

2022

**ENVIRONMENTAL MANAGEMENT PLAN FOR THE
OPERATION AND MAINTENANCE OF AN EXISTING 66KV
OTJIKOTO – KOMBAT TRANSMISSION LINE AND
KOMBAT SUBSTATION IN OSHIKOTO AND
OTJOZONDJUPA REGIONS**



The document is prepared
by NamPower's SHEW
Section



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1 LIST OF TERMS, ACRONYMS AND ABBREVIATIONS

APD	Anti-Perching Devices
BFD	Bird Flight Diverters
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMA	Environmental Management Act no 7 of 2007
EMP	Environmental Management Plan]
GIS	Geographical Information System
HIV/AIDS syndrome	Human immunodeficiency virus/ acquired immunodeficiency
MEFT	Ministry of Environment, Forest and Tourism
NHC	National Heritage Council
SHE	Safety, Health and Environment
SHEW	Safety, Health, Environment and Wellness
kV	Kilovolt

2 INTRODUCTION

In order to carry out its mandate of transmission and distribution of electricity, NamPower's has a transmission and distribution networks across all regions countrywide. The continuous operation of the 66kV Otjikoto – Kombat transmission line, Kombat substation and other infrastructures allow NamPower to provide uninterrupted supply of electricity to regions in order to improve the living conditions of Namibian citizens and to enable economic development.

The Otjikoto – Kombat transmission line runs westwards from Otjikoto substation, through a section of Karst Mountains, and then turns south-eastwards, going through another section of Karst Mountains, towards the Kombat Substation in the vicinity of the Kombat Mine. This transmission line is about 64 km in length. This transmission line has a kamerad hare structure. The Kombat substation covers a footprint of 3599 m². Besides the Otjikoto – Kombat line, there is another line feeding power to Kombat substation namely: 132kV Otjikoto – Asis west.

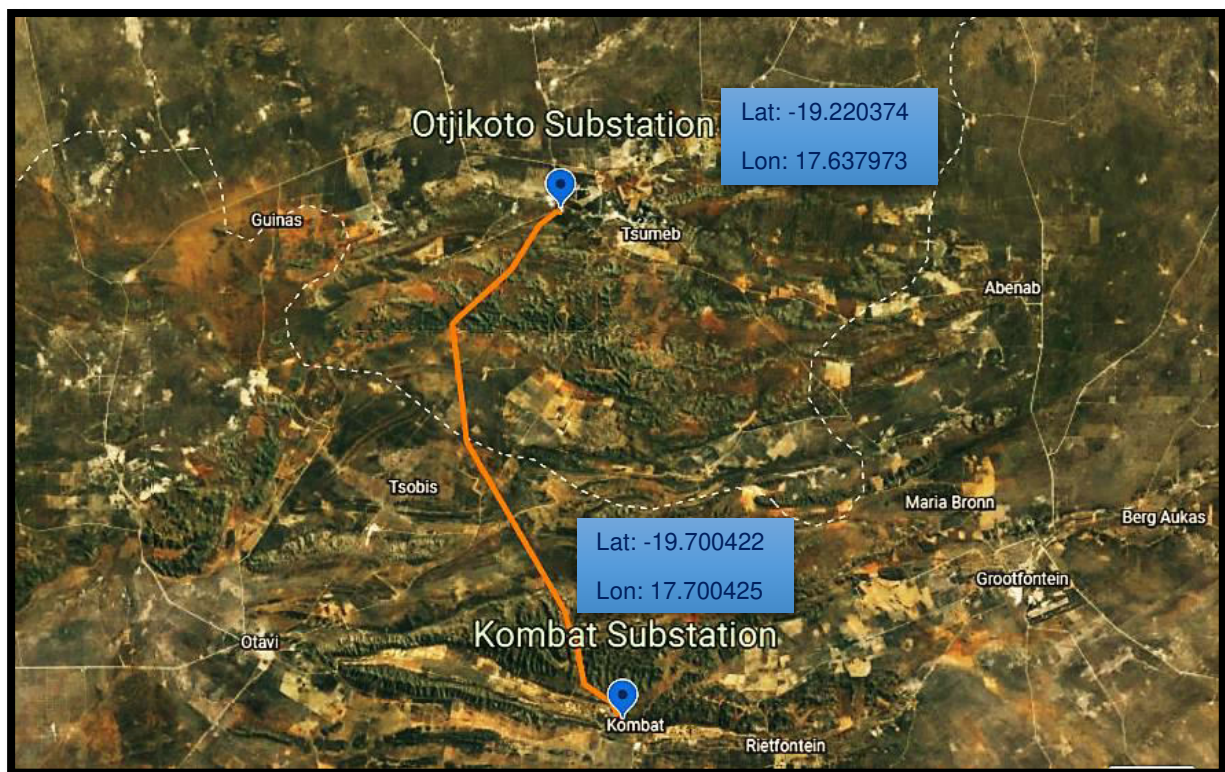


Figure 1: Locality map showing the 66kV Otjikoto – Kombat transmission line

2.1 General area description

The 66kV Otjikoto – Kombat transmission line falls within the vegetation type known as the Mountain Savannah and Karstveld. The main ephemeral rivers draining the general area flow westwards e.g. Omaramba Owambo or towards the northeast e.g. Omuramba Omatako (Cunningham, 2021).

The general line route, have certain anthropomorphic influences mainly associated with the farming activities, tracks and roads, railway line, and associated access route and infrastructures with none of the “other plant species” expected to be exclusively associated with the proposed route. The impact of line inspections and general maintenance activities would be site specific and have a relatively small environmental “footprint” and is not expected to have a major impact on any of the “other plant species” should these occur on site.

The Otjikoto-Kombat transmission line section is 64 in length of which 44.1% of the route is viewed as “high” sensitivity while 55.9% is viewed as “low” sensitivity (Cunningham, 2021).

One of the “high” sensitivity area is the well vegetated Karst Mountain areas and should be viewed as important with no unnecessary off-road driving during line inspections and/or general maintenance activities.



Figure: 2 Karst Mountains along the route are viewed as a sensitive habitat (“high”). Unique and protected species are associated with this habitat in Namibia.



Figure 3: The Karst Mountains are well vegetated with numerous protected and unique species.

3 OBJECTIVES AND SCOPE OF THIS ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The operation of the transmissions line and station can have a negative impact on the receiving environment. However, the impacts are limited to the station boundaries and line servitude. It is thus important that good management measures are implemented to ensure that environmental damage is minimised. This Environmental Management Plan (EMP) seeks to manage and keep to a minimum the negative impacts associated with the transmission line and station and at the same time, enhance the positive and beneficial impacts.

The scope of this EMP include all activities associated with the operation of the transmission line, substations and other infrastructures. It is necessary to highlight that the EMP is a living document that should be periodically reviewed and updated. It must also be noted that the EMP should be read in conjunction with laws and regulations outlined in section 5, Table 1 and all other applicable laws.

The aim of this EMP is to detail the management actions required to implement the mitigation measures identified thereby ensuring that any operational phase activity is carried out in a manner that takes cognisance of environmental protection and is in line with National legislation.

This EMP has the following objectives:

- To outline mitigation measures to be implemented during the operation phase, in order to manage and minimise the extent of environmental impacts.
- Minimise negative impacts and enhance positive impacts associated with the operations.
- To ensure that the operational activities do not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.
- To identify key personnel who will be responsible for the implementation of the measures, outline functions and responsibilities.
- To propose mechanisms for monitoring compliance and preventing long term or permanent environmental degradation.
- Create management structures that address the concerns and complaints of Interested

and Affected Parties (I&APs) with regards to the operational activities.

4 POLICY AND LEGISLATIVE FRAMEWORK

Table 1 below outline the legislative requirements which are applicable to the operational and maintenance activities.

Legislation:	Section (s) applicable:	Implications:
Environmental Management Act no 7 of 2007	<p><i>Section 3</i></p> <p><i>Section 27</i></p> <p><i>Section 33 onwards</i></p> <p><i>And all other applicable sections.</i></p>	<ul style="list-style-type: none"> • All activities performed should be in line with the following principles: <ul style="list-style-type: none"> ○ Interested and affected parties should have an opportunity to participate in decision making ○ Listed activities should be subject to an EIA ○ Polluter should pay for rehabilitation ○ Pollution should be minimized • Environmental assessments should be carried out for listed activities. The proposed activity can be classified under the following range of activities: <ul style="list-style-type: none"> ○ Generation of electricity ○ Transmission of electricity • These sections details the process to be followed in order to obtain a clearance certificate. • All existing listed activities must obtain a clearance certificate within one year of the law coming into effect. Therefore, all existing activities which can be considered a listed activity

		should apply for clearance.
EMA Regulations GN 28-30 (GG 4878) (February 2012)	<ul style="list-style-type: none"> Listed activity: 5.1 6 – 9; 13; 15; 21 -24 Any other applicable sections 	<ul style="list-style-type: none"> This activity can be considered as electricity generation and transmission. These sections details the process to be followed in terms of producing an Environmental Assessment and this process should be adhered to during the generation of information for this document.
No. 156 Labour Act, 1992: Regulations relating to the health and safety of employees at work .	All applicable regulations	All regulations applicable to different activities must be complied to.
Labour Act no 11 of 2007	<ul style="list-style-type: none"> Section 3 Section 4 Section 9 Section 39 – 42 All other applicable sections 	<ul style="list-style-type: none"> Children under the age of 16 may not be employed Forced labour may not be used. Basic conditions of employment as stipulated by the law must be met. The employer shall ensure the health and safety of all employees and non-employees on site. Employees must fulfil their duties in order to ensure their own health and safety and that of other employees and persons. Employees may leave the work site if reasonable measures to protect their health are not taken.
Electricity Act no 4 of 2007	<ul style="list-style-type: none"> Section 33 	<ul style="list-style-type: none"> Installations used for the provision of electricity should be operated with due compliance with the requirements of laws relating to health, safety and environmental standards. Therefore – any company involved within the Electricity Supply

		Industry must adhere to the laws covering the previously stated aspects or stand to lose their licenses to operate.
Water Act no 54 of 1956	<ul style="list-style-type: none"> • Section 21 and 66 • Section 23 • All other sections applicable to different activities. 	<ul style="list-style-type: none"> • Conditions in terms of the disposal and management of effluent are to be adhered to. • Any person causing pollution to a water source shall be guilty of an offence.
Public and Environmental Health Act no 1 of 2015	<ul style="list-style-type: none"> • Section 52 • Section 53 • All other sections applicable to different activities. 	<ul style="list-style-type: none"> • A person generating waste must ensure that the waste generated is kept and stored under conditions that causes no harm to human health or damage to the environment. • Waste must only be disposed of at a waste disposal site, including an incinerator approved by the local authority concerned.
Water Resources Management Act no 24 of 2013	<ul style="list-style-type: none"> • Section 89 • All other sections applicable to different activities. 	<ul style="list-style-type: none"> • The owner or occupier or other person in control of land where an incident that causes or is likely to cause a water resource to be polluted must take all reasonable measures to contain and minimize the effects of the incident; and to clean up polluted areas and remedy the effects of the incident.
Hazardous Substances Ordinance 14 of 1974	<ul style="list-style-type: none"> • Section 27 • All other sections applicable to different 	<ul style="list-style-type: none"> • To provide for the control of substances which may cause injury or ill-health to or death of human beings, by reason of their toxic,

	<p>activities.</p>	<p>corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances;</p> <ul style="list-style-type: none"> • To provide for the division of such substances into groups in relation to the degree of danger; • To provide for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances; and • To provide for matters connected therewith.
<p>Fertilizers, farm feeds, agricultural remedies and stock remedies Act no 36 of 1947</p>	<ul style="list-style-type: none"> • Definitions • Section 7 • Section 10 • All other sections applicable to different activities. 	<ul style="list-style-type: none"> • Arborocide application is defined as an agricultural remedy under this Act • Only registered pesticide may be used. • May only buy herbicides in a container that complies with the prescribed requirements and is sealed and labelled. • Only allowed to use herbicides in the prescribed manner. • Land owners must be notified about applications, and the following information must be supplied: <ul style="list-style-type: none"> ○ Purpose of administration ○ Registered name and number of the product

		<ul style="list-style-type: none"> • Precautions to be taken before, during and after each administration.
The Nature Conservation Ordinance (1975) as amended through the Nature Conservation Amendment Act of 1996.	<ul style="list-style-type: none"> • Chapter 11: Game Parks, Nature Reserves, Conservancies and Wildlife Councils 	<ul style="list-style-type: none"> • Permits are required to enter the Namib Naukluft and Dorob National Park. Permits are also required for the removal of any protected plant or tree. It also stipulates that no damage may be done to any object of geological, ethnological, archaeological, historical or other scientific interest without the appropriate permits.
National Heritage Act No 27 of 2004	<ul style="list-style-type: none"> • Section: 46, 48, 55 • All other sections applicable to different activities. 	<ul style="list-style-type: none"> • All heritage resources are to be identified and either protected or removed/mitigated with a permit from the National Monuments Council, before any development may take place • A chance find procedure should be followed in case of discovery of a heritage resource.

