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ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED AUAS – OTJIKOTO – LIFA 400 kV TRANSMISSION LINE

VOLUME 1: ROUTE EVALUATION & SCOPING REPORT

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LIST OF ABBREVIATIONS

EA	Environmental Assessment (In other countries this is usually called an Environmental Impact Assessment)
EMF	Electromagnetic Field
EMP	Environmental Management Plan
I&APs	Interested & Affected Parties (stakeholders)
kV	Kilovolts (1 kilovolt = 1000 volts)
MET	Ministry of Environment and Tourism
NBC	Namibian Broadcasting Corporation
PPP	Public Participation Programme (a component of the EA study)
SADF	South African Defence Force (prior to Namibian independence)

1 INTRODUCTION

1.1 The Project Proposal

1.1.1 Overview of the power line route

NamPower proposes to construct a 400kV power line from Windhoek to Ruacana via Tsumeb as part of a wider plan to meet the need for growth in power demand and supply in Namibia and the greater SADC Region.

The power line route is shown in **Figure 1**. The proposed route starts at the **Auas** substation (east of Windhoek) and proceeds northwards to **Gerus** substation (west of Otjiwarongo). From there it runs north-eastwards to the **Otjikoto** substation (near Tsumeb), then to Oshivelo. From a point north of Oshivelo it runs west-north-westwards to meet the B1 tar road west of Outapi. It proceeds westwards from Outapi to **Lifa** (near Ruacana) where a new substation will be built. A link to the substation at **Ongwediva** is also planned.

Mapping of the proposed route and alternatives was undertaken at a scale of 1: 250 000. Various aspects of the environment were mapped at that scale. A set of these topographic maps in colour is available with Eco.plan or NamPower. For the purposes of presentation in this report, however, these maps have been reduced in detail and scale to 1: 550 000 in black and white only. Both the 1: 250 000 and the 1: 550 000 are numbered from south to north as **Figures 2a - 2h**. The alternative (preferred) routes are also shown on those maps.

The alignment that is currently proposed represents the outcome of specialist studies on vegetation and birds, input from the public participation programme, and consideration of a variety of constraints upon power line construction – both physical and socio-economic constraints. One of the main considerations affecting the route alignment is the need to link the existing sub-stations (see **bold** type above). This is necessary in order to provide control over voltage fluctuations.

Co-ordinates of all bend points for the original proposed route, and the preferred alternative sections, are contained in **Appendix A**

1.1.2 The need for the proposed power line

The need for the power line arises out of NamPower's planning process to meet the future power demand needs in Namibia. The hydro power station at Ruacana generates about half of Namibia's power, while the rest is currently imported from South Africa. The growing demand in South Africa is expected to use up their surplus power generation capacity around the year 2007. Therefore Namibia is looking to alternative power sources. It is expected that the proposed Kudu Gas power station at Oranjemund will be operational around 2009. Kudu Gas will supply sufficient power for Namibia's needs for 20 years or more with spare capacity to export some of its power. The Kudu Gas power station will be suitable for generating the base load requirements, while Ruacana (like most hydro power stations) is able to vary its power output rapidly and is therefore very suitable to supply peak demand periods (e.g. early evening is a peak demand period).

For various reasons, NamPower intends to construct at least three major new power lines in the next 2 to 5 years. These include one from Kudu Gas (near Oranjemund) to Obib (near

Rosh Pinah). Another line will connect Katima Mulilo to the national grid (via Rundu and Tsumeb) because Katima was previously linked only to the hydro power plant at Livingstone in Zambia. The third major new line will link Auas – Otjikoto – Lifa. The reasons for these developments are: -

- To provide the necessary bulk transmission infrastructure to transport power from the new and existing sources of generation to areas where it is needed,
- To allow for the import and export of power in the most cost-efficient manner,
- A link to the proposed Inga Hydro Power Station on the Congo River is envisaged at some future date,
- Increased supply capacity to Angola is also envisaged,
- To strengthen the Namibian national power grid, and ensure stability of supply to areas of consumption,
- To meet the need for economic growth, particularly in the north of the country where a high percentage of the country's people live.

Areas around Tsumeb and further north are seen as growth areas in Namibia and the power demand there is expected to increase substantially over the next decade or two. If the proposed hydro power station near Popa Falls / Divundu is developed, this will also be linked in to the national grid via the proposed power line from Otjikoto, via Rundu, to Katima Mulilo.

These proposed new high voltage transmission lines are therefore intended for bulk distribution of power. They will **not** supply power directly to the communities through which they are routed because the voltage is too high for reticulation to individual consumers. The cost of sub-stations to transform this power to usable voltages is very high. Indirectly, however, by strengthening the national grid, it will be possible for utility companies (like Nored) to be supplied with power for distribution to consumers.

1.1.3 Description of the power line and related infrastructure

The exact voltage of the proposed power line has not yet been decided by NamPower, but the maximum would be 400kV. Eco.plan has therefore based this Environmental Assessment on the assumption that the line will be built with a capacity of 400kV – i.e. the worst case scenario (a lower voltage line requires shorter towers and narrower servitude). However, the line may be operated at a lower voltage in the short to medium term.

For technical and economic reasons it is necessary for high voltage power lines to be constructed in straight lines as far as possible.

The proposed towers will be approximately 40m high. The construction design preferred by NamPower is the **cross rope suspension tower**, which is shown in **Photo 1**. This design minimises the amount of steel used and is therefore most cost-effective. In some circumstances, **self-supporting suspension towers** are used in conjunction with cross rope suspension towers. Self-supporting structures have four legs as shown in **Photo 2**. They are normally used together with cross rope suspension towers – refer to **Photo 3**. A third type of tower is required at all bend points, namely a **straining tower**. This also has four legs and looks very similar to the self-supporting suspension tower, but the conductors are not suspended – in fact the tower is used to put the conductors in tension.

The new sub-station at Lifa will be similar in appearance to others such as the one at Auas. An aerial view of the Auas sub-station is shown on the **cover** of this report.

For a 400kV power line, a servitude of 55m wide is required. The servitude will be registered as an un-surveyed servitude prior to construction. Within that 55m servitude no buildings will

be permitted. However cultivation of crops or grazing of livestock can continue. A narrow strip of about 12 metres wide within that servitude will be cleared of trees and tall bushes before construction commences. This will be done only directly under the conductors – in order to reduce the risk of flash-overs between the power line and trees, and to protect the power line from fire. Veld fires increase the risk of flash-overs and power line failure due to ionisation processes in the air and smoke.

An access track of 4 - 5m wide is normally cleared within the servitude for vehicular access for construction and maintenance. Such tracks will be limited to a single route. Only bush and trees will need to be cleared from the tracks, while grass can remain. Where possible, existing public roads will be used to minimise the need for the creation of new tracks. Private farm roads will not normally be used.

The first 150 km (approximately) northwards from Auas will be a double servitude (2 x 55m wide) to allow for a possible future line, although only one line will be constructed at this stage.

1.2 Approach & Methodology

The purpose of this Scoping Report is stated as follows: -

- To present the project proposal,
- To record the process and results of the Public Participation Programme,
- To record the issues and concerns of Interested & Affected parties,
- To provide an opportunity for specialist input at an early stage in the planning process,
- To incorporate all the above considerations in determining the best alignment - to satisfy technical, economic and environmental requirements as far as possible,
- To determine the scope of the issues to be considered in the Environmental Assessment of the final route.

Since the best opportunity to avoid or minimise environmental impacts is at the route planning stage, a high priority has been given to determining the most environmentally acceptable route. However, this has to be achieved within the economic constraints. The construction of a 400kV power line costs approximately N$ 1 million / km (July 2004).

This Scoping Report presents the results of the first phase of the planning process for consideration by the public and the authorities.

NamPower originally proposed an alignment that was presented on maps at a scale of 1: 250,000. This alignment was based on the need to link certain sub-stations as explained above.

The proposed alignment was then critically assessed by Eco.plan by means of: -

- Making and analysing maps of vegetation, soils, distribution of settlements, road networks, and other infrastructure.
- Input from specialists – in regard to vegetation and birds.
- A helicopter flight along the proposed route, and certain route alternatives.
- Oblique aerial photos and video made from the helicopter.
- Consultations with Interested & Affected Parties, including landowners and Regional Councils, and responses to concerns that were expressed.

The outcome of this process is recorded in this Scoping Report, and the preferred route is shown in **Figures 2a – 2h**. In places where settlements are more closely spaced (in the north), the route is shown with a corridor on either side of the proposed alignment (red-hatching). This is to allow for flexibility to adjust the alignment in order to avoid houses and kraals when the route is surveyed in detail.

At the end of the Scoping Phase, the route corridor will be basically fixed. The second phase of the study – the Environmental Assessment - will then be confined to that corridor. However, minor adjustments can be made in the second phase when the route is examined in more detail with reference to more detailed mapping at a scale of 1: 50,000 and inspections on the ground.

Thus the study will be conducted in three phases: -

Phase 1: Route Evaluation / Scoping

- Mapping at 1: 250,0000
- Scoping Report

Phase 2: Environmental Assessment of Preferred Route

- Mapping at 1: 50,000
- Ground studies in selected areas that may be environmentally sensitive
- EA Report

Phase 3: Environmental Management Plan

- An EMP for Construction will address the impacts during the construction phase by means of a set of Environmental Specifications, which will be included in Contract Documents and enforced on site.

1.3 The Structure of this Scoping Report

Chapter 2 contains an account of the Public Participation Programme that was undertaken and the results thereof. It also indicates further opportunities for public input to the environmental management process.

Chapter 3 provides a brief description of the environments that are affected by the project.

Chapter 4 provides an explanation of the technical, economic and environmental constraints on the construction of the power line. The potential environmental impacts of the project are then explained and assessed at an appropriate level of detail – particularly in relation to the power line route. Possible mitigation measures are suggested in the case of certain types of impacts.

