffic will travel to and from site (from Walvis Bay and Swakopmund in particular) on a daily basis. Until the permanent access road is commissioned, all traffic will use the C28 road and the Welwitschia drive gravel road. Once the permanent access road is in use, all traffic will use the B2 and the permanent mine access road that crosses the Khan River. Traffic on the C28, the

Welwitschia drive and the B2 will comprise a combination of Husab, other mining, other business, private and tourism related traffic. Two road intersections have been identified as important focus points. These are the proposed intersection of the permanent access road with the B2 and the existing intersection between the C28 and the Welwitschia drive.

The impact of traffic on animals has been assessed in Section 7.3.4 and will not be repeated here.

TABLE 7-19: TRAFFIC IMPACTS – LINK TO PHASE AND ACTIVITIES/INFRASTRUCTURE

Construction	Operational	Decommissioning -	Closure
Construction traffic Temporary access road	Operation traffic Permanent access road Backup access road	Deconstruction traffic Permanent and backup access roads	N/A

7.10.3 ASSESSMENT OF IMPACT

Severity

Potential C28 related issues identified by Metago, the traffic specialist and the SEA report include the following:

- the C28 road can present a safety risk to people who are not familiar with driving on roads that are part tar and part gravel. The particular safety related issues are the dust that make visibility difficult and the gravel surface that can present a traction problem when vehicles drive quickly and/or attempt to pass other vehicles;
- the undulating nature of the road reduces the lines of sight from a safety perspective;
- uneven road surfaces causes significant vibration with knock on effects of higher vehicle maintenance and repair costs;
- loose gravel can lead to cracked windscreens;
- The intersection between the C28 and the Welwitschia drive gravel road is not adequately marked;
- road accidents have occurred over the past few years; and
- maintenance of the C28 by the relevant roads authority does not always keep pace with the wear and tear from current traffic levels.

Potential B2 related issues identified by Metago, the traffic specialist and the SEA report include the following:

- although the road is tarred and built to good standards, the current and future traffic volumes will put increasing pressure (with associated safety risks) on the current configuration of two single lanes, particularly between Swakopmund and Arandis. The SEA has identified a need to add additional lanes and strength to this section of the road;
- some road accidents, involving vehicles and animals, have occurred over the past few years; and

- maintenance of the B2 by the relevant roads authority does not always keep pace with the wear and tear from current traffic levels.

The proposed increases in traffic from the Husab Mine and other future developments, has the potential to add to the abovementioned issues and lead to additional road accidents.

In the unmitigated scenario, the potential for injury and death to road users gives this a high severity. With mitigation, the potential accident rate associated with the Husab Mine development should be reduced and therefore the severity reduces to medium - high.

Duration

Any serious injury or death is a long term impact in both the unmitigated and mitigated scenarios

Spatial scale

The direct impacts could be located within or outside the Husab Mine and linear infrastructure sites and the indirect impacts will extend to the communities to which the injured people belong.

Consequence

The consequence is high in both unmitigated and mitigated scenarios.

Probability

Without mitigation the probability of causing increased road accidents is definite. With mitigation this is reduced to low.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance reduces to medium. Metago's confidence level is moderate to high for this significance rating.

Tabulated summary of the assessed cumulative impacts – traffic impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
mitigated	**M-H**	**H**	**M**	**H**	**L**	**M**

7.10.4 CONCEPTUAL DESCRIPTION OF MITIGATION MEASURES

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the management measures is to reduce the potential for safety and vehicle related impacts on road users.

Actions

The relevant intersections at the C28 and the B2 will, as a minimum, be upgraded and constructed respectively according to the traffic specialist's design specifications in Figure 6-3 and Figure 6-4. Both intersections will be clearly marked as mine turnoff points.

The recommended speed limits for the approaches to these intersections is 80km/hour

As part of the detailed design of the B2 intersection point, consideration will be given to acceptable site distances that are:

- relevant to the final approved road approach speeds; and
- acceptable if the final position of the intersection is moved for any reason.