5 ROLES AND RESPONSIBILITIES

It is the responsibility of NamPower and/or contractor to ensure that all the environmental management actions are carried out effectively and timeously. It is important to note that the successful implementation of the EMP is, however dependent on clearly defined roles and responsibilities by several stakeholders. Below are the key employees that are responsible for the management of environmental and social issues during the operational phase:

Table 2: The roles and responsibilities for operational and maintenance activities:

Responsible person	Responsibilities
The Area Superintendent	<ul style="list-style-type: none"> • Is responsible for the enforcement of the EMP • To ensure that environmental requirements are adequately covered in any external service provider contracts. • To ensure that SHE requirements are included in the tender documents sent to the contractors. A copy of this EMP should also form part of the tender documents. • To ensure that corrective actions are implemented for non-compliances. • To ensure that appropriate records and information regarding compliance with environmental requirements are maintained. • To ensure that the stations and lines remain in compliance with the requirements of this EMP, through regular communication and monitoring. • To ensure that all incidents, accidents and complaints are reported to the project manager. The contractor to ensure that incidents and accidents are investigated to prevent re-occurrence.
Project Manager	<ul style="list-style-type: none"> • Is responsible for the enforcement of the EMP. • To ensure that SHE requirements are included in the tender documents sent to the contractors. • Must ensure that the contractor remains in compliance with the requirements of this EMP.
NamPower SHEW	<ul style="list-style-type: none"> • To ensure that all requirements with regards to this EMP are fulfilled. • To assist the Project Manager in ensuring that the contractor remains in compliance with this EMP.

	<ul style="list-style-type: none"> • Communicate NamPower SHEW requirement to the contractors and NamPower employees. • Request NamPower sections and contractors to submit SHEW files prior to any activity taking place for approval. • Provides SHEW inductions to NamPower and contractor employees. • Implement monitoring and conduct audits in consultation with the Project Manager. • Document and communicate monitoring, audit and inspection findings to project manager and area superintendent. • Communicate the final inspection report to the Project manager on contractor compliance to the EMP before the project close-off and final payment is made to the contractor.
Contractor	<ul style="list-style-type: none"> • Is responsible for the implementation of the EMP • To appoint as SHE officer responsible for the implementation of this EMP. • To ensure that all tasks undertaken under the scope of work, are in accordance both with NamPower's SHEW policies and procedures as well as to the requirements of this EMP. • Ensure that employees are regularly trained and awareness built relating to environmental and social management. • To ensure that all incidents, accidents and complaints are reported to the project manager. The contractor to ensure that incidents and accidents are investigated to prevent re-occurrence. • Ensuring that all employees receive a SHEW induction before the start of the project. • Ensuring that the work being done does not create a nuisance to any being working, residing or living on adjacent properties or

within the immediate surroundings of the site.

6 DESCRIPTION OF OPERATIONAL ACTIVITIES TO BE UNDERTAKEN AND ASSOCIATED IMPACTS

The table below outlines the summary of the operational activities and associated socio-economic and environmental impacts.

Table 3: Description of the activities related to the operational activities.

Activity	Description	Associated potential impacts
General functioning of the station and transmission line.	<ul style="list-style-type: none"> • Physical presence and functional characteristics of the station and associated line. 	<ul style="list-style-type: none"> • Animal (including birds) mortalities through collisions and electrocution. • Destruction of avifauna, especially protected spp. • Visual impact. • Community impacts in a form fatalities or injuries caused by electrocution. • Meeting electricity demand (positive impact).
Maintenance of the station and line	<ul style="list-style-type: none"> • The maintenance of the station and line entails: • General equipment repairs. • Replacement and servicing of batteries. • Maintenance of electrical equipment such as transformers, relays and 	<ul style="list-style-type: none"> • Soil and water contamination • Waste generation leading to filling up of landfill space • Destruction of vegetation; vertebrate fauna; avifauna especially protected spp. and sensitive habitats. • Social issues related to the introduction of new workers in the

	<p>capacitors.</p> <ul style="list-style-type: none"> • Maintenance of electrical equipment such as transformers, relays and capacitors. • Construction or repairing of access roads. 	<p>area, e.g. HIV/AIDS spreading.</p> <ul style="list-style-type: none"> • Loss of human life (through electrocution).
Construction	<ul style="list-style-type: none"> • Construction include the following activities: • Construction or refurbishment of buildings (digging and setting of foundations, digging of cable trenches and other activities) . • Installation or extension of boundary fences • Upgrade of electrical equipment (either in size, capacity or technology). • Personnel conduct in surrounding communities. 	<ul style="list-style-type: none"> • Noise emissions • Dust emissions • Introduction of new people in the area leading to the spread of diseases such as HIV/AIDS • Soil and water contamination • Waste generation leading to filling up of landfill space • Employment of casual workers • Loss of biodiversity reduces habitat availability and food sources for many animals. • Loss of sensitive plants and habitats. • Loss or damage of heritage resources.
Periodic inspections and monitoring	<ul style="list-style-type: none"> • Replacement, cleaning and maintenance of station and line components. 	<ul style="list-style-type: none"> • Soil and ground water contamination as a result of oil spills • Soil contamination as a result of improper waste handling and disposal.

		<ul style="list-style-type: none"> • Loss of biodiversity if existing access roads are not put to use.
Use and storage of Hazardous Substances	<ul style="list-style-type: none"> • Storage of hazardous material. 	<ul style="list-style-type: none"> • Possible oil spills and soil contamination from electrical units such as transformers.
Installation of Optic Fibre networks	<ul style="list-style-type: none"> • Design, Supply, Delivery, Installation and Commissioning of Optic Fiber networks for communication purposes. 	<ul style="list-style-type: none"> • Loss of biodiversity • Soil contamination as a result of improper waste handling and disposal. • Loss of sensitive plants and habitats.
Vegetation Management	<ul style="list-style-type: none"> • Removal of trees and bushes to maintain access to the line servitude. Removing weed from the substation yard. 	<ul style="list-style-type: none"> • Destruction of vegetation; vertebrate fauna; avifauna especially protected spp. and sensitive habitats. • Conflict with landowners • Loss of topsoil • Soil and water contamination • Loss or damage of heritage resources. • Soil erosion • Destruction of sensitive habitats

7 MANAGEMENT AND MITIGATION MEASURES

In order to ensure that the potential impacts are eliminated and/or minimised, it is necessary to ensure that the various activities related to the operation and maintenance of the powerlines

and station are adequately managed and monitored. Table 4 below outline mitigation measures as well as objectives to be achieved. A responsible person (s) have been assigned to each mitigation measure (s).

Table 4: Proposed mitigation measures for the general operational activities

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
Safety Health and Environmental (SHE) Awareness	<ul style="list-style-type: none"> • All employees should undergo SHE induction before work commences onsite. • All employees are to be made aware of their individual roles and responsibilities in achieving compliance with the EMP. • SHE toolbox talks to be conducted by the contractors and records to kept onsite. • Warning signs must be placed on and around the site. 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor
Safety Management	<ul style="list-style-type: none"> • Develop and implement an occupational health and safety system that comprises key elements such as risk assessment and safe working procedure. • All work activities to be done under the supervision of a competent person. • Appropriate warning signs must be placed on the facilities. 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor
Fire Management	<ul style="list-style-type: none"> • Eliminate the presence of potential sources of ignition and provide appropriate equipment to minimize fire risk. • Fire extinguishers to be readily available onsite, especially when hot works are conducted. 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Regular servicing of fire extinguishers. • Fire breaks must be implemented. 	
Air Quality	<ul style="list-style-type: none"> • Dust generation from all activities must be minimised. • Excavation, handling and transportation of erodible materials shall be avoided under high wind conditions or when a visible dust plume is present. • Speed limit to be enforced to control dust emissions. • Dust suppression measures shall be implemented when necessary. • Vehicle, machinery and equipment shall be maintained in good working order in order to minimise exhaust fume emissions. • Vehicle, machinery and equipment must be serviced by competent personnel and records must be kept onsite 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor
Resources Efficiency	<ul style="list-style-type: none"> • Minimise water wastage and record water usage. • Avoid wasteful use of materials. • Source goods and services locally where possible 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
Waste Management	<ul style="list-style-type: none"> • Minimise the generation of waste by applying the waste hierarchy. • Station and line servitude to be kept free of waste. • No burning, burying or dumping of any waste materials shall be permitted onsite. • Labelled waste bins with lids must be provided at substations/campsites for all waste streams and ensure that waste is disposed at nearest approved waste disposal site. • Ensure that waste segregation is done at source. • Hazardous waste shall be disposed of at a registered hazardous waste disposal site. • Safe disposal certificates for hazardous waste must be kept in the SHE file. • Concrete waste must not be dumped on site. 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor
Wastewater management	<ul style="list-style-type: none"> • Water containing environmental pollutants shall be collected and removed from site. • No waste water runoff or uncontrolled discharges from the site/working areas shall be permitted. 	<ul style="list-style-type: none"> • Project manager • Contractor • Area superintendent

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Mobile toilets or septic tanks should be used in remote areas. 	
Hazardous Substances	<ul style="list-style-type: none"> • The use, handling, storage and disposal of the hazardous chemical must be in accordance with the MSDS. • Containers must be clearly marked to indicate contents and quantities. • Hazardous substances storage areas must be bunded. A bund should be able to contain 110% of the volume of the largest container stored within it. • All transformers to be contained in bunded areas. • Diesel and other liquid fuel, oil and hydraulic fluid must be stored in appropriate storage tanks or in bowsers with secondary containment. • Inspect and maintain hazardous storage areas and bund walls to avoid overflows. • Ensure that drip trays are available for vehicles when conducting maintenance activities in case of transmission fluid spills. • Spill kit and absorbents must be available onsite at substations. • Hazardous substance storage areas must display safety symbolic signs. • All spills must be reported, cleaned and remediated to in compliance with 	<ul style="list-style-type: none"> • Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	SHEW requirements.	
Social Impact	<ul style="list-style-type: none"> • NamPower/ Contractor must sign land permission form and agreement with land owners prior to commencement of work onsite. • Employees should limit their contact with permanent residents of the area. • Employees should be properly educated about the impact of HIV / AIDS and pregnancies. • The use of intoxicating liquor or drugs of any kind by the employees is strictly prohibited. • Ensure that all queries and complaints are documented and dealt with. • A register shall be kept of all complaints from stakeholders. • All claims shall be handled immediately to ensure timely rectification. 	<ul style="list-style-type: none"> • Area Superintendent • Project Manager • All NamPower employees • Contractor
Archaeology	<ul style="list-style-type: none"> • Should a heritage site or archaeological site be uncovered or discovered during the operation phase, a “change find” procedure in appendix 8 should be applied. • Any chance finds must be reported to NamPower environmental section. • In an event of discovery of human remains or other artefacts the work shall 	<ul style="list-style-type: none"> • Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<p>cease. A professional archaeologist is to be consulted and carry out investigation.</p>	
<p>Fauna and Flora</p>	<ul style="list-style-type: none"> • Ensure that the site is kept clean and free of rubbish that could potentially attract animals and pests • No harvesting of plants is allowed. • Poaching or capturing of any animal (wild or domestic) is prohibited. • Bird nests may not be disturbed unless interfering with the normal operation of the line/station. • No domestic animals may be kept onsite site as they can introduce diseases or interbreed with the animals occurring naturally in the area. • Vehicles driving along the lines should engage four wheel drive to prevent spinning and consequent impacts on soil surface. • Existing tracks must be utilised. • Minimise activity in Karst areas. • No chemical and mechanical clearing in Karst areas – rather manual clearing in rocky areas. 	<ul style="list-style-type: none"> • Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Mechanical clearing, with chemical aftercare, in non-Karst areas is recommended. • Install electrostatic animal and/or squirrel guards on the bushings at substations and on-pole-mounted switching gear to prevent some mammals – e.g. small-spotted genet, mongoose that may be attracted to these structures from causing problems (only if problems experienced); • Identify potential bird collision prone areas and potential transmission line sensitive bird species. • Install bird flight diverters (BFD's) and anti-perching devices (APD's) to the transmission line at/along collision prone habitats. • Monitor all bird mortalities encountered under the transmission line. • All wildlife and electrical infrastructure interactions must be reported to the SHEW section. 	
Soil erosion	<ul style="list-style-type: none"> • Implement and maintain erosion control measures where applicable along the access route i.e. use the same tracks, cross drainage lines at right angles, no direct routes up steep slopes, etc. • Rehabilitate eroded areas annually i.e. after rainfall events (scarce and periodic in this area) 	<ul style="list-style-type: none"> •