Chapter 5 provides a discussion on specific sections of the route where the alignment may need to be changed, or where changes have been requested.

Chapter 6 concludes the report and highlights the route that is seen as the best compromise between environmental issues on the one hand, and technical and economic constraints on the other hand.

2 THE PUBLIC PARTICIPATION PROGRAMME (PPP)

2.1 Description of the PPP Activities

A comprehensive Public Participation Programme (PPP) was carried out at an early stage in the Environmental Assessment process in order that the concerns of interested parties, authorities, and the wider public could be established. The main purposes of the PPP were to: -

- introduce the project proposal,
- explain the PPP and Environmental Assessment (EA) processes,
- hear and record public issues and concerns,
- provide opportunities for public input and gathering of local knowledge.

Once the concerns of Interested & Affected Parties (I&APs) had been established, the study aimed to address these concerns in the environmental assessment process, together with issues raised by the environmental specialist team.

The following activities were carried out as part of the PPP: -

1. The project was advertised in the Namibian press - The Namibian (18th & 22nd June 2004), The Republikein (18th June 2004), and the Allgemeine Zeitung (18th June 2004). These advertisements invited people to attend the public meetings, and to register as Interested & Affected Parties (I&APs).

2. The public meetings were also advertised on NBC Radio, Radio Kudu and Radio 99.

3. An interview was given on the German Service of NBC Radio to inform the farming community, and the general public, about this project.

4. Known individuals and groups / organisations who may be interested or affected, were also contacted by letter, fax or email to draw attention to the project and the EA study.

5. The farm numbers for all farms within 5km of the proposed power line alignment were determined. Then the names and contact details of the owners of those farms were obtained. A letter and map of the relevant section (at a scale of 1: 250,000) was then sent to every farm owner. The letter invited them to attend the public meetings that also had been advertised in the press. It also invited them to write and express any concerns that they may have.

6. Letters were also sent to various authorities in Namibia, providing them with an opportunity to express their views or concerns (eg. the Roads Authority, the Airports Company, and MET)

7. All those who contacted Eco.plan, or who attended meetings, were registered as I&APs so that they could be kept informed about the progress of the project.

8. Public meetings were held to introduce the project, and to hear and record public concerns. A small-scale map was handed out at all the meetings. Contact details were also provided for written responses. These meetings took place as follows: -

    - Okahandja: Okahandja Lodge, 05 July 2004.
    - Otjiwarongo, Out of Africa Town Lodge, 05 July 2004.

- Tsumeb, Minen Hotel, 06 July 2004.
- Oshakati, Oshakati Country Lodge, 07 July 2004.
- Outapi, Multi-purpose Youth Resource Centre, 08 July 2004.
- Windhoek, Scientific Society, 20 July 2004.

9. Separate meetings were held with members of the Regional Councils of the Khomas, Otjozondjupa, Oshikoto, Oshana and Omusati regions. An information letter was also sent to the Kunene Regional Council in Opuwo, but they did not require a meeting.

10. Minutes of the public & regional council meetings were circulated to those who attended, and to any other parties who had registered as I&APs. A Summary of Issues & Concerns is contained in **Section 4.2** below. In the meetings and the minutes, I&APs were also invited to send written submissions if they wished to do so.

11. Several written submissions were received from farm owners, and one from a conservation group.

12. Following the public meetings and those with Regional Councils, it was apparent that affected people in Communal Areas had not been reached effectively. This issue was discussed in the relevant Regional Council Meetings, and it was agreed that the Councillors of Oshikoto, Oshana, and Omusati would assist in reaching the people in their constituencies along the power line route. Therefore, a short information letter and a map (showing the preferred northern alignment through those three regions) was sent to all the above-mentioned Regional Councils, and the Otjozondjupa and Khomas Councils.

13. In response to a few representations by farm owners and interest groups in the commercial farming areas, some meetings were held with individual farmers or their representatives. Eco.plan also communicated with some of the affected parties via telephone, email or post. In the case of farms in the Otjiwarongo area (Utreght to Gerus) a further letter and map was sent out by fax and post. This showed a possible alternative alignment closer to Otjiwarongo. The reason was to move the alignment further away from the proposed vulture “restaurant” on farm **Okatjemunde**.

Supporting documents on the Public Participation Process are contained in the Appendices as follows: -

- Advertisements in the press - **Appendix B**
- Letters and notifications to I&APs (including authorities) – **Appendix C**
- Presentations to public meetings & Regional Councils – **Appendix D**
- Minutes and attendance lists for meetings – **Appendix E**
- Written submissions from I&APs - **Appendix F**
- List of all registered I&APs – **Appendix G**

The results of the public participation programme are contained in the following section.

2.2 Results of the Public Participation Programme: Issues & Concerns Raised

2.2.1 Overview of the PPP

In this section, the outcomes of the Public Participation Programme are presented. This section serves as a record of issues and concerns that were raised by I&APs. **It must be emphasised that the issues and concerns are presented as participants raised them.** The issues raised are numbered 1 – 36 in Sections 2.2.2 – 2.2.4. **After each issue a**

response is given in *italics*. Some of the issues are dealt with in this Scoping Report, while others require more detailed investigation and will be dealt with in the next phase of the study - the Environmental Assessment and/or the Environmental Management Plan (EMP).

The public meetings in Windhoek, Okahandja and Otjiwarongo were attended mainly by farm owners. Attendance figures were fairly low, but it was apparent from the number of telephone calls from farmers that the notices had reached the target group. Attendance figures were even lower in Oshakati. In Outapi nobody arrived for the meeting. The target group in those towns was the affected people living in communal areas. As mentioned in Section 4.1 above, this problem was addressed by involving the Regional Councillors. A good understanding of the kinds of issues facing the communal residents was provided by the meetings with the Regional Councils.

The purpose of presenting the issues raised by participants in this section is simply to: -

- ensure transparency regarding the concerns that have been expressed, and
- provide a list of issues that need to be considered during the Environmental Assessment.

Issues that were raised by specialists are also included in the following summary of issues and concerns. For convenience, the issues and concerns have been divided into bio-physical issues, socio-economic issues, and issues relating to the planning process. This distinction is somewhat arbitrary and a degree of overlap between these categories is acknowledged.

2.2.2 Issues & Concerns: Bio-physical

1. Fatalities to large birds, affecting three groups of birds: -

    - Large birds such as flamingos, pelicans, cranes, herons, secretary birds etc. which fly between the Etosha Pans and the Oponono Pans to the north would have been at high risk from the route that was originally proposed,
    - The endangered Cape Vulture in the Otjiwarongo / Waterberg area is being fed by the Rare & Endangered Species Trust (REST) are in the process of establishing a "vulture restaurant" on the farm **Okatjemunde** near the original proposed alignment southwest of Otjiwarongo.
    - Birds such as bustards move over wide areas but not along defined routes, and these have been recorded as fatalities due to collisions and electrocutions with power lines.

    Response: The first two bullets above were addressed mainly by recommending changes to the alignment - refer to Sections 4.2.1 and 4.2.2 of this Scoping Report. In the case of the third bullet, relating to birds whose movements to not relate to a specific flight corridor or landing area, the problem is more difficult. Further details regarding powerline structures other mitigation measure measures will need to be considered in the EA report.

2. Clearing of vegetation, particularly large old trees in the servitude, e.g. Camel thorn trees, and in the north - Baobabs, Marula and other fruit trees.

    Response: The final alignment will "fine-tuned" to minimise the need to remove large trees, particularly protected species.

3. The potential impacts of buffalo weavers and other birds nesting on the towers was queried.

   Response: The nests of buffalo weavers in towers can become a problem for NamPower, and may have to be removed from time to time. Removal should be done during the non-breeding season. However, this is not an endangered species and its distribution is widespread.

4. Creation of new access tracks causing damage to vegetation, and possibly soil erosion.

   Response: These impacts can be addressed through alignment of the access track, and anti-erosion berms. These can be addressed in the EMP.

5. Veld fires and resulting loss of habitat due to large birds being electrocuted, and falling burning into the veld.

   Response: The question of appropriate alignment to minimise bird strikes is dealt with in Sections 4.2.1 and 4.2.2. Matters of design of structures and bird flappers will need to be addressed in the EA and EMP.

2.2.3 Issues & Concerns: Socio-economic

6. Concern was expressed about potential poaching of game on private farms during construction. Setting of snares was also possible. The power line servitude could also create access to parts of farms that were not previously accessible to outsiders. Farmers wanted to know whether compensation would be paid if they suffered stock or game losses as a result of poaching.

   Response: Access will be controlled by installing lockable gates. The question of compensation, if any, will need to be addressed in the EMP

7. Loss of game if game fences are removed during construction, and claims for compensation.

   *Response: Fences will **not** be removed. Gates will be installed by the Contractor and kept locked.*

8. Would NamPower take responsibility for the maintenance of private roads used for construction and maintenance? Many of these private roads are not designed for heavy vehicles and may be seriously damaged as a result of construction traffic. For example, a private road exists through the Ovipuka Conservancy that was built at the cost of the conservancy.

   Response: The Contractor should not use any private roads except by prior agreement. This must be specified in the EMP.

9. Gates and fences on private farms, during construction, will need to be removed and replaced at NamPower's cost.

   Response: Refer to 7 & 8 above.

10. Potential increase in veld fires, resulting in a loss of grazing land.

Response: Potential fires caused by Contractors will be addressed in the EMP. Refer also to 5 above.

11. Visual impacts affecting tourism potential - mainly with respect to privately owned farmland, e.g. game and hunting farms.

    Response: This is addressed mainly through alignment, where practical. Refer to Section 4.2.4.

12. Mess left by construction contractors or maintenance teams.

    Response: To be addressed in the EMP.