The roads authority will be informed of the development in order to have input into the final designs and to make provision for additional road maintenance and upgrade plans particularly for the sections of roads that will carry heavy vehicles. In this regard, trucks travelling between Swakopmund and Walvis Bay will avoid this section of the B2 and rather use the D1984 salt road that runs behind the dunes.

Swakop Uranium will continue assisting MET Directorate of Parks and Wildlife with the maintenance of the gravel road that routes from the C28 past the Welwitschia plains to the Husab Mine Site. This is a departure from the Uranium Rush SEA recommendation that all roads carrying more than 250 vehicles a day must be tarred. The deviation is considered justified on the basis that the cumulative volume of vehicles is only expected to exceed the 250 per day limit on two days a week until the permanent access road is established for use by Husab Mine construction traffic.

Promote basic road safety behaviour for all Husab employees and contractors through training and awareness. Typical issues include:

- keeping to safe speed limits, but as a minimum all specified road speeds will be adhered to;
- ensuring that drivers all have valid licenses;
- making sure that all vehicles are roadworthy;
- zero tolerance for drinking and driving; and
- using lights appropriately for night driving.

Emergency situations

Road accidents are considered emergencies and will be handled in accordance with the Husab emergency response procedure.

7.10.5 ISSUE: TOURISM AND RECREATION SOCIO-ECONOMIC IMPACTS

With reference to Table 7-20, the linear infrastructure will introduce activities and infrastructure in the construction, operation and decommissioning phases. The assessment of these activities and infrastructure components on tourism and recreation requires one to draw on the conclusions from many of the preceding environmental assessment sections. The noise, visual, archaeological and air impact sections are particularly relevant in this regard. Moreover, the assessment makes use of the direct input provided by the tourism representative bodies that were engaged as part of the specialist investigation (metago4Good, 2011).

At the end of the section the impacts will also be assessed cumulatively in the context of both the Husab Mine site and other mining developments in the study area. In this regard, the Husab Mine EIA concluded that the main impact on tourism and recreation from the actual Husab Mine site is the visual impact on the Welwitschia camp site at night (Metago, 2010).

TABLE 7-20: TOURISM AND RECREATION IMPACTS – LINK TO PHASES AND ACTIVITIES

Construction	Operational	Decommissioning -	Closure
Foundations Trenches Stockpiles Scaffolding at bridge crossing Cranes Borrow pits Crushing and screening Equipment movement Generators Construction camps Temporary road and traffic Partially built permanent road Temporary and permanent power lines Temporary and permanent pipelines Lights at substations Dust plumes Limited drilling and blasting	Above ground components of permanent pipeline Permanent power lines Permanent road and traffic Backup road and traffic Permanent substation and associated lights	Trenches Piles of rubble Piles of scrap Contractor camps Dust plumes Vehicle and equipment movement	N/A

7.10.5.1 Assessment of impact for the Husab mine and linear infrastructure

Severity

In the unmitigated scenario the linear infrastructure and Husab Mine will expose various tourism and recreation areas to high severity noise, dust, visual and archaeological landscape disturbances. The areas in question are:

- The Welwitschia campsite.
- The Swakop River campsites.
- The Khan Mine.
- The Khan River and tributary valleys to the northwest of the DNP.

If unmitigated these disturbances will limit the use of these areas for tourism and recreation. With mitigation the severity will be reduced to medium – low because alternative tourism and recreation facilities will be provided in most cases, or the potential impacts will be reduced through design and implementation interventions. It is worth noting further that the Welwitschia tourism experience can be improved by upgrading the facilities at the big tourist Welwitschia and by continuing to assist MET with the maintenance of the gravel road that routes from the C28 to the Welwitschi plains.

Duration

In the unmitigated scenario where removal of infrastructure and rehabilitation of disturbed areas is not done, tourism and recreation impacts will continue after the closure of the Husab Mine and related linear infrastructure. With mitigation, the impacts will be limited to the life of the mine and related infrastructure because all relevant activities will cease, all infrastructure will be removed and the disturbed land will be rehabilitated.