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> Maintain track discipline – i.e. no off-road driving; speed control; use the same track, etc. 	
Water Resources	<ul style="list-style-type: none"> Care must be taken to ensure that pollution of water does not occur. Naturally occurring water resources may not be used for any personal hygiene. Water may only be taken from a private or government property based on an agreement between the NamPower, contractor and custodian of the water source. 	<ul style="list-style-type: none"> Area superintendent Project Manager SHEW Contractor
Campsite Establishment	<ul style="list-style-type: none"> NamPower/ Contractor must sign land permission form and agreement with land owners prior to commencement of work onsite. Adequate ablution facilities must be provided onsite in relation to the number of employees. Ablution facilities must not be located within 100m of any river, stream channel, pan, dam or borehole Non-employees are not allowed to reside at the campsite. Fire extinguishers, first aid kits, assembly point, and emergency numbers must be available onsite. 	<ul style="list-style-type: none"> Area superintendent Project Manager SHEW Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Waste must be managed in accordance with waste management requirements outlined in this EMP. 	
Manual and Mechanical Vegetation Removal	<ul style="list-style-type: none"> • Obtain a permit from the Ministry of Environment, Forestry and Tourism to remove protected trees as per the Forest Act No. 12 of 2001. • Measures must be put in place to avoid erosion at rivers, stream channel crossings, and at places where existing erosion scars and dongas are encountered to avoid any further erosion. • Where manual bush-clearing is impractical, mechanical bush clearing shall be used, but an effort must be made to preserve the topsoil structure. • The disturbed soil must be levelled. • Do not remove wood cut on site as this would affect the recycling of nutrients locally as well as lead to a potential industry in firewood targeting the better quality tree species. • Where clearing is done near a river, the contractor/NamPower must ensure that no felled bushes/branches/shrubs are left behind in the riverbed. • No burning of bush cleared materials is allowed onsite. 	<ul style="list-style-type: none"> • Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Protected tree species, especially larger specimens, within the affected area i.e. 12m from centre line in either direction not expected to affect the transmission line could be avoided. • Manual and mechanical vegetation removal should be done in accordance with NamPower vegetation clearance and maintenance Procedure. • Avoid the cutting down of protected tree species [Forestry Ordinance No. 37 of 1952) not directly affecting the power lines during the line clearing operation. 	
Herbicide Use	<ul style="list-style-type: none"> • Prevent the application of selected herbicide(s) in sensitive areas – e.g. “high” & “medium” sensitivity areas (See annexure 1). Sensitive areas are known/expected to have higher biodiversity. • Avoid the spraying of protected tree [Forestry Ordinance No. 37 of 1952) not directly affecting the power lines during the line clearing operation. • Eradicate all invasive alien species potentially associated with the line/station. This would indicate overall environmental commitment. • Avoid spraying herbicide during windy days/periods. See the general product requirements for herbicide used. This could affect non-target areas and species. • Avoid spraying, removing and/or approaching trees with vulture (and other larger raptors) nests along the route. 	<ul style="list-style-type: none"> • Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	<ul style="list-style-type: none"> • Implement strict control over the storage, protective measures & application of the selected herbicide(s) throughout. • Herbicide should be applied directly to the plant's stem or leaves as a spray. • Herbicide will be handled in accordance with the requirements outlined in the NamPower Vegetation Clearance and Maintenance procedure. 	
Site Rehabilitation (progressive and post rehabilitation)	<ul style="list-style-type: none"> • Progressive rehabilitation when construction work is in progress. Post construction rehabilitation must also be done. All materials, equipment and waste must be removed from site. • A post construction audit within 1 week prior to the Contractor leaving site must be conducted. • SHEW to sign site close off or take over certificate once remedial corrective actions have been implemented. 	<ul style="list-style-type: none"> • Area superintendent • Project Manager • SHEW • Contractor

8 REPORTING, MONITORING AND AUDITING

The environmental monitoring and audits must be conducted in line with supporting procedures and requirements of this plan. Monitoring and audit reports detailing the monitoring and audit results shall be prepared by the SHEW section and communicated to the Area Manager, Superintendent and Project Manager. Records of monitoring and auditing report shall be kept and will be made available during inspection and audits.

The following general monitoring indicators and guideline are recommended should herbicides be used to do vegetation management along the line:

Table 5: General monitoring indicators and guideline recommended after herbicide application

Monitor trees adjacent the cleared area after herbicide application	A survey in year 1 (i.e. 6 months after application of herbicide) should be conducted along the affected route to determine the effect of the herbicide on non-target areas – i.e. adjacent vegetation. Focus on protected tree species along the route
Monitor coppicing and regrowth after herbicide application	A survey in year 2 (i.e. 1 year after application of herbicide) should be conducted along the affected route to determine the effect of the herbicide on bush clearing. This would indicate the success of the herbicide used as well as indicate the necessity of follow-up treatment.
Sample any open surface water after herbicide application	Very few open water sources are located along the route and although it is recommended that herbicides not be used in “high” and “medium” sensitivity areas, monitoring this would be viewed as a good practice. Take water samples from any surface water encountered and have these analysed to determine if herbicide used has entered these sources.

9 NON-COMPLIANCE AND CONFLICT MANAGEMENT PROCEDURES

The Area Superintendent and Contractor shall ensure that the employees and external service providers comply with the requirements outlined in this EMP. In the event of non-compliance the following recommended process shall be followed:

- Non – compliances will be identified during inspections or audits carried out by the SHEW Section and reported to the Area manager, Superintendent and Project Manager for corrective actions.
- Area Superintendent / Project Manager shall notify the responsible stakeholders about the non-compliance .
- Corrective and preventative actions must be implemented on an agreed timeframes.
- Follow – up inspections/audits shall be conducted to assess whether the corrective and preventative actions were implemented effectively.

The contractor shall notify NamPower of the following:

- Conflicts arising with any landowner / representative.
- Any special conditions requested by a landowner / representative.

NamPower has the right to stop all contractor's activities if it is found that a gross violation of the EMP is taking place.

10 RECORD KEEPING

Record keeping is important for the effective functioning and implementation of an EMP. EMP documentation must be kept in both the hard copy and electronic format for safe keeping. These must include:

- Copy of the Environmental Clearance Certificate
- A copy of an EMP
- EMP implementation activities
- Induction records
- Resource use records i.e. water and fuel consumption
- Audit and Inspection reports

In case chemical vegetation management is conducted, the following records should be kept:

- Date of application
- Herbicide applied

- Persons responsible for application
- Supervisor
- Type of herbicide used
- Method of application
- Time of application
- Equipment used
- Concentration of herbicide used

11 CONCLUSION

All management measures and legal requirements outlined in this EMP should be implemented in order to ensure environmental compliance by all parties undertaking the operational activities. This will ensure that potential negative impacts are identified, avoided or mitigated and positive impacts are enhanced..

12 ANNEXURES

Annexure 1: Areas of importance, with protected species potentially affected, along the Otjikoto – Kombat 66kV transmission line.

[Direction: Otjikoto Substation west- and south-eastwards towards the Kombat area]

Hotspot areas	Distance (km)	Area	Important species	Common names	Status	Aliens	Other important features	Importance ranking
1	0 to 14.0	Otjikoto SS area	<i>Sclerocarya birrea</i>	marula	F			Low
	14.0 to 26.0	Otjikoto SS area	<i>Sclerocarya birrea</i>	marula	F		Karst mountains	High
2	26.0 to 45.7	Tsumeb area						Low
	45.7 to 64.9	Kombat area	<i>Sclerocarya birrea</i>	marula	F		Karst mountains	High
	64.9 to 70.8	Kombat SS area						Low

Annexure 2: Herbicide application guideline

Management requirement
<i>Recommended herbicide:</i> Access 240 SL or any similar product with picloram or triclopyr as active ingredients should be used
<i>Recommended Application method:</i> Foliar application – spray or paint-on-stump –is recommended as this is target specific. Access mixed with water and Actipron (wetting agent).
<i>Technique:</i> The herbicide can be applied directly to the plant – stem or leaves – as a spray. Trees and shrubs with a stem diameter <10cm can be sprayed directly, but trees with a stem diameter >10cm should be felled before treatment of the cut surface for best results. Treatment should be done as soon as possible after felling and the entire cut surface and stump should be wetted. Coppice growth can also effectively be controlled.
<i>Use:</i> Active growing season – i.e. September to April (best in early growing season – September to November – before main rains) has best results.
<i>Concentration</i> Foliar application = 350ml/100l water + Actipron Super 500ml/100l spray mix. Cut stump application = 2l/100l water + Actipron Super 2l/100l spray mix.
<i>Application repeatability</i> <ul style="list-style-type: none">▪ Year 1: Apply herbicide (early growing season)▪ Year 2: Follow-up to target any regrowth and coppicing (early growing season)▪ Thereafter: As required – i.e. dependent on coppicing potential of various species. This could be determined during routine line inspections.

Annexure 3: Monitoring checklist for bush clearing and herbicide application

Activity: Bush clearing	Compliance	
	Yes	No
Site:		
Manual clearing conducted		
Mechanical clearing conducted		
Area adequately cleared – i.e. 12m from centre line		
Protected tree species on 12m boundary only trimmed		
Protected tree species not affecting line left <i>in situ</i>		
Raptor and vulture nesting sites left undisturbed		
Overall access improved		
Activity: Chemical application		
Active ingredient used = Triclopyr		
Application method used = spray		
Application technique used = spray leaves/cut stumps		
Application season = Sep to April (Sep to Nov = best)		
Application conditions = no wind		
Application procedures = protective masks/equipment used		
Application knowledge = certified users only		
Storage = safe/secure		
Storage = chemical register maintained		
Storage = equipment clean/functional		
Concentration: Foliar application = 350ml/100l water + Actipron Super 500ml/100l spray mix		
Concentration: Cut stump application = 2l/100l water + Actipron Super 2l/100l spray mix		
Repeatability: Year 1		
Repeatability: Year 2		
Repeatability: Year 3		
Sensitive “hotspot” areas avoided		
Water – open surface water encountered		
Water – open surface water samples taken		
Collateral damage observed (i.e. non target areas/species affected)		
Any complaints from landowners		

Annexure 4: Protection of Ecology & Vegetation – Otjikoto-Kombat

Activity: Protection of Ecology & Vegetation – Otjikoto-Kombat	Compliance	
	Yes	No
Track discipline		
Evidence of new tracks		
Evidence of offroad driving		
Evidence of turnaround violations		
Evidence of oil spills		
Evidence of waste		
Evidence of litter		
Illegal collection/damage of flora		
Evidence of illegal plant collection		
Evidence of vehicle damage to plants		
Evidence of unauthorised people/vehicles		
Erosion		
Evidence of erosion along route		
Evidence of recovery at rehabilitated sites		
Invasive alien plants		
Evidence of invasive alien plants along route - New		
Evidence of invasive alien plants along route - Existing		
Evidence of invasive alien plants at rehabilitated sites		
New species		
Any new plants encountered – i.e. not previously observed		
Domestic stock/pets		
Domestic stock and/or pets encountered along route (Relevant to Protected Areas only)		
Bird mortalities		
Record all dead birds encountered below the line		

Annexure 5: Landowner permission form



Landowner Permission Form



Landowner name: _____ Contact number: _____
Representative name: _____
Farm name: _____
Contractor: _____
Representative name: _____ Contact number: _____

General Notice

This form is to be used prior to a contractor entering a landowner's property to commence any work related to the construction or maintenance of power-line structures and servitudes.