13. Compensation may be requested from farmers for visual impacts as some contend that this leads to a decrease in the value of a farm.

    Response: There is no precedent for compensation due to visual impacts. It would be very difficult to establish whether, and to what degree land values had been affected, if at all.

14. Generally, farmers preferred the routing of the power line along existing tarred roads rather than through remote (unspoiled) areas to preserve the more scenic settings for generating income through tourism.

    Response: Routing near to existing infrastructure (where possible) also minimises impacts on the bio-physical environment.

15. Loss of part of some of the mahangu fields for the foundations of towers.

    Response: An effort will be made to avoid Mahangu fields when placing the towers. But compensation may be requested in places if lost productivity results.

16. It was a concern, particularly in the northern communal areas, that people living along the power line route would derive no benefits from it. It was queried whether more transformer stations could be built to supply the local populations. Regional Councils in the north considered it important that the new line should benefit people who live near the line in some way, otherwise they may resent the power line being there. It was requested by Regional Councils that NamPower / Nored should look to funding agencies to help with rural electrification.

    Response: It will not be possible to supply local communities directly from the new power line. However, the needs of communities for power have been brought to NamPower's attention.

17. A question was raised about opportunities for local labour in the construction of the power line so that there was at least some benefit to the community.

    Response: Construction requires mostly skilled labour, but a very small number of unskilled labourers may be sourced from local communities.

18. Some people wanted to know whether there were any potential impacts on human health caused by the electromagnetic field around power lines.

    Response: Refer to Section 4.3.3.

19. One or two farmers alleged that some cows had become infertile when kept in camps under power lines.

    Response: Refer to Section 4.3.3.

20. People wanted to know if the power line would pass over houses, plantations, dams etc.

    Response: It will not pass over houses (some may need to be removed). Dams and plantations will be avoided where possible.

21. If houses were relocated, would there be compensation?

    Response: Yes, owners will be compensated.

22. What was the minimum distance allowable between a house and power line?

    Response: In the case of a 400kV line, the minimum distance from a house would be 27.5m (i.e. half the servitude width of 55m).

23. Could the new power line interfere with the operation of existing infrastructure, e.g. telephone lines, existing power lines etc?

    Response: Only if the line runs both close to and parallel with another powerline, telephone line or railway line for some distance (say, 15km or more).

24. Could local farmers be supplied with electricity by means of secondary induction?

    Response: This is not a practical option as it tends to cause failures on the transmission line (J Bekker, pers comm).

25. Concern about the price of electricity as a result of further power line construction.

    Response: The electricity price is controlled by the Electricity Control Board. The price is also determined for the country as a whole, so there is no direct impact on consumers in a particular area.

2.2.4 Issues & Concerns: the Planning Process in General

26. Concern was expressed whether the public really would have any influence on the power line route.

    Response: This Scoping Report shows evidence of public input influencing the planning process.

27. A preference was expressed for a routing along the B1 highway northwards (Windhoek – Okahandja) instead of through farms.

    Response: Topographic constraints prevented major alternative alignments from Auas to the latitude of Okahandja.

28. In general it was considered better for the line to run close to existing power lines and/or existing roads rather than following a completely new route - i.e. an alignment along already disturbed routes is better than affecting unspoilt areas.

Response: Where is has been feasible without greatly increasing the costs, this approach has been followed by Eco.plan in recommending alternative alignments.

29. Requests were received to follow the farm boundaries instead of passing through the middle of farms. This has the added benefit that there are cut-lines along fences, so there is less destruction of vegetation required. Other requests were made for adjusting the alignment – mainly minor adjustments that would make them more acceptable to landowners.

    Response: Where possible without greatly increasing the costs, this has been recommended (e.g. from point A – B). However, the need for the powerline to be constructed in straight lines is a significant constraint.

30. A need to check conditions on the ground was emphasised when determining the alignment - to establish that conditions are suitable.

    Response: Ground checks will be carried out in sensitive areas as part of the EA.

31. Need to contact the people on the ground in rural areas, as these people can't get to public meetings. The Oshikoto Regional Council suggested another meeting in Onankali to speak to the Councillors of the relevant constituencies.

    Response: A second letter and map was sent to the Council with a request for Councillors to speak to their constituencies.

32. Try to avoid game camps.

    Response: The need for the power line to follow straight lines is a significant constraint in this regard.

33. Need for a contact person in NamPower if there are any complaints arising during construction.

    Response: To be addressed in the EMP.

34. Impacts of the power line on the Hosea Kutako and other airport and landing strips were queried.

    Response: Safe distances to be confirmed by the Airports Company.

35. Concern for a good supply of information during the planning and construction process.

    Response: This has been addressed at this Scoping phase and will need to be addressed in the EMP for the Construction phase.

36. Consideration for archaeological sites was requested in the planning process.

    Response: Archaeological field investigations have been carried out by J.Kinahan. Sample sections of the route were selected based on the likelihood of archaeological sites occurring, e.g. watercourses and certain geological strata.

Evaluation of many of the issues raised above is dealt with in Chapters 4 and 5, particularly with regard to alternative routes.

2.3 Further opportunities for public & authority input

This Scoping Report will be made available for comment from the public and authorities. Written submissions can be made to Eco.plan in response to the Scoping Report if people believe that their issues and concerns have not been captured in this report.

The next stage of planing will be to examine the route at a scale of 1: 50,000 and undertake ground-truthing where necessary.

The Environmental Assessment will then be conducted on the final route. The EA Report will also be made available to the public for their information.

3 DESCRIPTION OF THE PROJECT ENVIRONMENTS

3.1 Introduction and General

In this Chapter 3, descriptions of the affected environments are provided at a level of detail that is appropriate to the potential impacts of the project on those environments. This chapter draws on specialist input – particularly relating to vegetation types and birds – in so far as these two environmental aspects have an influence on the power line alignment. It also draws on published material, the findings from the helicopter trip, and input from the public participation programme.

Throughout this section, reference is made to the route markers A, B, C...Q,R,S on the route maps (**Figures 2a – 2h**).

Photos of the route sections are provided at the back of this volume. Photos 4 – 28 are referenced to the maps sheets (Figures 2a – 2h).

3.2 Auas – Otjikoto

3.2.1 Climate

The climate has no influence on the routing of the power line, but for the sake of completeness the following climatic information is provided.

Temperatures increase from south to north along the power line route. This is true for both minimum and maximum temperatures. This is due to the effects of latitude and lower altitude as the route progresses northwards. Average minimum temperatures in the south near Windhoek are 2 – 4 °C, while in the north of the route near Tsumeb the average minimum increases to about 6 °C. Frost occurs on average 10 – 20 nights per year near Windhoek, and less than 5 nights per year near Tsumeb. The coldest month is normally July. Average maximum temperatures are 30 - 32 °C near Windhoek, increasing to 32 – 34 °C near Tsumeb. The hottest month is normally December.

Annual rainfall is extremely variable and unreliable throughout the country. This has implications for the rehabilitation of any areas that are disturbed during construction because rain cannot be relied on to ensure rapid regrowth of vegetation. Mean annual rainfall ranges from approximately 400 mm near Windhoek, increasing northwards to 550mm near Tsumeb.

Between Windhoek and Tsumeb, wind direction is highly variable and there is no prevailing wind direction, although an easterly component is slightly more frequent than from any other direction. Wind speeds are generally lowest at night and early mornings, reaching a maximum around 14h00 in the afternoons. Average wind speeds are generally moderate. The mean maximum wind speeds are highest in summer when they average approximately 15 km/hour at 14h00 in the afternoon.

3.2.2 Geology, Topography and Soils

Sheet 2216 Windhoek (Figure 2a)

In the south, the power line route traverses the **Khomas Hochland Plateau**, an area comprised mainly of schists as far north as Okahandja. Soils in this area are generally shallow and gravely, being derived from the underlying schist, with its quartzitic veins. These soils have poor water retention properties and support only low densities of livestock and wildlife. The power line route follows fairly flat terrain, passing through a gap in the otherwise mountainous terrain south of Midgard. This gap provides the only viable route from Auas substation to the north.

Sheets 2116 Okahandja & 2016 Otjiwarongo (Figures 2b-c)

North of the latitude of Okahandja to Otjiwarongo beyond, the route traverses the very flat terrain of the Central Western Plains and Kalahari Sandveld. Here the soils are relatively deep – being derived either from wind blown Kalahari sand or recent deposits of fine sand that has been deposited by water. These soils are therefore sandy, well drained, and generally low in clay material.

The route crosses the Omatako River upstream from the Omatako Dam.

Sheets 1916 Tsumeb (Figures 2d)

From Otavi to Tsumeb and some distance to the north, the route traverses the Karstveld, where the underlying dolomite and limestone has a major influence on the terrain and soil types, except where it is overlain by deep Kalahari Sands. Shallow calcrete horizons are common in places – most notably north-west of Tsumeb where these calcretes are used for road making materials. Between Otavi and Tsumeb, the route passes through two narrow gaps between dolomite hills - these being the only topographic constraints on the alignment in this area. The combination of dolomite rock outcrops, Kalahari sands and calcrete horizons gives rise to a wide variety of soil and moisture conditions. This variety is reflected in the diversity of vegetation types – as further detailed in the following sub-section.

3.2.3 Vegetation

The information on the vegetation along the power line route was obtained from two existing vegetation maps, a helicopter trip and video of the route, a review of the video by a botanist (B. Strobach) and his personal knowledge of the affected areas.

From Windhoek to Otavi the information was based mainly on maps by Giess (1988). From Otavi to Ruacana more specific maps are available from Mendelsohn *et al* (2000).

From these sources of information it was possible to narrow the field of study for the EA to follow. Thus a more detailed investigation of the vegetation in the Karstveld sections of the route is recommended during the EA. The highland rocky areas in the south of the route may also be worth a brief visit on the ground to identify any potentially sensitive areas of the vegetation.