Spatial scale

In the unmitigated scenario, the impact will be widespread as it will reach further than the Erongo region to as far as tour operators in Windhoek. In the mitigated scenario, the spatial scale will be reduced, but will still impact some local tourism and recreation people. The reason for this is that most of the well-known tourist attractions and routes will remain viable attractions and the business of local and national tour operators will not be materially affected. In contrast, the less frequented Khan River area to the northwest of the DNP will remain materially affected despite the mitigation measures aimed at preserving similar areas downstream.

Consequence

Without mitigation the consequence is high. With mitigation the consequence reduces to medium – low because the severity, duration and spatial scale are reduced.

Probability

Without mitigation the probability of the impacts occurring is definite. With mitigation the probability is reduced to medium-low. This reduction in probability assumes that Swakop Uranium and MET will be successful in establishing alternative facilities where required.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance is reduced to medium. Metago's confidence level is moderate to high for this significance rating.

Tabulated summary of the assessed incremental impact – tourism and recreation

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**H**	**H**	**H**	**H**
Mitigated	**M-L**	**M**	**M**	**M-L**	**M-L**	**M-L**

7.10.5.2 Assessment of the cumulative impact for the Husab mine, the associated linear infrastructure and other mines in the study area

The simplified departure point is that the cumulative impact of multiple mine and infrastructure developments in the study area could result in a material reduction in tourism jobs and income. This is particularly relevant if the additional mine developments directly impact the Swakop River below the Khan Swakop confluence, the Moon Valley landscape, and the drive along the Swakop River from the Swakop River campsites to the Moon Valley. Moreover, the situation could be worsened if, by the perceived development of dangerous uranium mines in close proximity to these tourist attractions, the tourism brand for the Erongo region is tarnished in the eyes of the foreign tourism market. In this regard, it must be noted that Swakopmund and Walvis bay are currently regarded as gateways to tourism in Namibia because of the unique combination of the excellent accommodation and hospitality in the towns together with the world renowned tourist attractions of the NNNP and DNP which are in such close proximity to the towns.

To analyse the above scenario, the specialist provided a break even cost benefit analysis view on the cumulative impacts (metago4Good, 2011). The specialist concludes that the jobs created by three new mines can offset the unlikely cumulative scenario of 50% job losses to the Erongo tourism industry. Alternatively, the Gross Geographic Product of two new mines will offset an unlikely 50% loss associated with the Erongo tourism industry. This does not mean that it is acceptable to develop the mining industry at the expense of the tourism industry. Rather it highlights how important both industries are and that mitigation measures are required to enable both industries to continue. Further discussion on the mitigation measures is provided below.

7.10.5.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Appendix O).

Objective

The objective of the mitigation measures is to limit the negative socio-economic impacts on tourism and recreation.

Actions

Swakop Uranium will continue to meaningfully engage with relevant people and entities in the tourism, conservation and recreation sector to ensure that potential negative impacts from mining are managed in a way that the related impacts on tourism are acceptable. This engagement may be through new or existing collective structures and it will ideally also involve other mining and exploration companies that have the potential to negatively and positively impact on tourism in the NNNP, DNP and study area.

Specific tourism offsets will be established by Swakop Uranium in conjunction with MET Directorate of Parks and Wildlife. These offsets will provide the tourism and recreation sectors with equivalent or better facilities and experiences currently associated with the Welwitschia and Swakop River campsites.

In order to enhance the tourism experience at the big tourist Welwitschia, Swakop Uranium will assist MET Directorate of Parks and Wildlife to upgrade the big tourist Welwitschia facilities. In addition, Swakop Uranium will continue to assist with the maintenance of the gravel Welwitschia drive road. This is a departure from the Uranium Rush SEA recommendation that all roads carrying more than 250 vehicles a day must be tarred. The deviation is considered justified on the basis that the cumulative volume of vehicles is only expected to exceed the 250 per day limit one two days a week until the permanent access road is established for use by Husab Mine construction traffic.

Swakop Uranium will work together with MET Directorate of Parks and Wildlife to actively conserve a section of the Khan River (downstream) so that tourists and recreation seekers that will be affected by the Khan River linear infrastructure will have alternative options for accessing areas with similar wilderness experiences in the Khan River.