The form must be completed by either the landowner or his / her legal representative on the property.

Section A: Before activities commence

Activities to be undertaken on the property (completed by the contractor):

Use of water resources
Powerline erection
Powerline refurbishment
Trimming of vegetation
Use of other infrastructure
(please specify)

Camping
Bush clearing
Herbicide application
Access road usage
Rehabilitation

Specific conditions to be met on the property (as stipulated by the landowner):

Dates when access is needed:

From: _____

To: _____

Signatures (prior to entry)

Landowner/Representative

Contractor representative

Date

Date

Section B: Upon completion of work and prior to leaving the property

Remarks on compliance or misconduct (upon completion of activities):

Issues still to be resolved upon completion of activities:

Signatures (upon completion)

Landowner/Representative Contractor representative

Date Date

Annexure 6: pre-application consent form for herbicide/pesticide application

PRE-APPLICATION CONSENT FORM	
Name of Landowner / Representative:	
Contact Details:	
Name of Farm:	
Name of Contractor:	
Name and Details of Contact Person:	
Herbicide/pesticide to be used:	
Period of Application:	
NamPower District Supervisor:	
Contact Details:	
NamPower Installation to be Treated:	
<u>Comments from Landowner/Representative:</u>	
<u>Signed:</u>	
Landowner/ Representative:	NamPower Representative:
Date:	Date:

Annexure 7: Post application review form for herbicide/pesticide applications

POST-APPLICATION REVIEW FORM	
Name of Landowner / Representative:	
Contact Details:	
Name of Farm:	
Name of Contractor:	
Name and Details of Contact Person:	
Herbicide/pesticide to be used:	
Period of Application:	
NamPower District Supervisor:	
Contact Details:	
NamPower Installation to be Treated:	
<u>Outstanding Issues:</u>	
<u>Signed:</u>	
Landowner/ Representative:	NamPower Representative:
Date:	Date:

Annexure 8: Chance find procedure

Definition: The “chance finds” procedure covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person.

Compliance: The “chance finds” procedure is intended to ensure compliance with relevant provisions of the National Heritage Act (27 of 2004), especially Section 55 (4): “ a person who discovers any archaeological object must as soon as practicable report the discovery to the Council”. The procedure of reporting set out below must be observed so that heritage remains reported to the NHC are correctly identified in the field.

Procedure:

Action by person identifying archaeological or heritage material

- a) If operating machinery or equipment stop work
- b) Identify the site with flag tape
- c) Determine GPS position if possible
- d) Report findings to foreman

Action by foreman

- a) Report findings, site location and actions taken to superintendent
- b) Cease any works in immediate vicinity

Action by superintendent

- a) Visit site and determine whether work can proceed without damage to findings
- b) Determine and mark exclusion boundary
- c) Site location and details to be added to project GIS for field confirmation by archaeologist

Action by archaeologist

- a) Inspect site and confirm addition to project GIS
- b) Advise NHC and request written permission to remove findings from work area
- c) Recovery, packaging and labelling of findings for transfer to National Museum

In the event of discovering human remains

- a) Actions as above
- b) Field inspection by archaeologist to confirm that remains are human
- c) Advise and liaise with NHC and Police
- d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed

**ECOLOGY AND VEGETATION ASSESSMENTS
WITHIN VARIOUS NORTHERN NAMPOWER
TRANSMISSION LINES
– OTJIKOTO TO KOMBAT 66kV (Kombat/Tsumeb
area)
[Rapid Ecology & Vegetation Assessments]**

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Ecology and flora expected and observed along the Otjikoto-Kombat 66kV transmission line (Kombat/Tsumeb area)

1 Introduction

A desktop study (i.e. literature review) was conducted between 1 and 4 May 2022 on the flora (e.g. trees/shrubs) expected to occur in the general area in north central Namibia – i.e. Kombat/Tsumeb area – along a the NamPower 66kV transmission line known as Otjikoto-Kombat between the Otjikoto Substation and the Kombat Substation.

The 66kV transmission line (Otjikoto-Kombat) falls within the vegetation type known as the Mountain Savannah and Karstveld (Giess 1971) or Karstveld (Mendelsohn *et al.* 2002). This literature review was to determine the actual as well as potential flora associated with this vegetation type along the transmission line. The main ephemeral rivers draining the general area flow westwards – e.g. Omaramba Owambo – or towards the northeast – e.g. Omuramba Omatoko (Mendelsohn *et al.* 2002).

The vegetation structure is classified as Karstveld (Giess 1971, Mendelsohn *et al.* 2002). Areas of special ecological importance throughout Namibia include mountains and inselbergs with the Otavi Mountains viewed as an area of special ecological importance due to its biotic richness in plants and birds (Curtis & Barnard 1998). The Karst areas are also known to have numerous caves, sinkholes and springs with associated endemic fauna (Curtis & Barnard 1998). More broadly speaking, the Savannah Biome – of which the Otjikoto-Kombat 66kV transmission line forms part of – is underrepresented in the protected area network in Namibia covering 37% of the land area, but only 7.5% of the biome while the Mountain Savannah and Karstveld with its unique vegetation types is wholly unprotected (Barnard 1998).

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and figies (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species – approximately 687 species in total – are mainly associated with the Kaokoveld (northwestern) and the succulent Karoo (southwestern) Namibia. The major threats to the floral diversity in Namibia are:

- 1). Conversion of the land to agriculture (with associated problems) and,
- 2). poorly considered development (Maggs 1998, Mendelsohn *et al.* 2002).

Karstveld

Although the vegetation in the Mountain Savannah and Karstveld varies considerably, the area is characterised by trees such as *Kirkia acuminata*, *Berchemia discolor*, *Croton* spp., *Gyrocarpus americanus*, *Pachypodium lealii* and many others. The Karst regions with recent surface limestone deposits and shallow soils often support *Combretum imberbe*, *Dichrostachys cinerea* and *Terminalia prunioides* (Giess 1971). At higher elevations the grass cover consists of *Brachiaria serrata* and other valuable grasses, while *Digitaria seriata* and *Panicum maximum*, which occur in the semi-shade under trees and shrubs, forming the climax association while *Eragrostis scopelophila* and others are dominant on the lower slopes (Giess 1971). The Karstveld vegetation structure is classified as mixed woodlands with the availability of graze and browse being good and the average plant production “high to very high” while the variation in green vegetation biomass is viewed as “medium” and estimated at 10-15% (Mendelsohn *et al.* 2002). The Karstveld is known for its high plant

species richness (Maggs 1998) and Simmons (1998) puts the plant endemism in the general area at between 1 and 20 species depending on the locality. The overall plant diversity (all species - “higher” plants) in the general area is viewed as “high” and estimated at between 400 and 499 species with the plant endemism viewed as “low” with 2 to 5 species (Mendelsohn *et al.* 2002)

2 Methods

2.1 Literature review

A comprehensive and intensive literature review (i.e. desktop study) regarding the flora (trees and shrubs) and ecology that could potentially occur in the general/immediate Komat/Tsumeb area (i.e. along the Otjikoto-Kombat 66kV transmission line) was conducted using as many references as manageable. A list of the references consulted can be viewed in the Reference section (Page 32).

2.2 Fieldwork

A vehicle survey along the ~64km Otjikoto-Kombat 66kV transmission line was conducted on 11 May 2022. According to the ToR (Terms of Reference) the following was expected:

1. Identify all floral species growing within 20 metres of each side of the centre line of the power line;
2. Identify all “sensitive flora species” – i.e. endemic, protected and / Red Data floral species occurring within 12 metres on each side of the centre line of the power line and indicate the location of these species to ensure that proper action is taken to prevent negatively affecting these areas and/or species (if technically feasible);
3. State detailed yet practical mitigation measures along with monitoring indicators and guidelines.

The following will be expected as tasks / outcomes of the above stated activity:

1. Site visit to determine conditions on site;
2. Identify unique habitats and/or “sensitive flora species”;
3. Practical mitigation measures to prevent potential site disturbances; and
4. Monitoring checklist.

During the fieldwork the most accessible route – usually under the pylons – was followed. However, along this route much of the route is not accessible – e.g. rocky areas, dense bush, fence and gate issues, etc. – and the route deviated considerably due to the terrain. This route has not been maintained for years with the bush having regrown to such an extent that much of it impassable.

The terrain traversed was classified according to its “sensitivity” (high/medium/low) – i.e. unique habitats, biodiversity hotspots, clumps of protected species, etc. – and odometer readings were used to zone the entire route (See Table 5).

Protected tree/shrub species were identified *in situ* and photographs were taken to visually represent various species and features discussed throughout this report.

3 Results

3.1 Tree and Shrub Diversity

It is estimated that at least 147 species of larger trees and shrubs (>1m) occur in the general Kombat/Tsumeb area (Mannheimer and Curtis 2018).

The trees and shrubs known and/or expected to occur in the general Kombat/Tsumeb – i.e. north/central Namibia – area (Mannheimer and Curtis 2018) is presented in Table 1. Species indicated below are known from the quarter-degree square distribution principle used and don't necessarily occur throughout the entire area.

Table 1. Larger trees and shrubs known and/or expected to occur in the general Kombat/Tsumeb area and confirmed during the fieldwork (√).

Species: Scientific name	Species confirmed	Namibian conservation and legal status	International status (IUCN 2021)
<i>Acacia arenaria</i>			
<i>Acacia ataxacantha</i>	√		
<i>Acacia erioloba</i>	√	Protected (F)	LC
<i>Acacia erubescens</i>			
<i>Acacia fleckii</i>	√		
<i>Acacia hebeclada</i>			
<i>Acacia hereroensis</i>			
<i>Acacia karroo</i>			
<i>Acacia kirkii</i>			
<i>Acacia luederitzii</i>			
<i>Acacia mellifera</i>	√		
<i>Acacia nebrownii</i>			
<i>Acacia nilotica</i>	√		
<i>Acacia reficiens</i>			
<i>Acacia tortilis</i>			
<i>Adansonia digitata</i>		Protected (F)	
<i>Adenium boehmianum</i>		Protected (F)	
<i>Albizia anthelmintica</i>		Protected (F)	LC
<i>Aloe littoralis</i>		NC; C2	LC
<i>Baissea wulfhorstii</i>			
<i>Baphia massaiensis</i>			
<i>Bauhinia petersiana</i>			
<i>Bauhinia urbaniana</i>			
<i>Berchemia discolor</i>		Protected (F)	LC
<i>Boscia albitrunca</i>		Protected (F)	LC
<i>Boscia foetida</i>	√		
<i>Burkea africana</i>		Protected (F)	
<i>Caesalpinia rubra</i>			
<i>Carissa bispinosa</i>			
<i>Carissa edulis</i>			
<i>Cassia abbreviata</i>			
<i>Catophractes alexandri</i>			
<i>Cissus nymphaeifolia</i>			
<i>Combretum apiculatum</i>	√		
<i>Combretum collinum</i>			
<i>Combretum engleri</i>			
<i>Combretum hereroense</i>			
<i>Combretum imberbe</i>	√	Protected (F)	LC