From Auas to Otjikoto, the power line will pass through three major vegetation types: -

- Highland Savanna,
- Thornbush savanna, and
- part of the Karstveld (vegetation types sensu Giess 1998).

Along the Auas to Otjikoto route, the power line will have little impact on the vegetation, the potential impacts are limited to: -

- Clearing of a 4 – 5m wide access track within the servitude, where trees and bush need to be cleared,
- Trimming of tall vegetation (trees and bush) within a 12m wide strip is necessary in places in order to achieve a clearance of at least 8.1m under the conductors. Grass and small plants will not be cleared but may be damaged by construction activities.
- Injudicious clearing of the access road could potentially lead to increased erosion.
- Veld fires have been reported when birds get electrocuted on the power line, and fall burning into the vegetation.

A few areas have, however been identified for closer inspection in the next phase of planning. These are detailed below.

Auas substation to Swakop River Valley (Figure 2a)

The vegetation of the eastern Highland Savanna north of the Auas substation is not well known. Although the area is flatter than the Khomas Hochland, it still consists of a rolling landscape. Most of the area is covered by thorn bushes, often moderately to densely encroached. The Highland savannas are known for their erodible soils, thus care needs to be taken with the access track (refer to **Section 4.2.3**) On even moderately steep slopes, the track should cross the contours at an acute angle and should meander. The construction of mitre berms across the road will also reduce the erosive effect of run-off. In the area around Neudamm – Frauenstein (even further north) numerous omiramba (shallow, wide water courses) exist. These watercourses, in their natural condition, do not display any sign of a river bed or gully erosion, but rather form a wide alluvial basin. These are extremely erodible (due to the nature of the sediments filling the basin). Therefore extra care should be taken with these omiramba. As the omiramba are generally covered by a grass layer with few or no trees, these areas should preferably be avoided, and should certainly not be cleared.

In the open areas amongst the thorn bushes and small thorn trees are a few protected evergreen species such as the Shepherds tree / Witgat (*Boscia albitrunca*). This protected tree is, however common and widespread in the area.

The Highland Savannah is known for its diversity. The areas of greatest interest for vegetation are rocky outcrops. Here clumps of Euphorbias occur on rocky outcrops. An example of this type of habitat is the escarpment going into the Swakop river valley (i.e. on the south side of the valley). Here rocky outcrops should be avoided as far as possible in the final route planning. This will also be the steepest part of the route, necessitating special care with the planning of the access route.

Swakop River Valley (Figure 2a-b)

In the Swakop valley at Midgard and surroundings, expansive Camelthorn savannas are found on the alluvial soils. Care should be taken to destroy as little as possible of these majestic old trees.

Swakop River Valley to Gerus (including the Omatako River Valley) (Figure 2b-c)

The Thornbush savanna starts north of the Swakop river valley, extending to the north of Gerus - about halfway between Otjiwarongo and Otavi. One sensitive feature of this area is the catchment area of the Omatako Omuramba. This is formed by expansive erosion plains between the Omatako and Etjo mountains, and funnels into the Omatako river before it enters the Omatako dam. The water course is lined with large trees such as Camelthorns (*Acacia erioloba)*, and large Buffalo thorn (*Ziziphus mucronata*), and Karee (*Rhus lancea*) specimens. The proposed route alignment is well chosen, as it crosses this band of forest vegetation at the narrowest point, and it also avoids the Omatako Erosion plains.

Generally in the Thornbush Savannah care should be taken to avoid destruction of the limited numbers of large trees found – as far as possible. These include numerous patches of Camelthorns that are found on more sandy soils. An effort must be made avoid these patches as far as possible when the alignment is "fine-tuned" during the EA stage. Omiramba and vlei systems are also widespread, yet not as sensitive due to the relatively flat slopes.

From Otavi area - to Otjikoto substation (Figure 2c-d)

Northwards from Otavi to the Angolan border, detailed vegetation and soil maps are available from the Environmental Profile of the Central North of Namibia (Mendelsohn et al, 2000). This survey offers a more specific characterisation of the vegetation than is available for the area from Windhoek to Otavi.

The Karstveld is characterised by dense bush and tree habitats, and much of it is heavily bush-encroached, particularly on the plains where it is characterised by *Terminalia prunioides / Combretum apiculatum* woodland. However there are also patches of large trees. These include certain potentially threatened trees, such as Leadwood (*Combretum imberbe*) and Tamboti (*Spirostachys africana*). Little is known of the vegetation of the Karstveld with regard to the under-storey layer. However, the power line will pass around the dolomite hills rather than over them. For Karstveld a more intensive study is needed during the EA phase, especially regarding the undergrowth.

3.2.4 Animals & Birds

The Auas – Otjikoto section of the power line route crosses mainly grazing lands on private or company owned farms. The most important livestock is beef cattle. Many farms also support significant numbers of wild game animals, with or without game fences. Some of these farms form part of registered commercial conservancies (refer **Figure 2a-d**). During a helicopter flight over the area, the following animals were seen – kudu, eland, warthog, red hartebeest, springbok, oryx, and cheetah. Evidence of smaller burrowing animals, such as ground squirrels or mongooses, was also found. Warthog burrows were also evident in sandy banks / stabilised dunes.

However, no study of the **terrestrial fauna** has been conducted for this EA for the following reasons: -

- Firstly, there is no reason for concern about impacts of the power line on terrestrial animals. During construction larger animals will simply move out of the way. A few burrows (e.g. of warthog or ground squirrels) may be destroyed, but the affected animals will simply move and dig new burrows.
- Secondly, most animals that have restricted habitats occur on rocky hills or "koppies". However, the route has been designed to avoid such hills in order to minimise the costs of construction and the environmental impacts. For these reasons, there would be no significant impact on terrestrial animals, and no further study is necessary.

Some species of **birds**, however, are highly susceptible to collisions and electrocutions from power lines. Between Auas and Otjikoto, only two areas have been identified as being of particular concern with regard to birds: -

- The Rare and Endangered Species Trust (REST) is in the process of establishing a vulture feeding site on the farm **Okatjemunde** near Otjiwarongo. This is for the purpose of conserving the rare and highly endangered Cape Vultures, which nest in the Waterberg.
- Further south there are several nests of White-backed vultures in trees in the vicinity of the farms Doornkom, Apostle and Miershoop.

Because the power line has the potential for serious negative impacts on a number of species of large birds, and route selection is the most effective way to mitigate the impacts on large birds, this issue is dealt with in detail in Section 4.2.1 below.

3.2.5 Environmentally sensitive areas from Auas to Otjikoto

The following areas should be regarded as potentially environmentally sensitive and should be looked at in more detail during the EA: -

- Any **hilly areas with rock outcrops** that fall within the power line servitude. In Namibia hilly / rocky areas often support plant communities that are relatively rare or have limited distributions, and for this reason should be considered potentially sensitive. Hilly / rocky areas occur in the south of the route occur from from Neudamm Agricultural College for about 55 km northwards, and also in the Otavi – Tsumeb area.
- **Stands of "special" trees** occur at **river crossings** (e.g. Swakop River and Omatako River). These are likely to include protected species such as Camelthorn and Ana Trees. On sandy, low lying areas dense stands of Camelthorn occur in places, while Tamboti, or Leadwood occur further north towards Otavi and Tsumeb.

Where sensitive plant communities occur some minor adjustments may be desirable to avoid or minimise impacts on sensitive vegetation.

Sensitive areas in regard to birds are dealt with in Section 4.2.1 below.

3.2.6 Archaeological sites

Dr John Kinahan undertook preliminary investigations to establish whether any significant archaeological sites may be affected by the proposed power line alignment. His approach was first to identify likely areas of interest from the 1: 250,000 maps – based on prior knowledge of the geology and environmental conditions likely to have attracted people to

particular locations during pre-historic times. This was followed by investigations on the ground at selected localities.

Kinahan, (pers comm) indicated that "in general, the (proposed) alignment is not problematic from an archaeological point of view" and that archaeological issues are unlikely to influence the alignment of the power line. For this reason archaeological sites have been considered only briefly at this Scoping Stage of the study. On the colour 1: 250,000 topographic maps (Figures 2a-h) the areas that were sampled are marked with a purple or orange highlighter. Those in purple did not reveal any significant archaeological material. However those marked in orange may be significant, and should be further considered in the next planning stage.

The numbers in the subheadings below are the 1: 250,000 topographic map numbers. The names in **bold** are the names of farms that have been investigated.

Sheet 2216 Windhoek (Figure 2a)

The following localities were sampled by fieldwalking: -

- On the farms **Otjozonjati** and **Okamuvia**, the graben of the upper Swakop River were investigated. Isolated outcrops of Khomas schist associated with the Matchless amphibolites occur here. The area contains a low density of open station archaeological sites dating to within the last 1000 years. None of the sites observed were significant. However, it is possible that pre-colonial copper working sites are located within the alignment. Open-file records at the National Museum of Namibia list a number of finds of copper smelting tuyeres from the two farms mentioned above.

Sheet 2116 Okahandja (Figure 2b)

Portions of the following farms were sampled by fieldwalking – these are listed from south to north: -

- **Agagia**,
- **Schwabenhof**,
- **Okamaja**,
- **Evero**,
- **Welgevonden**,
- Particular attention was paid to the crossing of the Omuramba Omatako (Evero). All the above were examined and found to be of low archaeological significance.

Sheet 2016 Otjiwarongo (Figure 2c)

The following localities were sampled by fieldwalking: -

- During the present sampling exercise the potentially fossiliferous exposures of the Omingonde Formation (Joumbira) were examined, in the north-east end of Omboroko Mountain (farm **Joumbira**). These yielded nothing of archaeological or paleontological interest.
- The **Okanjande-Highlands-Tweekoppies** group of farms has been intensively surveyed in the past (J.Kinahan, pers comm). That survey showed a very low concentration of archaeological sites but yielded some important examples of late pre-colonial settlement remains.