The archaeology mitigation measures (see Section 7.8.1.3) are implemented particularly near to the Khan Mine.

If the cumulative impact scenario becomes a reality and the tourism industry is faced with material job and income losses, a state fund is required to financially assist the affected tour operators in redeploying their businesses elsewhere in the DNP and NNNP. This financial assistance could (amongst other mechanisms) be in the form of loans, tax reductions and/or grants. In addition to financial assistance, institutional support will be required to advise and assist with strategies and tactics for the redeployment of the affected part of the tourism industry.

Emergency situations

None identified.

8 KEY ASSUMPTIONS, UNCERTAINTIES AND LIMITATIONS

Assumptions, uncertainties and limitations have been discussed throughout the EIA report and in the various specialist studies. The more significant of these are included below.

8.1 ENVIRONMENTAL ASSESSMENT LIMIT

The EIA focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards, and that Swakop Uranium will adhere to these.

8.2 PREDICTIVE MODELS IN GENERAL

All predictive models are only as accurate as the input data provided to the modellers. If any of the input data is found to be inaccurate or is not applicable because of project design changes that occur over time, then the model predictions will be less accurate.

8.3 GEOLOGY

Not applicable.

8.4 TOPOGRAPHY

Not applicable.

8.5 SOILS AND LAND CAPABILITY

There is uncertainty about the possibility of reinstating and/or creating two specific soil features. These include the surface crust that has been identified on the plains and the less permeable calcrete layer that is situated below the topsoil horizon. Both of these features are considered to be important from a moisture retention perspective and the surface crust has the added role of erosion prevention. On-going pilot tests will be conducted by Swakop Uranium as required to determine the most effective means of creating similar features.

8.6 BIODIVERSITY

Commitments have been made to rehabilitate and restore areas that are disturbed or destroyed by the linear infrastructure. Given the unique setting of the linear infrastructure and the Husab Mine, there is no track record that rehabilitation and restoration is actually possible. Given this, a conservative approach to the assessment has been applied.

There is insufficient available data to be certain of the water dynamics of all riparian trees and the limit thresholds of extraction rates and water depths. Given this, a conservative approach to the assessment has been applied.

There is insufficient available data to be certain of the regional movements of zebras, ostriches and large mammals and the related ecosystem functions and processes. Given this, a conservative approach to the assessment has been applied.

8.7 SURFACE WATER

Not applicable.

8.8 GROUNDWATER

Not applicable.

8.9 AIR

The baseline data for PM10 is not definitive and even though there is a fairly good correlation between the predicted and measured background concentrations (SAIEA, 2010) additional work is required to firmly quantify the situation. Given this, the cumulative impact assessment for PM10 cannot be considered absolute and it is subject to confirmation by on-going PM10 monitoring.

8.10 ARCHAEOLOGY

Not applicable.

8.11 NOISE

Not applicable.

8.12 BLASTING

Not applicable.

8.13 VISUAL

Not applicable.

8.14 SOCIO-ECONOMIC

The consideration of the cumulative economic impact on the tourism industry is based on assumptions that were obtained by consulting with key stakeholders in the tourism sector. These assumptions are not supported by hard data.

9 ENVIRONMENTAL IMPACT STATEMENT & CONCLUSION

The impact assessment presents the potential for positive economic and negative environmental and social impacts that can all be mitigated to acceptable levels when considered incrementally (in isolation of other developments). As with the assessment for the Husab Mine (Metago 2010), there are significant cumulative impacts (impacts from the linear infrastructure, the Husab Mine and other developments). The most significant potential cumulative impacts are:

- impacts on biodiversity from physical destruction, temporary water abstraction and general disturbance;
- air pollution impacts from particulate matter;
- visual impacts;
- noise impacts;
- traffic impacts; and
- impacts on the tourism and recreation sectors.