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Species: Scientific name	Species confirmed	Namibian conservation and legal status	International status (IUCN 2021)
<i>Combretum mossambicense</i>			
<i>Combretum psidioides</i>			
<i>Combretum zeyheri</i>			
<i>Commiphora africana</i>			
<i>Commiphora angolensis</i>			LC
<i>Commiphora glandulosa</i>	√		LC
<i>Commiphora glaucescens</i>		N-end	LC
<i>Commiphora mollis</i>			LC
<i>Commiphora pyracanthoides</i>			LC
<i>Commiphora tenuipetiolata</i>			LC
<i>Cordia sinensis</i>			
<i>Croton gratissimus</i>	√		
<i>Croton menyharthii</i>			
<i>Cyphostemma juttae</i>		End; Protected (F); NC	LC
<i>Dialium engleranum</i>		Protected (F)	LC
<i>Dichrostachys cinerea</i>	√		
<i>Diospyros chamaethamnus</i>			
<i>Diospyros lycioides</i>			
<i>Dombeya rotundifolia</i>			
<i>Ehretia alba</i>			
<i>Ehretia namibiensis</i>			
<i>Elaeodendron transvaalense</i>		Protected (F)	
<i>Elephantorrhiza elephantina</i>			
<i>Elephantorrhiza suffruticosa</i>			
<i>Entada arenaria</i>			
<i>Erythrina decora</i>		End; Protected (F)	
<i>Erythrocca menyharthii</i>			
<i>Erythrophleum africanum</i>			
<i>Euclea divinorum</i>			
<i>Euclea undulata</i>			
<i>Euphorbia avasmontana</i>		C2	
<i>Euphorbia guerichiana</i>		C2	LC
<i>Faidherbia albida</i>		Protected (F)	LC
<i>Ficus burkei/petersii</i>		Protected (F)	
<i>Ficus cordata</i>	√	Protected (F)	LC
<i>Ficus ingens</i>			
<i>Ficus sycomorus</i>		Protected (F)	LC
<i>Flueggea virosa</i>			
<i>Fockea multiflora</i>			
<i>Grewia avellana</i>			
<i>Grewia bicolor</i>	√		
<i>Grewia falcistipula</i>			
<i>Grewia flava</i>	√		
<i>Grewia flavescens</i>	√		
<i>Grewia olukondae</i>			
<i>Grewia retinervis</i>			
<i>Grewia schinzii</i>			
<i>Grewia subspathulata</i>			
<i>Grewia tenax</i>			
<i>Grewia villosa</i>			
<i>Gossypium triphyllum</i>			
<i>Gymnosporia buxifolia</i>			
<i>Gymnosporia senegalensis</i>			
<i>Gyrocarpus americanus</i>	√		
<i>Heteromorpha stenophylla</i>			

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Species: Scientific name	Species confirmed	Namibian conservation and legal status	International status (IUCN 2021)
<i>Hyphaene petersiana</i>		Protected (F)	LC
<i>Ipomoea adenioides</i>			
<i>Kirkia acuminata</i>	√		
<i>Laggera decurrens</i>	√		
<i>Lannea discolor</i>		Protected (F)	LC
<i>Lycium bosciifolium</i>			
<i>Lycium cinereum</i>			
<i>Maerua juncea</i>			
<i>Maerua parvifolia</i>			
<i>Maerua schinzii</i>		Protected (F)	LC
<i>Montinia caryophyllacea</i>			
<i>Moringa ovalifolia</i>		Protected (F); NC; N-end	
<i>Mundulea sericea</i>			
<i>Obetia carruthersiana</i>		N-end	
<i>Ochna cinnabarina</i>			
<i>Ochna pulchra</i>			
<i>Olea europaea</i>			
<i>Opilia campestris</i>			
<i>Osyris lanceolata</i>			
<i>Ozoroa crassinervia</i>		Protected (F); N-end	LC
<i>Ozoroa insignis</i>			
<i>Ozoroa paniculosa</i>	√		
<i>Ozoroa schinzii</i>			
<i>Pachypodium lealii</i>		Protected (F); NC; N-end	
<i>Pavetta zeyheri</i>			
<i>Peltophorum africanum</i>	√		
<i>Philenoptera nelsii</i>	√		
<i>Pouzolzia mixta</i>			
<i>Pseudolachnostylis maprouneifolia</i>			
<i>Psydrax livida</i>			
<i>Rhigozum brevispinosum</i>	√		
<i>Rhigozum trichotomum</i>			
<i>Rothea myricoides</i>			
<i>Schinziophyton rautanenii</i>		Protected (F)	LC
<i>Securidaca longepedunculata</i>			
<i>Sclerocarya birrea</i>	√	Protected (F)	
<i>Searsia ciliata</i>			
<i>Searsia lancea</i>	√	Protected (F)	LC
<i>Searsia marlothii</i>			
<i>Searsia tenuinervis</i>			
<i>Spirostachys africana</i>		Protected (F)	LC
<i>Steganotaenia araliacea</i>			
<i>Tarchonanthus camphoratus</i>	√		
<i>Terminalia brachystemma</i>			
<i>Terminalia prunioides</i>	√		
<i>Terminalia sericea</i>	√		
<i>Tetradenia riparia</i>			
<i>Tinnea eriocalyx</i>			
<i>Tinnea rhodesiana</i>			
<i>Vangueria infausta</i>			
<i>Vangueriopsis lanciflora</i>			
<i>Ximenia americana</i>			
<i>Ximenia caffra</i> var. <i>caffra</i>			
<i>Ziziphus mucronata</i>	√	Protected (F)	LC

End = Endemic; **N-End** = Near-endemic (Mannheimer and Curtis 2018)

Protected F = Forest Act No 12. of 2001

NC – Nature Conservation Ordinance No. 4 of 1975

C2 – CITES Appendix 2 species

LC = Least Concern (IUCN 2021)

Source for literature review: Mannheimer and Curtis (2018)

According to Mannheimer and Curtis (2018) at least 147 species of larger trees and shrubs are known and/or expected to occur in the general area of which 2 species are classified as endemic (1.4%), 5 species classified as near endemic (3.4%), 27 species are protected by the Forest Act No. 12 of 2001 (18.4%), 4 species are protected by the Nature Conservation Ordinance No. 4 of 1975 (2.7%) and 3 species are classified as CITES Appendix 2 species (2%) – i.e. 32 species (including endemic and near endemic) have some form of conservation status (21.8%) (See Table 1).

According to their protective status *Cyphostemma juttae* (end, F, NC), *Erythrina decora* (Forestry, endemic) and *Pachypodium lealii* (end; F; NC; N-end) are probably the trees/shrubs most unique that are expected to occur in the general area.

Species often associated with Karsveld in Namibia include *Carissa bispinosa*, *C. edulis*, *Elaeodendron transvaalense*, *Gyrocarpus americanus*, *Heteromorpha stenophylla*, *Kirkia acuminata*, *Opilia campestris*, *Pouzolzia mixta* and *Tinnea rhodesiana* (Mannheimer and Curtis 2009).

Other important, albeit more widespread protected tree/shrub species, are *Aloe littoralis* (Windhoek aloe), *Combretum imberbe* (lead wood), *Euphorbia avasmontana* (slender candelabra Euphorbia) and *Moringa ovalifolia* (phantom tree) (See Table 1).

Loots (2005) lists at least 7 species of conservation concern – i.e. Red Data species – from the general Kombat/Tsumeb area of which 5 species are endemic, 2 species viewed as rare (*Eriospermum lavranosii*, *Decorsea dinteri*), 1 species viewed as near threatened (*Ceropegia mafekingensis*), 4 species protected by the Nature Conservation Ordinance No. 4 of 1975, 2 species listed by CITES as Appendix 2 species and 4 species viewed as least concern (Table 2).

Table 2. Important species – i.e. Red Data spp. – known to occur in the general Kombat/Tsumeb area according to Loots (2005).

Species: Scientific name	Conservation status
<i>Aloe dinteri</i>	End, NC, C2, LC
<i>Ceropegia dinteri</i>	End, NC, LC
<i>Ceropegia mafekingensis</i>	NC, NT
<i>Cyphostemma juttae</i>	End, LC
<i>Eriospermum lavranosii</i>	End, Rare
<i>Decorsea dinteri</i>	End, Rare
<i>Habenaria epipactidea</i>	NC, C2, LC

End = Endemic (Loots 2005)

Rare; NT (Near Threatened); **LC** (Least Concern) (Loots 2005)

NC = Nature Conservation Ordinance No. 4 of 1975

C2 = CITES Appendix 2 species

During the rapid assessment conducted on 11 May 2022 28 species of larger trees/shrubs were encountered of which 6 species are protected by the Forest Act No. 12 of 2001 (Table 1). Some species have more than one conservation status. The dominant tree/shrub

species were *Dichrostachys cinerea* (sickle bush) and *Terminalia prunioides* (purple-pod Terminalia).

There were a total of 50 species confirmed along the Otjikoto-Kombat 66kV line (Table 3).

Table 3. Vegetation confirmed along the Otjikoto-Kombat 66kV transmission line during the fieldwork – all species.

Species: Scientific name	Namibian conservation and legal status	International status (IUCN 2021)
<i>Abutilon rehmannii</i>		
<i>Acacia ataxacantha</i>		
<i>Acacia erioloba</i>	Protected (F)	LC
<i>Acacia fleckii</i>		
<i>Acacia mellifera</i>		
<i>Acacia nilotica</i>		
<i>Acrotome fleckii</i>		
<i>Aristida adscensionis</i>		
<i>Aristida meridionalis</i>		
<i>Aristida stipitata</i>		
<i>Blepharis obmitrata</i>		
<i>Boscia foetida</i>		
<i>Cenchrus ciliaris</i>		
<i>Combretum apiculatum</i>		
<i>Combretum imberbe</i>	Protected (F)	LC
<i>Commiphora glandulosa</i>		LC
<i>Croton gratissimus</i>		
<i>Cymbopogon caesius</i>		
<i>Cynodon dactylon</i>		
<i>Dichrostachys cinerea</i>		
<i>Enneapogon cenchroides</i>		
<i>Eragrostis cylindriflora</i>		
<i>Eragrostis nindensis</i>		
<i>Eragrostis trichophora</i>		
<i>Ficus cordata</i>	Protected (F)	LC
<i>Gomphocarpus tomentosus</i>		
<i>Grewia bicolor</i>		
<i>Grewia flava</i>		
<i>Grewia flavescens</i>		
<i>Gyrocarpus americanus</i>		
<i>Heteropogon contortus</i>		
<i>Hibiscus caesius</i>		
<i>Hirpicium gazanioides</i>		
<i>Kirkia acuminata</i>		
<i>Laggera decurrens</i>		
<i>Leucas pechuelii</i>		
<i>Nidorella resedifolia</i>		
<i>Ozoroa paniculosa</i>		
<i>Peltophorum africanum</i>		
<i>Petalidium variable</i>		
<i>Philenoptera nelsii</i>		
<i>Rhigozum brevispinosum</i>		
<i>Sclerocarya birrea</i>	Protected (F)	
<i>Searsia lancea</i>	Protected (F)	LC
<i>Sesamum triphyllum</i>		
<i>Stipagrostis uniplumis</i>		
<i>Tarchoanthus camphoratus</i>		

Species: Scientific name	Namibian conservation and legal status	International status (IUCN 2021)
<i>Terminalia prunioides</i>		
<i>Terminalia sericea</i>		
<i>Ziziphus mucronata</i>	Protected (F)	LC

End = Endemic; **N-End** = Near-endemic (Mannheimer and Curtis 2018)

Protected F = Forest Act No 12. of 2001

NC – Nature Conservation Ordinance No. 4 of 1975

C2 – CITES Appendix 2 species

LC = Least Concern (IUCN 2021)

Source for literature review: Mannheimer and Curtis (2018)

The Otjikoto-Kombat 66kV route runs westwards from the Otjikoto Substation through a section of Karst Mountains and then turns south-eastwards towards Kombat. The entire route is densely vegetated except for sections cleared by private landowners for grass harvesting purposes (Figures 2-4).



Figure 2. Dense impassable stands of *Dichrostachys cinerea* (sicklebush) and *Terminalia prunioides* (purple-pod Terminalia) dominate large sections of the line.



Figure 3. Lack of a track beneath the line makes passage difficult throughout.



Figure 4. Most of the route is impassable due to dense bush.

3.2 Grass Diversity

It is estimated that up to 111 grasses – 73 to 88 species – (Müller 2007 [88 sp.], Müller 1984 [73 sp.], Van Oudshoorn 2012 [73 sp.]) occur in the general Kombat/Tsumeb area.