- Parts of the farm **Wittenberg**, south-east of Okaruso Mine were also investigated and did not yield any archaeological findings.

Sheet 1916 Tsumeb (Figure 2d)

The following localities were sampled by fieldwalking. They are listed from south to north following the proposed alignment: -

- Portions of the farms **Marburg** and **Maxwell** on the Aiamsvlakte north and north-east of Otjiwarongo respectively. Most of this area has a low archaeological significance. However, it should be noted that the calcrete pans immediately west of the alignment on the Aiamsvlakte are archaeologically sensitive, so any re-alignment here might be problematic.
- The sand flats on the farm **Gabus** was also found to be of low archaeological significance. However, the escarpment area west of Gabus (farm Uisib) is known to have archaeological sites including rock art, and the isolated kopjes in this area should be avoided wherever possible. For example, one very small outcrop at Ombaranga near Otavi has a highly significant rock art site with archaeological deposit, but this is not on the alignment.
- Isolated quartzite kopjes on the farm **Neuhorst** (now Okapunya) were also of low significance.

3.2.7 Land ownership and use

Land ownership along the entire power line route from Auas to Oshivelo is almost exclusively privately or company owned farms. These farms are used for livestock, mainly beef cattle, game farming and hunting. A few of the farms have lodges for tourism and/or hunting. Almost no cultivation is carried out in the south, with the exception of a few small patches of land for fodder or vegetables under small scale irrigation from farm dams or boreholes. These small operations are carried out for the farmers own use. Somewhat more land is given over to cultivation in the Otavi – Tsumeb area, but most of the land is still used only for grazing of livestock.

Conservancies on commercial farms are shown in a brighter shade of green on the colour 1: 250,000 maps (**Figures 2a-d**). Between Auas and Otjiwarongo there are numerous farms along the proposed route that belong to conservancies. Although these have been taken into account, it has proved practically very difficult to avoid these conservancies without substantially increasing the length of the power line and the associated costs of construction.

3.3 Otjikoto – Lifa

3.3.1 Climate

Moving from Tsumeb towards the northwest, the climate becomes slightly hotter and much drier. The coldest month is still July, but the hottest month occurs earlier as one moves towards the northwest, ranging from November to October. This is due to intense solar heating without the cooling effects of rain, and the effects of subsiding air from the sub-continental high-pressure system.

Average minimum temperatures near Tsumeb are about 6°C, while in the northwest of the route near Ruacana the average minimum increases to about 8°C. Frost is very rare. The coldest month is normally July. Average maximum temperatures are 32 – 34°C near

Tsumeb, increasing to 34 - 36°C near Ruacana, where the hottest month is normally October.

Annual rainfall is lower and more unreliable as one moves towards the northwest. Mean annual rainfall ranges from approximately 550mm near Tsumeb to about 350mm at Ruacana.

Wind data northwest of Ondangwa is not readily available. At Ondangwa winds may blow in any direction, but the easterly wind becomes more frequent. Average wind speeds are similar to those at Tsumeb.

3.3.2 Geology, Topography and Soils

Sheets 1916 Tsumeb, 1816 Namutoni, 1814 Etosha (West) & 1714 Oshakati (Figures 2d-h)

From Tsumeb to Oshivelo the route initially traverses a very flat Karstveld area with conspicuous calcrete horizons near the surface. From the Oshivelo area west-northwestwards the geology is comprised of deep Kalahari Sands all the way to Ruacana. The landscape is very flat. The main topographical influences are the dry watercourse of the Omuramba Owambo, and the oshanas of the Cuvelai drainage basin which drain towards the Etosha Pans. The drainage pattern has been influenced by the orientation of Kalahari dunes in recent geological time. Thus the Cuvelai drainage pattern has a north-west to south-east orientation. Most of the water in the Cuvelai drainage system flows from the higher rainfall areas in southern Angola, with only a small contribution from rainfall in Namibia.

The soils in this northern part of the power line route are strongly influenced by the rainfall and drainage patterns. As the water moves southwards from Angola towards Etosha, it brings with it salts and carbonates in solution, and fills up the shallow pans and “oshanas”. As the water evaporates, its dissolved load is precipitated, so that the salts are accumulated in pans and in the near-surface layers of the soil. This leads to calcrete horizons in the soil, and the pans become increasingly saline towards the south of this drainage system. The high soil salinity in the south has engineering implications for the power line as these conditions cause corrosion of the concrete foundations.

In the south only a limited number of plant species can survive in the saline soil conditions. This gives rise to extensive saline grasslands, which are particularly important for certain species of birds. This will be further explained in the following sections (3.3.3 and 3.3.4).

Northwest of the Oshakati area, the soils benefit from the greater water supply and are more fertile, with high base saturation.

3.3.3 Vegetation

Northwards from Otavi to Ruacana the information below is based upon the vegetation map in A Profile of north-central Namibia by Mendelsohn et al (2000). This information is more specific than Giess (1988) and includes information on soils. A video of the route made from a helicopter was also used in identifying the various vegetation types.

Oshikoto to Oshivelo (Figure 2d-e)

Northwards from Otjikoto, for about half the distance to Oshivelo, the vegetation is *Terminalia prunioides / Combretum apiculatum* woodland on loam and clay soils. Thereafter, the vegetation is mostly dominated by *Terminalia prunioides* woodlands on calcrete as far as Oshivelo. The matrix of vegetation includes Acacia shrublands. These habitats are densely encoached.

Patches of Tambuti (*Spirostachys africana*) are also known from nearby the Omuramba Ovambo, whilst Maroela (*Sclerocarya birrea*) and Leadwood (*Combretum imberbe*) occur in between. Little is known about the undergrowth. It is suggested that the power line should follow the existing power line as closely as possible. Small adjustments will need to be made to avoid damaging big, protected tree species en route.

Just south of Oshivelo the route enters a complex matrix of various types of Mopani savanna, Broad-leafed savannas, the Ekuma grasslands and oshanas.

Oshivelo to Lifa

North of Oshivelo the power line will go through relatively intact broad-leafed savannas. As the SADF cleared a wide strip along the main road for security purposes, it is suggested that this clearing (overgrown as it is already) be used for the power line.

The original route proposed by NamPower was a southerly route from Okashana through the Ekuma grasslands. This would have opened new access routes to these grasslands, which are at present fairly unused and in relatively pristine condition due to the lack of access and the lack of water. With an access route, this situation could change – even if it is only for wood harvesting in the mopane savannas.

However, because of the threat posed by the southern route to large birds, a more northerly alignment was chosen which entirely avoids the saline grasslands. This preferred route bypasses the Ekuma plains to the north thereof, and follows the southern edge of the settlement areas fairly closely. Here the vegetation is fairly disturbed. The route traverses a number of vegetation types (refer **Figure 3**). From south-east to north-west these are: -

- mixed Acacia / Kalahari woodland on deep sands,
- *Terminalia prunioides / T. serecia* woodlands on deep sands (avoiding the grasslands of the Andoni flats to the south),
- Mopane shrubland on sandy loams,
- Palms and pans mosaic on sodic sands (avoiding the Oponono saline grasslands which are important for some large species of birds),
- Oshana – Kalahari mosaic on sodic sands,
- Mopane shrub and low trees on oshanas,
- Cuvelai palms and fruit trees on loamy sands, and
- the Ruacana sand plateau.

The more sensitive elements of the vegetation of some of these habitats are the following. Palm trees (*Hyphaene petersiana*) occur scattered and in clumps along the route, especially south of Ondangwa and Oshakati. Further west, especially between Tsandi and Okahau, a variety of big trees e.g. Maroela (*Sclerocarya birrea*), Bird plum (*Berchemia discolor*) and Boabab (*Adansonia digitata*) occur but are sparcely distributed. In the drier areas along the route, large expanses of Mopane shrubveld are encountered. Although this habitat is of low diversity and is very common, it is a valuable resource to the local people for building and firewood. Therefore clearing should still be limited to the absolute minimum.

In the communal areas the clearing of a any new cut line will create an access route to previously unsettled areas (e.g. parts of the mopane veld). This is a further reason in support of the proposed new alternative alignment, which runs through, or close to, settled areas.

3.3.4 Animals & Birds

Along the original proposed route north of Etosha, the land is relatively uninhabited and is still valuable in terms of nature conservation. However, along the preferred alternative route, from Oshivelo north-westwards, the land is communally occupied. Low density rural settlements are scattered all along the route. The presence of people and the effects of heavy grazing by domestic cattle and goats has resulted in most wildlife not being able to occupy these areas. However a few springbok and oryx are seen in the very sparsely settled saline grassland areas closer to Etosha and Opono Pans. For the same reasons set out in Section 3.2.4 above, no impacts on terrestrial fauna are likely from power line construction and therefore no further study of these animals is required. On the alignment that was originally proposed by NamPower the possible impacts of elephants on the power line towers in the western parts was considered. However, along the alignment that is now proposed, elephants do not occur because of the human settlements there.

The impacts on birds however could be considerable, and this fact necessitated the investigation and establishment of an alternative route to the originally proposed by NamPower.

Large areas of grasslands – classified as the Oponono saline grasslands (refer Figure 3), are extremely important for a number of species of large birds, some of which are rare and endangered. Because a power line would present a serious threat to these birds, this issue is dealt with in detail in Section 4.2.1 below.

3.3.5 Environmentally sensitive areas from Otjikoto to Lifa

Since the preferred route avoids the saline grasslands, the plant communities that are affected on the preferred route from Oshikoto to Lifa are generally not sensitive but further consideration should be given to the following: -

- Any stands of Tamboti, Leadwood or Camelthorns that may occur south of Oshivelo.
- Any individual trees in the northern parts such as Baobab, Marula, *Berchemia discolor*, and clumps of Makalani Palms or any other large trees.