It must be noted that inward migration related impacts on the already stressed regional infrastructure and services (housing, education, health care, sanitation, power and water supply) remains a critical cumulative issue, but the linear infrastructure is not expected to materially add to this impact and it has already been identified and assessed as part of the Husab Mine EIA (Metago 2010).

In the case of people related impacts, the assessment focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

Swakop Uranium will be required to follow a two-pronged approach to managing impacts. The first ‘prong’ is the management of its incremental (Husab Mine and linear infrastructure) impacts. The second ‘prong’ is working collectively with other mines, the Uranium Institute of the Chamber of Mines, the SEMP office, non-government organisations, industry and government to tackle the regional strategic issues that have been identified and detailed in this EIA and in the Central Namib Uranium Rush Strategic Environmental Assessment.

A tabulated summary of the impact assessment is provided in Table 9-1.

TABLE 9-1: SUMMARY OF POTENTIAL CUMULATIVE IMPACTS ASSOCIATED WITH THE PROPOSED HUSAB PROJECT

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)	
		Unmitigated	Mitigated
Topography	Injury to people, birds and animals from hazardous excavations and infrastructure.	**H**	**M**
Soils and land capability	Loss of soil resources from pollution	**H**	**L**
	Loss of soil resources from physical disturbance	**H**	**M**
Biodiversity	Physical destruction of biodiversity from clearing land and placing infrastructure	**H**	**M-H**
	Loss of biodiversity from the loss of subsurface water resources in the Swakop River	**H**	**L**
	General disturbance of biodiversity	**H**	**M-H**
Water	Pollution of surface and groundwater	**M**	**L**
Air quality	Air pollution (PM10)	**H**	**H**
Noise	Noise pollution.	**H**	**M**
Blasting	Blast injury to third parties or damage to structures	**M**	**M-L**
Archaeology	Damage to archaeological sites and landscapes	**H**	**M**
Visual impacts	Visual impact from sensitive views within the NNNP	**H**	**M**
Socio-economic impacts	Traffic	**H**	**M**
	Tourism	**H**	**M-L**

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10 REFERENCES

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APPENDIX A – PROJECT TEAM CURRICULUM VITAE

APPENDIX B – INFORMATION SHARING RECORD

The following is included:

- Scoping summary letter with EIA terms of reference.
- Alternatives workshop minutes.

The following documents were included in the Husab Mine EIA (Metago, 2010) and will not be re-attached in this section because the process for the Husab Mine EIA and the linear EIA was one and the same:

- Correspondence with MET distributing the BID
- Correspondence with IAPs distributing the BID
- Photos of site notices
- Newspaper adverts
- Scoping meeting minutes
- Letter from MET
- EIA summary letter to IAPs
- Minutes of EIA review meetings
- Review comments from external reviewer and IAPs

APPENDIX C – IAP DATABASE

APPENDIX D – ISSUES TABLE SPECIFIC TO THE LINEAR EIA

APPENDIX E – SOILS AND LAND CAPABILITY ASSESSMENT

APPENDIX F – BIODIVERSITY ASSESSMENT

APPENDIX G - SURFACE WATER ASSESSMENT

APPENDIX H – GROUNDWATER ASSESSMENT

APPENDIX I - AIR QUALITY ASSESSMENT

APPENDIX J – NOISE ASSESSMENT

APPENDIX K – ARCHAEOLOGY ASSESSMENT

APPENDIX L – VISUAL ASSESSMENT

APPENDIX M – SOCIO ECONOMIC ASSESSMENT

APPENDIX N: TRAFFIC ASSESSMENT

APPENDIX O - HUSAB EMP

Metago Environmental Engineers (Pty) Ltd
Consulting Engineers and Scientists

RECORD OF REPORT DISTRIBUTION

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C/o reference librarian	Arandis public library	14	May 2011	CP
Reception	Swakop Uranium Office (Swakopmund and Windhoek)	15,16	May 2011	CP
Michele Kilbourn Louw	Swakop Uranium	17	May 2011	CP
Librarian	Metago	18	May 2011	CP
Peter Tarr	SAIEA	19	May 2011	CP
Bryony Walmsley	SAIEA	20	May 2011	CP
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