The grasses known and/or expected to occur in the general Kombat/Tsumeb area (¹Müller 1984, ²Van Oudtshoorn 2012, and ³Müller 2007) is presented in Table 4 below.

Table 4. Grass diversity known and/or expected to occur in the general Kombat/Tsumeb – i.e. north/central Namibia – area.

Species: Scientific name	Species confirmed	Status	Ecological Status	Grazing Value
^{2,3} <i>Andropogon chinensis</i>			Decreaser	High
¹ <i>Andropogon schinzii</i>			Decreaser	High

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Species: Scientific name	Species confirmed	Status	Ecological Status	Grazing Value
^{1,2,3} <i>Antheaphora pubescens</i>			Decreaser	High
^{1,3} <i>Antheaphora schinzii</i>			?	Low
^{1,2,3} <i>Aristida adscensionis</i>	√		Increaser 2	Low
^{1,2,3} <i>Aristida congesta</i>			Increaser 2	Low
^{2,3} <i>Aristida stipitata</i>			Increaser 2	Low
^{1,3} <i>Aristida effusa</i>			?	Low
^{1,2,3} <i>Aristida meridionalis</i>	√		Increaser 3	Low
^{1,2,3} <i>Aristida rhiniochloa</i>			Increaser 2	Low
^{1,3} <i>Aristida stipitata</i>	√		Increaser 2	Low
³ <i>Aristida stipoides</i>			?	Low
^{1,2,3} <i>Brachiaria deflexa</i>			Increaser 2	Average
² <i>Brachiaria eruciformis</i>			Increaser 2	Average
^{1,2} <i>Bothriochloa radicans</i>			Increaser 2	Low
³ <i>Brachiaria malacodes</i>			Increaser 2	Low
^{1,2} <i>Brachiaria marlothii</i>			Increaser 2	Low
^{1,2,3} <i>Brachiaria nigropedata</i>			Decreaser	High
¹ <i>Brachiaria poaeoides</i>			?	Average
^{1,2,3} <i>Cenchrus ciliaris</i>	√		Decreaser	High
² <i>Centropodia glauca</i>			Decreaser	High
^{1,2,3} <i>Chloris virgata</i>			Increaser 2	Average
^{1,2,3} <i>Cymbopogon caesius</i>	√		Increaser 1	Low
² <i>Cymbopogon plurinodis</i>			Increaser 1	Low
^{1,3} <i>Cymbopogon pospischilii</i>			Increaser 1	Low
^{1,2,3} <i>Cynodon dactylon</i>	√		Increaser 2	High
^{1,2,3} <i>Dactyloctenium aegyptium</i>			Increaser 2	Average
^{1,3} <i>Danthoniopsis ramosa</i>			?	Average
^{2,3} <i>Dichanthium annulatum</i>			Decreaser	High
¹ <i>Dichanthium papillosum</i>			Decreaser	High
^{1,2,3} <i>Digitaria eriantha</i>			Decreaser	High
^{2,3} <i>Digitaria velutina</i>			Increaser 2	Low
² <i>Diplachne fusca</i>			Decreaser	High
^{1,2,3} <i>Echinochloa holubii</i>			Increaser 2	Average
² <i>Eleusine coracana</i>			Increaser 2	Low
^{1,2,3} <i>Elionurus muticus</i>			Increaser 3	Low
^{1,2,3} <i>Enneapogon cenchroides</i>	√		Increaser 2	Average
^{1,2,3} <i>Enneapogon desvauxii</i>			Intermediate	Average
³ <i>Enneapogon scaber</i>			?	Low
^{1,2,3} <i>Enneapogon scoparius</i>			Increaser 3	Low
^{1,3} <i>Entoplocamia aristulata</i>			?	Average
^{1,3} <i>Eragrostis annulata</i>			?	Low
^{2,3} <i>Eragrostis bicolor</i>			?	Low
^{1,2,3} <i>Eragrostis biflora</i>			Increaser 2	Low
² <i>Eragrostis cilianensis</i>			Increaser 2	Low
² <i>Eragrostis curvula</i>			Increaser 2	High
^{1,3} <i>Eragrostis cylindriflora</i>	√		Increaser 2	Low
³ <i>Eragrostis dinteri</i>			Increaser 2	Average
^{1,2,3} <i>Eragrostis echinochloidea</i>			Increaser 2	Average
² <i>Eragrostis gummiflua</i>			Increaser 2	Low
^{1,2,3} <i>Eragrostis lehmanniana</i>			Increaser 2	Average
^{1,2,3} <i>Eragrostis nindensis</i>	√		Increaser 2	Average
^{1,3} <i>Eragrostis omahekensis</i>		Endemic	Increaser 2	Low
^{1,3} <i>Eragrostis porosa</i>			Increaser 2	Low
^{1,2,3} <i>Eragrostis rigidior</i>			Increaser 2	Average
^{1,2,3} <i>Eragrostis rotifer</i>			?	Average
^{1,3} <i>Eragrostis scopelophila</i>		Endemic	Decreaser	Average

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Species: Scientific name	Species confirmed	Status	Ecological Status	Grazing Value
^{1,2,3} <i>Eragrostis superba</i>			Increaser 2	Average
^{1,2,3} <i>Eragrostis trichophora</i>	√		Increaser 2	Average
¹ <i>Eragrostis truncata</i>			?	Average
^{2,3} <i>Eragrostis viscosa</i>			Increaser 2	Low
^{1,2,3} <i>Fingerhuthia africana</i>			Decreaser	Average
^{1,2,3} <i>Heteropogon contortus</i>	√		Increaser 2	Average
^{1,2,3} <i>Hyparrhenia hirta</i>			Increaser 1	Average
² <i>Imperata cylindrica</i>			Increaser 1	Low
³ <i>Leptochloa fusca</i>			?	Average
^{1,2,3} <i>Melinis repens</i>			Increaser 2	Low
^{1,2,3} <i>Microchloa caffra</i>			Increaser 2	Low
^{1,3} <i>Monelytrum leuderitzianum</i>			?	Low
³ <i>Odysea paucinervis</i>			?	Low
^{2,3} <i>Oropetium capense</i>			Increaser 2	Low
^{1,2,3} <i>Panicum coloratum</i>			Decreaser	High
^{1,3} <i>Panicum lanipes</i>			?	High
^{1,2,3} <i>Panicum maximum</i>			Decreaser	High
³ <i>Panicum novemnerve</i>			?	Low
³ <i>Panicum repens</i>			Decreaser	High
^{1,3} <i>Panicum stapfianum</i>			Decreaser	High
^{1,3} <i>Pennisetum foermeranum</i>		Endemic	?	Low
^{1,3} <i>Pogonarthria fleckii</i>			Increaser 2	Low
^{1,2,3} <i>Pogonarthria squarrosa</i>			Increaser 2	Low
^{2,3} <i>Schizachyrium sanguineum</i>			Increaser 1	Low
^{1,2,3} <i>Schmidtia kalahariensis</i>			Increaser 2	Low
^{1,2,3} <i>Schmidtia pappophoroides</i>			Decreaser	High
^{1,3} <i>Setaria finita</i>		Endemic	?	Low
² <i>Setaria incrassata</i>			Decreaser	High
² <i>Setaria pallide-fusca</i>			Increaser 2	Average
^{1,2,3} <i>Setaria verticillata</i>			Increaser 2	Average
³ <i>Sorghum bicolor</i>			?	High
^{2,3} <i>Sporobolus festivus</i>			Increaser 2	Low
^{1,2,3} <i>Sporobolus fimbriatus</i>			Decreaser	High
^{1,2,3} <i>Sporobolus ioclados</i>			Increaser 2	Average
² <i>Sporobolus pyramidalis</i>			Increaser 2	Low
^{1,2} <i>Stipagrostis ciliata</i>			Decreaser	High
^{1,2,3} <i>Stipagrostis hirtigluma</i>			Increaser 2	Low
^{1,3} <i>Stipagrostis hochstetteriana</i>			Decreaser	High
^{1,2,3} <i>Stipagrostis namaquensis</i>			?	Average
^{1,2,3} <i>Stipagrostis obtusa</i>			Decreaser	High
^{1,2,3} <i>Stipagrostis uniplumis</i>	√		Increaser 2	Average
^{1,2} <i>Themeda triandra</i>			Decreaser	High
^{2,3} <i>Tragus berteronianus</i>			Increaser 2	Low
³ <i>Tragus racemosus</i>			Increaser 2	Low
^{1,2,3} <i>Tricholaena monachne</i>			Increaser 2	Average
² <i>Trichoneura grandiglumis</i>			Increaser 2	Low
¹ <i>Triraphis purpurea</i>			Increaser 1	Low
^{1,3} <i>Triraphis ramosissima</i>			?	High
¹ <i>Urochloa bolbodes</i>			Decreaser	High
³ <i>Urochloa brachyura</i>			?	Average
^{2,3} <i>Urochloa oligotricha</i>			Decreaser	High
^{2,3} <i>Urochloa panicoides</i>			Increaser 2	High
³ <i>Urochloa trichopus</i>			?	Low
³ <i>Willkommia sarmentosa</i>			?	High

Endemic – Müller (2007)

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

Up to 111 grasses are expected in the general Kombat/Tsumeb area of which 4 species are viewed as endemic (*Eragrostis omahekensis*, *Eragrostis scopelophila*, *Pennisetum foermeranum* and *Setaria finite*). *Pennisetum foermeranum* is associated with rocky mountainous terrain and consequently only expected in such suitable habitat. *Eragrostis omahekensis* is virtually only found on disturbed soils – e.g. close to watering points – while *Eragrostis scopelophila* is associated with mountainous areas under trees and shrubs. The endemic *Setaria finite* is associated with drainage lines in the general area; never very common and probably the grass species most likely to be affected most by development in the area.

Only 12 species of grass were observed along the route with various *Aristida* and *Eragrostis* species dominant throughout.

None of the grasses mentioned in Table 4 are exclusively associated with the general area and quite variable and associated with local rainfall events.

3.3 Important Species

Trees/shrubs

The most important tree/shrub species occurring in the general area are *Cyphostemma juttae* (end, F, NC), *Erythrina decora* (Forestry, endemic) and *Pachypodium lealii* (end; F; NC; N-end). The species protected by the Nature Conservation Ordinance No. 4 of 1975 and the Forest Act No. 12 of 2001 in the general area – i.e. *Aloe litoralis* (Windhoek aloe), *Combretum imberbe* (lead wood), *Euphorbia avasmontana* (slender candelabra Euphorbia) and *Moringa ovalifolia* (phantom tree) – are also viewed as important. *Eriospermum lavranosii*, *Decorsea dinteri* (rare) and *Ceropegia mafekingensis* (near threatened), listed by Loots (2005), are probably the most important species potentially occurring along the route (See Figures 5-6; Tables 1-3).

The Red Data species known/expected to occur in the general Kombat/Tsumeb area (See Table 3, Loots 2005) are all viewed as important, however none of these species are exclusively associated with the Otjikoto-Kombat 66kV.

Other

Aloes

Aloes are protected throughout Namibia with 3 aloe species not included in Table 2, but which potentially occur in the general area, and also viewed as important are *Aloe dinteri*, *A. hereroensis* and *A. zebrina* (Rothmann 2004). *Aloe* species are often illegally collected by unscrupulous collectors which could potentially affect their survival, especially species with limited range and unique habitat features – e.g. *A. dinteri*.

Commiphora

Many endemic *Commiphora* species are found throughout Namibia (Steyn 2003) with other *Commiphora* species known/expected to occur in the general area include *Commiphora crenato-serrata*. Furthermore, some species are also known to have an economic potential – i.e. resin properties of *C. wildii* used in the perfume industry (Nott and Curtis 2006) – which makes them an important group of plants.

Euphorbias

At least 47 species of *Euphorbia* occur throughout Namibia of which 4 species are listed as rare, 1 endangered, 1 vulnerable and 1 near threatened (Möller and Becker 2019). *Euphorbia* species known/expected to occur in the general Kombat/Tsumeb area include at

least 8 species (*Euphorbia avasmontana*, *E. espinosa*, *E. otavimontana*, *E. guerichiana*, *E. lignosa*, *E. monteiroi*, *E. transvaalensis*, *E. trichadenia*). Möller and Becker (2019) view *E. otavimontana* as endangered, but this is not included in the IUCN (2021) Red Data listings.