Extensive areas of Mopane trees are **not** ecologically sensitive although they are a useful resource for firewood and building materials.

3.3.6 Archaeological sites

Sheet 1816 Namutoni (Figure 2e)

The following localities were sampled by fieldwalking: Omuntele area south-east of Ondangwa; Tertiary dune area west of Trig point 1101; a pan north-west of Oshivelo; the west bank of Omuthiya River; crossing point on Omuramba Ovambo on the farm Operet; the grassy pans on farm Buffelshoek. Most of this area has a low archaeological significance, but the traditional **well fields** north-west of Oshivelo are significant. There may be more well

fields on this part of the alignment and this can be determined from the orthophoto sheets during the next phase of the study.

Sheet 1714 Oshakati (Figure 2f)

The following localities were sampled by fieldwalking: tillite scarp south of Calueque; sand flats near Omindamba; vicinity of Ombalantu; area north of Tsandi; panveld north of Okahau. Most of this area has a low archaeological significance, with the exception of the area around Ombalantu. Here, **all baobab trees**, especially local concentrations of baobabs should be considered archaeologically and historically significant. It is recommended that detailed 1: 50 000 orthophoto maps should be used to identify these baobabs, as they are generally visible at that scale. Towards Tsandi there are large well features. These are also archaeologically significant. The wells are highly visible on the orthophoto sheets.

3.3.7 Land ownership and use

All the land along the power line route is communal land and plots are allocated to families by the traditional leaders in each area. The land is used mainly for grazing of cattle and goats. Small plots are cultivated for mahangu and maize production on a subsistence basis. This is dry land farming. Only a few small patches of land west of Outapi are irrigated for commercial crop production.

A number of the larger species of trees are used for fruits, fibre, beverages and medicinal products, and for use in crafts. Some of the more important species in this regard are the Marula (*Sclerocarya, birrea*), Baobab (*Adansonia digitata*), Brown ivory tree (*Berchemia discolor*) and the nuts of the Makalani Palm (Hyphaene petersiana). It will therefore be necessary to avoid removing these species as far as possible through careful route alignment.

Mopane trees are common and widespread and are used for construction of dwellings, and for firewood.

The Oshanas are used for fishing when they are seasonally inundated with water, but the power line would have no impact on the fish resources, even if an occasional tower has to be constructed in a pan. However NamPower will try to avoid pans for reasons of access during construction, maintenance of the power line, and corrosion of structures.

In the northern sections of the power line route (northwest of Oshivelo – all the way to Ruacana) the power line route will encounter sparsely distributed settlements. As far as possible, an effort will be made to avoid dwellings and kraals rather than moving them.

Two communal conservancies in the northwest – the Uukwaluudhi and Ruacana conservancies may have been affected (at least visually) by the original route proposed by NamPower. However, the preferred alternative route will have no impact on any of the communal conservancies in the north.

4 POTENTIAL ENVIRONMENTAL ISSUES & MITIGATION

4.1 Environmental constraints on the alignment

The following issues represent constraints upon the development of the proposed power line. These include human structures and natural factors: -

- For technical and economic reasons, high voltage power lines need to be routed in **straight lines** as far as possible. The cross rope suspension towers, which are relatively economical structures, are only suitable for straight sections of the power line. Wherever bends are required, four-legged towers are necessary. These require far more steel and also have a slightly greater visual impact as a result of their heavier construction. At approximately N$ 1 million / km (July 2004 estimate), the costs of construction demand that the shortest possible route is taken.

- **Densely settled areas** have been avoided in determining the alignment of the power line route as the line may not go over dwellings for safety reasons. Dwellings that cannot be avoided will have to be moved short distances (say 50 - 100m) and the owners compensated. Stock kraals also represent a problem of access. Vandalism and theft of materials from installations is also a greater problem for NamPower in areas that are both densely settled and easily accessible by vehicle.

- **Existing infrastructure** (power lines, telephone lines, railways, communication towers, and airfields) can represent constraints. If a power line travels close and parallel to another power line, telephone line, or railway line for more than about 15km a current can be induced in the parallel line (C.Loftie-Eaton pers comm). Power lines are normally separated from other power lines by the width of the servitude associated with the voltage level. Thus a 400kV line must be at least 27.5m (i.e. half the servitude width of 55m) from the edge of a servitude for a neighbouring parallel line. Where power lines must cross roads, other power lines and telephone lines, they should do so at an angle close to 90°. Furthermore, it is not desirable to construct power lines within a road reserve in case of accidental collision by motor vehicles. The risks associated with power lines close to airfields are obvious enough. Communications towers are less of a problem as they are usually associated with hilltops, which the power line normally avoids.

- Due to visual impacts, it is desirable to keep power lines away from **tourist establishments** where possible.

- **Farm dams, and pans** represent an obvious constraint upon the construction of power lines. Such water bodies also attract large birds which are at risk of collision or electrocution form the power line.

- North of Etosha, the **saline soils** cover large areas. This represents an engineering problem as the salts corrode concrete and steel foundations. Larger, stronger foundations therefore have to be designed at greater cost.

- Areas of high environmental sensitivity may include areas of **special vegetation** – which is rare or supports threatened, or unique ecosystems and / or species.

- Most importantly, the power line should avoid intersecting the regular flight paths of **large birds**, which could be killed by the line. This will be further explained in the following section.

4.2 Potential impacts of power lines on the bio-physical environment & mitigation

4.2.1 Fatalities to birds

The greatest potential impact the proposed power line on the bio-physical environment is likely to occur in relation to **large birds**. Collisions and electrocutions of large birds are common all over the world and have seriously endangered the survival of certain species (Ferrer & Janss, ed. 1999). This issue has therefore required detailed assessment at the route selection stage. The assessment (by Dr C. Brown) that follows has focussed on: -

(a) routing of the power line – to minimise impacts of the line on birds, and the impacts of birds on the line and power transmission, and
(b) where problem areas cannot be avoided, ways to mitigate impacts are recommended.

There are a number of impacts involving birds and power lines, the following two being the most common:

- **Collision** - particularly by larger species such as vultures and eagles, grassland species such as cranes, bustards, korhaans and secretary birds, and wetland species such as flamingos, pelicans and other large birds. In some situations collisions can become a serious threat to some species which fly in large flocks, which fly at night, and particularly where power lines cross well-established flight-paths;
- **Electrocution and short circuits** - particularly of large perching species, including raptors, storks and pelicans. With modern tower designs, the risk of electrocution to perching birds and birds stretching their wings on take-off and landing, has been dramatically reduced. Electrocution also poses a risk of power interruptions. Some raptors and crows nest in support towers, as do a few smaller species of the weaver affiliation that build large colonial nests. These nests can sometimes impact on the power supply if they cause “flash-overs” (usually when wet from rainfall) and may ignite, disrupting power supply. Local veld fires can also ignite nests, which may cause damage to equipment. Finally, fish-eating birds (cormorants, pelicans, herons) in particular, roosting above and excreting over insulators, can reduce their insulating properties and cause flash-overs.

Auas to Otjikoto

This section of the line passes through highland, thornveld and karstveld savanna vegetation types. These vegetation types are generally not particularly sensitive from the perspective of the avifaunal assemblages that they support, provided that the line is not routed near high concentrations of vulnerable species, such as near wetlands and vulture colonies. After a new line is constructed there may initially be a somewhat higher incidence of collisions than the normal low level in such habitats, particularly of species such as secretary birds, bustards and korhaans. The resultant level of mortality is not considered to be a threat to the species concerned.

The line passes some 10 km west of the Omakato dam, which is sufficient distance to not anticipate collisions. It is also unlikely to attract perching by fish-eating birds (pelicans, herons, cormorants) in any numbers. If this prediction proves to be incorrect, an effective

and cost efficient solution is to fit perch guards to the towers above the insulators. Therefore **no** change in alignment is considered necessary.

The line passes well to the west (more than 40 km) of the Waterberg Plateau and will not pose a threat to the highly endangered Cape Vultures in that area. There are a number of White-backed vultures (which nest in trees, either singly or in loose colonies) scattered through the savanna system. Some of these nests are known to be in close proximity to the proposed alignment. While it is advisable to avoid going closer than about 5 km to such sites, in practice this is often difficult, as White-backed vultures do move their nesting sites from time to time, depending on food supply, disturbance and other factors. Indeed, White-backed vultures are known to breed successfully in electricity transmission towers. It is recommended that minor alignment changes be made only if a colony of five or more nests are encountered within about 500 m of the servitude.

A vulture research facility and feeding site (vulture “restaurant”) are under construction on the farm Okatjemunde 309, some 18 km south-southwest of Otjiwarongo. This is an initiative of the Rare and Endangered Species Trust (REST), which is monitoring and conducting long-term research on vultures in the region. The vulture restaurant attracts large numbers of birds to the site - sometimes well over 200 individuals belonging to three species. The original proposed alignment crosses this farm. Birds taking off with full crops (up to 1.5 kg of meat) are at their least manoeuvrable and often remain at low altitude for some distance before gaining height. It is recommended that the line be shifted some 10 km to the east to avoid collisions.

There are no further issues of concern regarding birds on this stretch of the intended power line.

Otjikoto to Lifa

This section of the line passes through karstveld savanna and skirts along the edge of degraded north-eastern Kalahari woodland on the north-eastern corner of Etosha National Park. From here the original alignment heads west through Etosha grasslands and into the open palm and saline grassland vegetation of the southern Cuvelai drainage system. Here the route would have cut between the Etosha Pan and Lake Oponono - a cluster of depressions that collect water from the funnel end of the fan-shaped deltoic Cuvelai system. Once out of the Cuvelai grasslands, the line enters mopane shrublands, and then runs along the edge of western Kalahari tree and shrub savanna.

From Tsumeb to the north-eastern corner of Etosha National Park the line runs to the immediate east of the national road. This is a low-risk area from the perspective of birds, and there are no issues that need special consideration.

The avifauna of the next two vegetation types, Etosha grasslands and the Cuvelai wetlands, are highly sensitive to the introduction of power lines.

The **Etosha grasslands** support one of the largest populations of large walking birds such as korhaans, bustards and secretary birds. In addition, the Blue Crane uses this area seasonally. Blue Cranes in Namibia comprise a single, isolated population confined to Etosha and the immediately adjacent grasslands and Cuvelai systems. Recent genetic studies have found that this population is genetically distinct from its closest neighbours, some 1,500 km to the south. A number of bustard species and the Blue Crane are all Red Data species in Namibia and of conservation concern. Blue Crane are foremost on this list, with the entire Namibian population being no more than some 60 individual birds. Power lines pose a serious threat to these species. The single most important mitigation is to move the line northwards, off the grassy plains, and into the edge of the shrubby woodlands.

Moreover, with the recent opening of the King Nahale gate to the north of Namutoni, there is an increasing flow of tourism traffic into the north central regions of Namibia. This is part of a tourism development plan for these regions. In response, communities are developing wildlife and culture – based tourism, and are starting to form conservancies. One of these encompasses the grasslands north of the King Nahale gate. This is an additional reason to retain the pristine nature and visual appeal off the grasslands and the wide open spaces of this area.

The **Cuvelai wetlands**, incorporating the Cuvelai - Lake Oponono – Ekuma – Etosha Pan system is the largest ephemeral wetland in Namibia. It consists of a fan-shaped delta-like system of shallow drainage channels (oshanas), lake-like depressions, floodplain saline grasslands, and occasionally flooded palm-grassland savanna and saline pans. The Etosha Pan is a designated Ramsar site – a wetland of international importance proclaimed by Cabinet under the Ramsar Convention. One of the main criteria for such sites are their importance for wetland bird conservation, including Red Data species such as flamingos and pelicans. Birds are the main indicators used to monitor wetland diversity and ecosystem health.

The Etosha Pan and the associated Ekuma-Lake Oponono-Cuvelai support nationally, regionally and internationally important populations of flamingos, pelicans and other Red Data wetland birds, including storks, herons, ibis, geese and ducks, particularly in years of good rainfall. Birds from throughout southern Africa and from as far afield as the rift valley in East Africa, congregate in Etosha and Lake Oponono to breed. In some years, over 1 million flamingos congregate on the Etosha Pan.

When this happens, huge numbers of birds move up and down the Etosha-Cuvelai system **on a daily basis**, feeding in different parts of the system. The main flight paths are between Etosha Pan, the Ekuma river and Lake Oponono. Birds feed during the day and at night. They also fly at night, both between their non-breeding and breeding areas (e.g. from the coast to Etosha), as well as between feeding areas within the Etosha system.

For these huge numbers of flamingos, pelicans and other wetland species, a power line across their flight path would present a huge hazard to the birds, as well as a cause of bird-strike and power interruptions in a flooded area. Both flamingo species (Greater and Lesser) are Red Data birds. Because their nesting and feeding grounds present such high concentrations of these birds at one place, and constitute such a large proportion of the population, every care must be taken to prevent causes of mass mortality in these areas.

A second set of high profile birds that use the Cuvelai wetlands system are the three species of cranes that occur in southern Africa, Wattled, Crowned and Blue Cranes - all three are Red Data species. The Blue Crane is resident and moves widely within the Etosha and Cuvelai grasslands system, while the other two species are wet season visitors. All three species are known to be highly vulnerable to power line collisions.

It is clear that the alignment of the power line cannot pass south of the Lake Oponono area. The alignment should be shifted to avoid the saline grasslands on their eastern and northern sides. It is mainly for this reason that the preferred alternative route shown in Figure 1 and Figures 2e - 2h was proposed by the team of environmental consultants.

As tourism discovers the north central regions of Namibia, the Lake Oponono-Ekuma areas will become a sought-after and high value destination, drawing people northwards from the camps in Etosha. Re-aligning the power line away from this area will also maintain the tourism potential of the area.

An inspection by helicopter has confirmed that the power line can be routed due west to cross the oshanas some 50 km upstream of Lake Oponono, then swing northwest between the oshanas and meet the Oshakati-Ruacana road some 12 km west of Outapi. From here the alignment could run parallel to the road to Lifa.

In conclusion of this section, it is emphasised that birds are a very significant component of the environmental assessment on this project. This is because the intended power line could impact on nationally and globally important breeding sites and populations of rare and threatened species, as well as on associated areas of high tourism potential.

The only way to avoid major impacts on the large birds in northern Namibia is to ensure that the power line is aligned carefully. Secondary mitigation for a poor alignment would not be effective. The line should therefore avoid the Oponono grasslands of the Etosha plains north of the King Nehale gate. A more northern alignment along the edge of the woodland is recommended.

Most important of all, the power line must be realigned well to the east and north of the Lake Oponono- Ekuma system, which is an important fly-way to hundreds of thousands of birds during the wet season, and to a number of Red Data species throughout the year.

Secondary mitigation measures are also recommended in some cases. These include bird flappers near vulture breeding sites and at sites where the lines cross the oshanas north of Lake Oponono. It may be necessary to use illumination markers on particular sites along the power line if there are significant numbers of collisions – particularly from birds flying at night – but it is recommended that this mitigation be evaluated on a need basis once the line is constructed.

4.2.2 Fires

Lightning strikes on steel towers may lead to veld fires.

Farmers have also reported that when birds get electrocuted on the power lines, the birds burn and fall to the ground causing veld fires.

It is difficult to mitigate the impacts of potential fires. However an alignment near a road should help to limit the spread of fires as the road acts as a fire-break.

4.2.3 Destruction of natural vegetation & soil erosion

Natural vegetation is affected in three ways: -

- Clearing of trees and tall bushes from a 12m wide corridor under the conductors is normally a negative impact. However in areas (e.g. north of Tsumeb) that suffer from bush encroachment from species such as ‘Sekelbos’ (*Dichrostachys cinerea*) and ‘Swarthaak’ (*Acacia mellifera*) the clearing of such bush would be a positive impact – opening up land for grasses.

- New access tracks will affect a narrow strip where bushes may have to be cleared. Where possible existing roads and tracks will be used. On flat ground the tracks can often coincide with the cleared strip under the conductors.

- On steep ground there is the potential for soil erosion created by poorly managed tracks. However, on this project there is very little hilly terrain, so there should be very little risk of soil erosion. Mitigation measures can be implemented to prevent erosion: -
  - Tracks should not be bladed so that the ground cover of grass is not disturbed more than necessary.
  - On even moderately steep slopes, the track should cross the contours at an acute angle and should meander. It should not go up or down any hill in a straight line perpendicular to the contours.
  - The construction of speed-bumps (mitre berms) in the road will also help to reduce the erosive effect of run-off.

- Omiramba (shallow, wide water courses) are often covered by grass with little or no trees. As the fine sandy alluvial material can be highly susceptible to erosion, these areas should be avoided where possible, and should not be cleared of their grass cover. For example, in the area around Neudamm – Frauenstein numerous omiramba exist which, in their natural condition are generally not eroded but could become so if disturbed.

- All developments carry some risk of introducing alien invasive plants. Seed can be accidentally introduced on vehicles, or in construction materials.

4.2.4 Visual impacts

One of the most common objections to power lines is the visual impacts, particularly in attractive rural settings. Mitigation of visual impacts is limited. However, a number of aspects need to be considered with regard to the routing of power lines in relation to visual impacts (refer to **Photos 29-32**): -

- **Proximity**: The closer a power line is to a sensitive receptor, e.g. a tourist establishment, the more visible it will be. At a distance exceeding 2km, a 400kV power line becomes relatively inconspicuous. However there is often a trade-off to be made between visual and other impacts. From a bio-physical point of view, it makes sense to build a power line close to existing roads where there is already a disturbance of the bio-physical environment. However, this has a greater visual impact. To align the power line far from the road often increases the impacts on natural vegetation. So a trade-off has to be made. People who attended some of the public meetings for this Environmental Assessment, suggested that tourists preferred a power line to run along a road (where there is already a visual intrusion) rather than through “pristine” open country.

- **Aspect:** Visual analysis of existing power lines suggests that they are most visible in situations where: -
  - the towers can be highlighted by the sun against a background of hills in shadow, or
  - the towers are silhouetted against the sky.

  On the other hand, where the power line is seen against a hilly backdrop and both are lit by the sun, the lines blend in quite well at distances over a kilometre or so.

Towers are most conspicuous when they are new and the galvanised iron is still highly reflective. One way to reduce this visual impact slightly would be to “paint” the towers with vegetable oil so that the dust sticks and they become dulled.

Mitigation of visual impacts is best achieved by appropriate alignment. Consideration could also be given to finishes on the towers to dull the highly reflective nature of the new galvanised iron towers.

4.3 Potential impacts of the power line on the socio-economic environment & mitigation

4.3.1 Tourism / hunting

Because power lines are unsightly, they have a negative impact on the enjoyment of tourists who come to Namibia because of its large expanses of natural habitats without human-made structures. Tourism is the fastest growing industry in Namibia. Ideally, therefore, power lines should avoid areas with tourist facilities as far as possible.

Potential mitigation measures were suggested above, but the best opportunity for mitigation is at the planning stage – the selection of the route alignment. In general, participants in the public participation programme considered that it was preferable to align power lines close to existing infrastructure, especially roads and power lines. This has the effect of concentrating the intrusions into a narrow band of disturbance while leaving most of the countryside open and free of human structures. Thus tourism and hunting areas are less affected.