Ferns

At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general area include at least 30 indigenous species (*Actiniopteris radiata*, *Adiantum capillus-veneris*, *A. incisum*, *Asplenium cordatum*, *Blechnum australe*, *Cheilanthes dinteri*, *C. eckloniana*, *C. involuta*, *C. marlothii*, *C. multifida*, *C. pentagona*, *C. viridis*, *Christella chaseana*, *Doryopteris concolor*, *Marsilea aegyptiaca*, *M. ephippiocarpa*, *M. farinosa*, *M. marcocarpa*, *M. nubica*, *M. unicornis*, *M. vera*, *Microlepia speluncae*, *Ophioglossum polyphyllum*, *O. reticulatum*, *O. sandieae*, *Pellaea calomelanos*, *P. dura*, *P. pectiniformis*, *Pteris vittata*, *Thelypteris confluens*) with no endemics known/expected (Crouch *et al.* 2011). The general area is undercollected with more species probably occurring in the general area than presented above.

Lichens

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

Lithops

Lithops species – all protected (See Nature Conservation Ordinance No. 4 of 1975) – are also known to occur in the general area and often difficult to observe, especially during the dry season when their aboveground structures wither. However, no Lithop species are known/expected from the area with the closest known species being – *Lithops pseudotruncatella* subsp. *pseudotruncatella* var. *elisabethiae* – southeast of Otjiwarongo (Cole and Cole 2005, Earle and Round n.d.).

Other

Other species with commercial potential that could occur in the general area include *Harpagophytum procumbens* (Devil's claw) – harvested for medicinal purposes and often over-exploited – and *Citrullus lanatus* (Tsamme melon) which potentially has a huge economic benefit (Mendelsohn *et al.* 2002). Devils' Claw and Tsamma Melons are usually associated with sandy soils throughout their range.

Although the focus during this literature survey was on the more visible trees, shrubs, grasses and more important other species potentially occurring in the general Kombat/Tsumeb area, many more species occur throughout the area and are viewed as important.

Invasive aliens

Invasive alien species observed along the route included *Flaveria bidentis* (smelter's bush), *Lantana camara* (lantana) and *Ricinus communis* (castor oil plant) – all associated with disturbed areas – e.g. cleared sections along road verge, Kombat Mine area, etc. (Figures 7-9).

The general Otjikoto-Kombat 66kV transmission line route, have certain anthropomorphic influences mainly associated with the farming activities, tracks and roads, railway line, transmission line and associated access route and infrastructures with none of the “other plant species” expected to be exclusively associated with the proposed route. The impact of line inspections and general maintenance activities would be site specific and have a relatively small environmental “footprint” and is not expected to have a major impact on any of the “other plant species” should these occur on site. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on all flora – including “other plant species” – potentially occurring in the area.



Figure 5. *Acacia erioloba* (camel thorn) – Protected F; LC – is widespread throughout Namibia although less frequently observed in the general Kombat/Tsumeb area.



Figure 6. *Sclerocarya birrea* (marula) – Protected F – are important fruit trees throughout the area.



Figure 7. The invasive alien *Flaveria bidentis* (smelter's bush) were encountered in open disturbed areas along the route.



Figure 8. The invasive alien *Lantana camara* (lantana) was only observed at the Kombat Mine area.



Figure 9. The invasive alien *Ricinus communis* (castor oil plant) was observed at disturbed areas and the Kombat Mine area.

3.4 Important Areas

Important areas and species – i.e. “Hotspot” areas – are indicated in Table 5 as measured in km sections – odometer readings – from the Otjikoto Substation to the Kombat Substation. The presentation of route sections below is as it was travelled during the fieldwork component also indicating the direction of travel. This section was mostly surveyed along tracks and roads adjacent and/or in the general vicinity of the transmission line as there is no service track below the line and access impossible due to bush thickening and lack of maintenance over the years. Parts of this route also go over/through the Karst Mountains in the area without access routes.

Otjikoto Substation to Kombat Substation

The Otjikoto-Kombat route runs westwards, through a section of Karst Mountains, and then turns south-eastwards, going through another section of Karst Mountains, towards the Kombat Substation in the vicinity of the Kombat Mine.

The route is heavily vegetated with most of the route beneath the line totally covered in bush and dominated by *Dichrostachys cinerea* (sicklebush) and *Terminalia prunioides* (purple-pod Terminalia) trees/shrubs.

The route passes through 2 “hotspot” areas classified as “high” sensitivity (See Table 5; See Figures 10-11). The areas of “high” sensitivity are viewed as the well vegetated Karst Mountain areas (i.e. areas with high biodiversity).

The Otjikoto-Kombat section is 70.8km in length of which 31.2km (i.e. 44.1% of the route) is viewed as “high” sensitivity while 39.6km (55.9%) is viewed as “low” sensitivity.

The “high” sensitivity area – especially the well vegetated Karst Mountain areas – should be viewed as important with no unnecessary offroad driving during line inspections and/or general maintenance activities – i.e. maintain track discipline.



Figure 10. Karst Mountains along the route are viewed as a sensitive habitat (“high”). Unique and protected species are associated with this habitat in Namibia.



Figure 11. The Karst Mountains are well vegetated with numerous protected and unique species.

Table 5. Areas of importance, with protected species potentially affected, along the Otjikoto-Kombat 66kV transmission line.
[Direction: Otjikoto Substation west- and south-eastwards towards the Kombat area]

Hotspot areas	Distance (km)	Area	Important species	Common names	Status	Aliens	Other important features	Importance ranking
1	0 to 14.0	Otjikoto SS area	<i>Sclerocarya birrea</i>	marula	F			Low
	14.0 to 26.0	Otjikoto SS area	<i>Sclerocarya birrea</i>	marula	F		Karst mountains	High
2	26.0 to 45.7	Tsumeb area						Low
	45.7 to 64.9	Kombat area	<i>Sclerocarya birrea</i>	marula	F		Karst mountains	High
	64.9 to 70.8	Kombat SS area						Low

Distance: 70.8km

Importance ranking: High and Low

Status: End = Endemic spp.

F: Forest Act No. 12 of 2001

LC: Least Concern (IUCN 2021)

NT: Near threatened (Loots 2005)

4 Practical mitigation measures to prevent potential site disturbances

All development have potential negative environmental consequences, but identifying the most important flora species including high risk habitats beforehand, coupled with environmentally acceptable mitigating factors, lessens the overall impact of such development. Although the focus during this literature survey and rapid ecology/flora assessment was on the more visible trees and shrubs potentially and actually occurring in the general area – especially along the pylon route – many more species – e.g. herbs, succulents, etc. – occur throughout the area and are viewed as important.

For the entire route, especially the “high” and “medium” sensitivity areas – the following is recommended:

- Maintain track discipline – i.e. no offroad driving allowed;
- Stick to the existing, albeit rudimentary, tracks;
- Use pre-determined turn around points;
- Ensure that drip trays are available for heavy vehicles when conducting maintenance activities in case of transmission fluid spills;
- Remove all equipment from sites after maintenance activities;
- Do not litter along the route;
- Do not collect, damage, remove any plants when exiting vehicles for transmission pole inspections, etc.;
- Document/record any invasive alien plants encountered along route;
- Document/record any new plant species encountered – i.e. out of the ordinary or not previously observed; and
- Report any people in area other than NamPower staff to MEFT.

The rationale is as follows:

- The route falls partially within the Karst Mountains which is a unique vegetation type;
- Biodiversity is viewed as particularly unique in the Karst rocky areas;
- Karst areas potentially have numerous unique vertebrate fauna susceptible to disturbances;
- Collection of plants is not only illegal but could encourage trade in valuable species with dire consequences to our natural heritage;
- Invasive alien plants pose a threat to indigenous flora and habitats;
- Domestic stock and/or pets could cause serious damage to the local fauna and flora (Relevant to Protected Areas only);
- Litter would detract from the overall uniqueness of the area and encourage further littering; and
- NamPower has an environmental responsibility to such a unique habitat.

Good practices mentioned above are recommended, as the Karst areas in Namibia are unique, etc. and non-conformances are harmful to the environment.

This route would have to be cleared of bush under the line and maintained thereafter, or else maintenance and monitoring along this route would be impossible due to the current dense bush cover preventing accessing this line.

5 Monitoring Indicators, Guidelines and Checklist

The following general monitoring indicators and guidelines are recommended for line inspections and general maintenance activities along the Otjikoto-Kombat 66kV transmission line:

- Monitor track discipline
 - After each line inspection and/or general maintenance activities along the route, an overall assessment of tracks along the transmission line route should be conducted – i.e. an increase of tracks or remain stable;
 - Any evidence of offroad driving and unauthorised turnaround points used;
 - Any evidence of transmission fluid spills;
 - Any evidence of NamPower staff and/or contractor related waste; and
 - Any evidence of litter.
- Monitor illegal collection/damage of flora
 - Any signs of illegal plant collections – i.e. evidence of flora removed;
 - Any signs of vehicle damage to flora; and
 - Any unauthorised people/vehicles encountered along the route.
- Monitor erosion
 - Any signs of erosion along track used; and
 - Signs of recovery at rehabilitated sites.
- Monitor invasive alien plants
 - Any signs of invasive alien plants along track used - New;
 - Any signs of invasive alien plants along track used - Existing; and
 - Signs of re-infestation at rehabilitated sites.
- Monitor new plants encountered
 - Any new plants observed – i.e. out of the ordinary or not previously observed.
- Monitor domestic stock/pets encountered
 - Any domestic stock and/or pets observed (Relevant to Protected Areas only).
- Monitor bird mortalities
 - Any dead birds located below the line should be recorded.

The following monitoring checklist to ensure that NamPower line inspections and general maintenance activities are conducted in accordance with guidelines – i.e. ecological best practices – could be used:

Table 6. Monitoring checklist to ensure that line inspections and general maintenance activities were conducted in accordance with guidelines – i.e. ecological best practices.

Activity: Protection of Ecology & Vegetation – Otjikoto-Kombat	Compliance	
	Yes	No
Track discipline		
Evidence of new tracks		
Evidence of offroad driving		

Evidence of turnaround violations		
Evidence of oil spills		
Evidence of waste		
Evidence of litter		
Illegal collection/damage of flora		
Evidence of illegal plant collection		
Evidence of vehicle damage to plants		
Evidence of unauthorised people/vehicles		
Erosion		
Evidence of erosion along route		
Evidence of recovery at rehabilitated sites		
Invasive alien plants		
Evidence of invasive alien plants along route - New		
Evidence of invasive alien plants along route - Existing		
Evidence of invasive alien plants at rehabilitated sites		
New species		
Any new plants encountered – i.e. not previously observed		
Domestic stock/pets		
Domestic stock and/or pets encountered along route (Relevant to Protected Areas only)		
Bird mortalities		
Record all dead birds encountered below the line		

6 Potential impacts:

The following impacts of the transmission line on fauna, flora, sensitive and protected areas were identified and assessed:

6.1 Introduction

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

6.2 Impacts – Methods

The operation of the NamPower transmission line would result in various impacts on the vertebrate fauna and flora and can be placed into three categories:

Direct Impacts: These are directly as a result of the construction of the transmission line and include general habitat destruction and the destruction of species of conservation concern.

Indirect Impacts: These are not directly associated with the transmission line, but potentially affect species of conservation concern recorded within the general area and include impacts as a result of changes in the hydrology, etc. and affect species rather on a population level.

Cumulative Impacts: These are impacts that the transmission line will have from a broad area perspective by considering land-use and transformation of natural habitat in areas surrounding the site (i.e. considering past, present and anticipated changes to biodiversity).

Mitigation measures are not always straightforward and/or easy to implement, but should be based on the following steps as mitigation hierarchy:

Step 1: Avoid/prevent loss to biodiversity and ecosystem services: The project location, layout and phasing should avoid negative impacts on biodiversity. Areas of high biodiversity should be identified prior to development activities to avoid negative impacts;

Step 2: Minimise impacts on biodiversity and ecosystem services: The project location, layout, and phasing should minimise the negative impacts on biodiversity;

Step 3: Rehabilitation – concurrently, progressively and on cessation of the activity: Rehabilitation should attempt to return the affected area(s) to pre-development natural state; and

Step 4: Offset significant residual negative impacts on biodiversity or ecosystem services: This refers to the compensation for the remaining and unavoidable negative impacts on biodiversity.

Assessment Criteria

The environmental impacts are assessed with and without mitigation measures and the results are presented in impact tables summarising the assessment. Mitigation and management actions are recommended in an attempt to enhance positive impacts and minimising negative impacts.

The following risk assessment was used to determine the significance of impacts.

Significance = (Magnitude + Duration + Scale) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts are rated as high, medium or low significance on the following basis:

High environmental significance = 60-100 points

Medium environmental significance = 30-59 points

Low environmental significance = 0-29 points

Magnitude (M)

[Description & Numerical value]

Very high = 10

High = 8

Moderate = 6

Low = 4

Minor = 2

Duration (D)

[Description & Numerical value]

Permanent = 5
Long-term (ceases at end of operation) = 4
Medium-term = 3
Short-term = 2
Immediate = 1

Scale (S)

[Description & Numerical value]

International = 5
National = 4
Regional = 3
Local = 2
Site = 1
None = 0

Probability (P)

[Description & Numerical value]

Definite (or unknown) = 5
High = 4
Medium = 3
Low = 2
Improbable = 1
None = 0

The following criteria against which these activities are assessed are presented below.

Nature of the Impact

This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Scale of the Impact

A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, national or international scale.

Duration of the Impact

This provides an indication of whether the lifespan of the impact would be immediate, short term (0-5 years), medium term (6-15 years), long term (cesses at end of operational phase) or permanent.

Probability of Occurrence

This describes the probability of the impact actually occurring. This is rated as none, improbable (low likelihood), low, medium, high and definite.

Significance

This describes the degree of significance for the predicted impact based on the available information and level of knowledge and expertise – i.e. High, Medium and Low.

6.3 Assessment: Operational Phase

The impacts that the transmission line and operation of the line may have on the vertebrate fauna and flora recorded throughout the general area were based on a comprehensive literature review and rapid field assessment.

Possible impacts and their sources that this transmission line is likely to have on the biodiversity and ecology (vertebrate fauna and flora) are provided for the operational phase (Table 7).

Table 7. Impacts expected to occur during the Operational Phase.

Impact - Description	Impact - Source	Affected Area
Destruction of vegetation, especially protected tree/shrub spp.	Maintenance clearing of servitudes – e.g. mechanical, manual, arborocides – and vehicle movement	Servitude area
Destruction of vertebrate fauna, especially protected spp.	Maintenance clearing of servitudes – e.g. mechanical, manual, arborocides – and vehicle movement	Servitude area
Destruction of avifauna, especially protected spp.	Overhead transmission lines	Servitude area
Destruction of sensitive habitats	Maintenance clearing of servitudes – e.g. mechanical, manual, arborocides – and vehicle movement	Servitude area
Soil erosion issues	Maintenance clearing of servitudes – e.g. mechanical, manual, arborocides – and vehicle movement	Servitude and surrounding areas
Introduction & spread of invasive alien plant spp.	Vehicle movement	Servitude and surrounding areas

6.4 Impacts: Operational Phase

The following impact tables describe the impacts that are expected to occur during the operational phase and provide practical mitigation measures:

Operational Phase:

1. Destruction of vegetation, especially protected spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Local (2)	Permanent (5)	Very high (10)	Definate (5)	High (85)	Definate
With Mitigations	Site (1)	Long term (4)	Low (4)	High (4)	Medium (36)	High

Description of Impact: Maintenance clearing of servitude operations along the servitude would result in the destruction of vegetation (i.e. especially protected species in Karst areas).

Mitigation Measures:

- Do not destroy, damage, collect any protected flora species that may be encountered during maintenance clearing of servitude operations;
- Minimise activity in Karst areas (See Table 5);
- Only remove/prune flora directly affecting the transmission line;
- No chemical and mechanical clearing in Karst areas – rather manual clearing in rocky areas;
- Mechanical clearing, with chemical aftercare, in non-Karst areas;
- No offroad driving; and
- Maintain and enforce track discipline.

2. Destruction of vertebrate fauna, especially protected spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Local (2)	Permanent (5)	Very high (10)	Definate (5)	High (85)	Definate
With Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High

Description of Impact: Maintenance clearing of servitude operations, including vehicle movement along the servitude would result in the destruction of vertebrate fauna (i.e. especially slow moving species).

Mitigation Measures:

- Do not kill, harm, harass, collect any vertebrate fauna that may be encountered during maintenance clearing of servitude operations;
- Install electrostatic animal and/or squirrel guards on the bushings at substations and on-pole-mounted switching gear to prevent some mammals – e.g. small-spotted genet, mongoose – that may be attracted to these structures from causing problems (only if problems experienced);
- No offroad driving; and
- Maintain and enforce track discipline.

3. Destruction of avifauna, especially protected spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	National (4)	Long term (4)	High (8)	High (4)	High (64)	High
With Mitigations	Site (1)	Short term (2)	Low (4)	Low (2)	Low (14)	Low

Description of Impact: Overhead transmission lines would result in bird mortalities through collision and electrocution (i.e. especially transmission line sensitive bird species).

Mitigation Measures:

- Identify potential bird collision prone areas (i.e. habitats);
- Identify potential transmission line sensitive bird species;
- Add bird flight diverters (BFD's) and anti-perching devices (APD's) to the transmission line at/along collision prone habitats; and
- Monitor all bird mortalities encountered under the transmission line.

4. Destruction of sensitive habitats

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Regional (3)	Permanent (5)	Very high (10)	Definite (5)	High (90)	Definite
With Mitigations	Site (1)	Long term (4)	Low (4)	High (4)	Low (24)	High

Description of Impact: Maintenance clearing of servitude operations along the servitude would result in the destruction of sensitive habitats (i.e. unique areas and associated vertebrate fauna/flora species, especially Karst areas).

Mitigation Measures:

- Minimise activity in Karst areas (See Table 5);
- Maintain connectivity of habitats, especially linking the sensitive areas (i.e. rocky areas, and drainage lines);
- Only remove/prune flora directly affecting the transmission line;
- No chemical and mechanical clearing in Karst areas – rather manual clearing in rocky areas;
- Mechanical clearing, with chemical aftercare, in non-Karst areas;
- No offroad driving; and
- Maintain and enforce track discipline.

5. Soil erosion issues

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High
With Mitigations	Site (1)	Short term (2)	Minor (2)	Low (2)	Low (10)	High

Description of Impact: Maintenance clearing of servitude operations along the servitude including vehicle movement along the access route under the transmission line would result in erosion issues if not continuously maintained (i.e. especially in Karst areas).

Mitigation Measures:

- Implement and maintain erosion control measures where applicable along the access route – i.e. use the same tracks, cross drainage lines at right angles, no direct routes up steep slopes, etc.;
- Rehabilitate eroded areas annually – i.e. after rainfall events (scarce and periodic in this area); and

- Maintain track discipline – i.e. no offroad driving; speed control; use the same track, etc.

6. Introduction & spread of invasive alien plant spp.

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without Mitigations	Site (1)	Long term (4)	Moderate (6)	High (4)	Medium (44)	High
With Mitigations	Site (1)	Short term (2)	Minor (2)	Low (2)	Low (10)	High

Description of Impact: Invasive alien plant species would become established on disturbed areas and could also inadvertently continuously be transported into the area as seed on the various vehicles accessing the mining site.

Mitigation Measures:

- Remove and destroy all invasive alien plants encountered along the transmission line route; and
- Ensure that vehicles accessing the project area are free of vegetation, especially if contractors are used which also use their vehicles in urban areas.

6.5 Impacts: Avifauna

Avifauna is the group of vertebrate fauna most likely to be affected by overhead transmission lines during the operational phase:

Pylon sensitive species

The effect of aboveground transmission line infrastructure is expected to be detrimental to certain birds – e.g. “pylon sensitive species” (“Pylon sensitive species” is a term used by Scott and Scott n.d. and includes bird species potentially affected by pylons and transmission lines).

Pylon sensitive bird species known/expected to occur in the general area (See Scott and Scott n.d.) include:

- African fish-eagle;
- bateleur;
- dwarf bittern;
- blue crane;
- crowned crane;
- great white pelican;
- greater flamingo;
- kori bustard;
- lappet-faced vulture;
- lesser flamingo;
- maccoa duck;
- marabou stork;
- martial eagle;
- peregrine falcon;
- saddle-billed stork;
- southern ground hornbill;
- tawny eagle;
- wattled crane;

- white-backed vulture; and
- white-headed vulture.

Other potential transmission line issues related to birds would be species that typically nest on such structures.

Nest induced faulting caused by birds (See Scott and Scott n.d.) includes:

- Cape crow;
- pied crow;
- sociable weaver;
- red-billed buffalo-weaver;
- various eagles;
- various herons; and
- various vultures.

Transmission line – Impact 66kV

Bird streamer (faecal matter) problems usually occur on 66kV lines at night when the presence of large bird species perching on pylons (e.g. vultures, herons, eagles, storks, etc.) could cause flashovers as their faecal streamers are large enough to cause flashovers by bridging the air gap on 66kV structures (Van Rooyen 2003).

Birds expected to be negatively affected (i.e. collision and/or electrocution) by transmission lines include (See Van Rooyen 2003):

- Birds flying at pylon height – e.g. bustards, swifts, sandgrouse, ravens, raptors and aquatic and marine species.
- Birds with nocturnal transients – e.g. Palearctic migrants and wetland birds (i.e. coastal area).
- Birds following certain geological and/or landscape features (e.g. rivers; mountain ranges, etc.) whilst foraging and/or migrating – e.g. aquatic/marine species and raptors.
- Birds attracted to the area during rainfall events – e.g. bustards – and temporary water sources in ephemeral rivers/drainage lines – e.g. aquatic/marine species.

Factors influencing collision risk

The following factors influence the collision risk for birds (See: Van Rooyen 2003):

- Voltage levels – i.e. there is correlation between the physical size of a bird and the risk of collision;
- Body size and flight behaviour – i.e. birds with a heavy body size and small wing surface are more prone to collisions;
- Flight height and habitat use – i.e. birds that fly short distances at low altitude where there is an increased frequency of overhead structures have increased levels of collision with these structures;
- Age (i.e. young birds are more prone to collisions);
- Resident versus migratory birds (i.e. birds that move into unfamiliar terrain have increased risk of collisions);
- Weather (i.e. inclement weather increases collisions);
- Time of day (i.e. nocturnal movement increases collisions);
- Land use (i.e. cultivated areas attract birds with increased risk of collisions); and

- Topography (i.e. birds following mountains/rivers/shorelines, which act as corridors, have increased risk of collisions with structures placed in these areas).

Bird flyways

Although very little is known regarding bird flight paths in Namibia, especially species moving/migrating at night, most birds seem to follow the shortest routes between selected habitats – e.g. dams, estuaries, bays, etc. However, unpredictable rainfall events may lure species into areas not normally frequented and storms (e.g. berg winds) may also force birds into areas not regularly visited. Planning for all eventualities is therefore not always possible.

Avifauna is expected to be potentially affected by any new (and existing) overhead transmission line(s) in the area – i.e. expected to be detrimental to certain birds – e.g. “pylon sensitive” species.

Species potentially affected by overhead transmission line(s) and at greatest risk would be those larger species flying at pylon height (e.g. bustards, eagles, vultures); nocturnal travellers (e.g. flamingos and Palearctic species) and species potentially visiting the area for roosting/foraging, etc. (e.g. bustards).

Although very little is known regarding the actual flight paths used by the birds frequenting the general area, Figure 12 indicate documented bird mortalities caused by transmission lines in Namibia.

As the general area is a known bird mortality “hotspot” with numerous pylon sensitive bird species frequenting the Karst areas, anti-perching devices should be placed on all new pylons and anti-collision mechanisms – BFD’s such as coils, flappers, etc. – should be attached to all new transmission line(s) as well as along unique/sensitive habitats (See Table 5).

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