4.3.2 Mahangu fields

In the communal areas to the north, a minor impact on some mahangu fields is likely to occur where towers are placed in a field. Suitable soil for cultivation is often very limited so that the loss of a few square metres can be a significant impact for an individual subsistence farmer.

Mitigation is possible to a limited extent by altering the spacing of towers to try to avoid the scattered crop lands. Where this is not possible, compensation to the farmer would be necessary. Compensation is however, an inadequate form of mitigation as it often leads to impoverishment in the long term.

4.3.3 Health impacts on humans and animals

Electrical current flowing through a wire generates an electromagnetic field around the wire. Studies to determine whether these electromagnetic fields (EMFs) around power lines could cause diseases such as cancer, have so far proved inconclusive. In some studies correlations have been found between the incidence of certain types of cancer and proximity to sources of electromagnetic fields (www.midtod.com/9603/voltage.phtml). That article suggests that the strength of EMF fields from power lines could be problematic within 20 – 50 metres of high voltage power lines. However, the same article points out that EMFs do **not** produce ionising radiation or any charged particles, and that the “energy in the fields to which most of us are exposed is tiny tens of millions too small to break the molecules in cells”. Furthermore, all living organisms evolved in the presence of the earths magnetic field.

Correlations however, do not prove cause and effect. There could be many causative factors of health problems in any one local environment. Therefore cause-effect relationships need to be established before any conclusions can be drawn. However, there is currently no established theoretical basis to link EMFs to diseases as a causative agent.

On the basis of the evidence currently available, it is impossible to confirm or refute the allegations that proximity to power lines can cause disease. The evidence so far is almost entirely circumstantial, with no established theoretical basis.

However, where there is an element of doubt about health impacts, the “precautionary principle” should be applied. For this reason, further **literature research** should be undertaken in the EA to follow. In the EA, an effort will also be made to establish the **“safe limit” standards** that are applied in developed countries, and use these standards as a guideline in “fine-tuning” the alignment.

A remark by a farmer at a meeting during the public participation process claimed that cows kept in a field under a power line had become infertile. However, elsewhere high voltage power lines have had no effect on the fertility of cows (PJ Orford, pers comm). Such anecdotal evidence, based on isolated reports, however has no statistical or scientific validity.

It is also important to point out that the strength of an EMF field reduces exponentially with increased distance from the source. Therefore over just short distances from a power line there is considerable reduction in field strength.

The power line will not be constructed over any houses, or within 27.5 m of any house, because no structure will be allowed within the 55 metre-wide servitude. In most cases the distance will be far greater. For this reason there should be no reason for concern about the EMFs related to the power line.

5 DISCUSSION OF THE ROUTE ALTERNATIVES

As a result of the environmental assessment process to date, a number of suggested alternatives to the proposed route have been put forward. The suggested re-alignments have arisen as a result of input from environmental specialists, interest groups, the public participation process, and engineering considerations. For example: north of Etosha the alignment was changed completely due to the risks to large birds, the existence of saline soils, and the accessibility of the line by road. Sensitive ecosystems (e.g. saline grasslands in the north) were also taken into account. Further south, changes were suggested in response to mining operations, and requests from farm-owners. Airfields, settlements and other infrastructure also had to be taken into account.

Any changes to the proposed alignment were subject to the need to construct the power lines in straight lines, the need to link existing sub-stations, and economic constraints (1 km of power line costs approximately N$ 1 million (July 2004)). NamPower has agreed, in principle, to the suggested changes that are described below. However, during the next phase of project planning, these alignments will be viewed in greater detail at scale of 1: 50,000 and, in areas with tight spatial constraints, also on the ground.

The changes that have been suggested by the study team are summarised below and are shown on the 1: 250,000 maps (**Figures 2a – 2h**). The broken **blue line** indicates the route originally proposed by NamPower, while the broken **red lines** indicate the suggested alternative alignments. In the northern parts, through communal areas with greater settlement densities, the map shows a corridor (shaded in red) rather than a single line. That is to allow for some flexibility to avoid obstacles such as houses, kraals, pans and large trees when the alignment is planned in more detail.

The following alternative alignments are currently under consideration. Please refer to the route markers A, B, C etc on the 1: 250 000 map (**Figure 2a – 2h**) for identification. These are set out from south to north.

Route alternative A – B: Auas sub-station – Okaparkaha Farm (Figure 2a)

Section A – B runs northwards from the Auas sub-station east of Windhoek to the farm Okaparkaha.

Some of the affected farm owners requested that the route should follow the farm boundaries (red) in order to minimise impacts on activities such as an existing hiking trail. Since the suggested alternative is straighter than that originally proposed (blue), NamPower has agreed to this alternative route in principle, to be confirmed at the next phase of the study – the Environmental Assessment.

Original Proposed Route Approximate Distance (km)	Preferred Alternative Route Approximate Distance (km)	Difference (km)
42.50	41.25	1.25
The alternative route is thus approximately 1.25km shorter than the original proposed route.		

Route alternative C-D-E: Doornkom – Gerus sub-station (Figure 2c)

The concern in this section of the proposed route is that a vulture "restaurant" is to be established by the Endangered Species Trust on the farm **Okatjemunde**. This feeding project is aimed at conserving the **Cape griffin vultures** – a species which is endemic to southern African and which is also seriously threatened in the sub-region. In Namibia there are only about 6 to 8 birds left (C. Brown, pers comm). These birds nest in the Waterberg mountains but they roam over great distances in search of food. They are currently being fed on a farm to the north of the Waterberg. The proposed line (red) runs within 2 – 3 km of the proposed vulture "restaurant" site. The alternative route (blue) runs more than 12 km further away. According to C. Brown (pers comm), these birds are particularly vulnerable to power lines that are located within 5 km of sites where they regularly take off and land. The vulture "restaurant" would obviously be a focus of such activity.

In addition to the issue of the Cape griffin vultures, there are reported to be seven nests (in trees) of the relatively common **White-backed vulture** in the area of the farms Doornkom, Apostle and Miershoop. One of these nests was seen from the helicopter. These vultures nest for a few years in the same nest, but they also move around in response to the availability of food. Thus, after using a particular nest site for a few years, they often move off and establish new nest sites (C.Brown, pers comm). This unpredictable behaviour makes it impossible to design the power line alignment to suit the habits of this species. For this reason no re-alignment has been recommended, although it was an issue of concern raised by I&APs. It is recommended, instead, that the nests should be located during the next phase of this study, and bird flappers should be installed on the power line in the vicinity of the current nest sites.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
95.0	96.25	1.25
The alternative route is thus approximately 1.25km longer than the original proposed route.		

Route alternative E – F: Gerus sub-station – Hannover Farm (Figure 2d)

Along this section of the route, some of the landowners requested that the proposed power line should run parallel and as close as possible to the existing 220 kV power line. The request was made in order to limit the visual impacts to a corridor that was already disturbed by the existing power line. This principle is supported by Eco.plan for two additional reasons:

- if the two power line servitudes run adjacent to each other, it may be possible to service both from the same access track, and
- although this route section is not on any specific corridor of bird movement, constructing the power lines close together may reduce the potential for bird impacts relative to the alternative of two separate power line corridors.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
139.0	139.0	0
The two routes are approximately the same distance.		

Route alternative F – G: Hannover Farm – Otjikoto sub-station (Figure 2d)

The originally proposed route (blue) traverses the site of the proposed Tschudi open pit copper mine. Ongopolo holds the mining rights and they have expressed concern about the power line. The area to be mined is on the farms Wandelberg and Vogelberg. Thus the original proposed route would conflict with the mining activities.

The alternative suggested by Eco.plan follows the existing 220 kV line all the way to Otjikoto sub-station. The main constraints in following the existing power line are two relatively narrow gaps through the hills. Elsewhere the terrain is quite flat. The first gap is due north of Otavi. The second gap lies between Walrode East and a kink in the railway line just north of the Bobos railway siding. These two gaps between hills will need to be investigated in more detail on the ground to confirm that the alternative (preferred) alignment is viable.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
46.75	43.25	3.5
The alternative route is thus approximately 3.5 km shorter than the original proposed route.		

Route alternative G – H: Otjikoto sub-station – a point north of Oshivelo (Figure 2d-e)

Along this section, the land is flat and the route alignment is subject to few constraints. The original proposed alignment is the straightest route and is therefore preferred by NamPower. There do not appear to be any serious environmental problems with this route. However, in order to minimise the impacts on the affected farms, it would be preferable to follow the existing 132 kV line which is closer to the national road (B1). The final alignment could be anywhere within the red-shaded area but the closer to the existing line the better. Any increase in distance would be minimal, but additional four-legged towers may be necessary if extra bend points are introduced. The final alignment would also be constrained by the railway line which is currently under construction, and which runs close to the road. The line would also need to bypass the small town of Oshivelo on its east side. A landing strip just west of Oshivelo will also need to be taken into account in terms of aviation safety.

Point H lies to the north of Oshivelo and close to the north-easternmost corner of Etosha National Park.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
101.25	undetermined	undetermined
An alternative alignment closer to the tar road would add a very small distance – possibly a few hundred metres.		

Route alternative H – Q: to the north of the Oponono saline grasslands (Figures 2e-h)

The need to avoid the Oponono saline grasslands, in order to avoid major impacts on birds, was explained in Section 4.2.1 above.

In response to the problems with the original proposed route, a number of alternatives were considered in the communal area north of Etosha, but these were rejected: -

- An alternative route following the tar road (B1) all the way from Oshivelo to Lifa was rejected by NamPower because of the density of settlements along that road.
- Variations of the preferred alternative were also considered, but involved either greater distances, or dense settlements - based on the helicopter survey.

The **preferred alternative route** is shown on Figures 2e-h and described as follows.

From point H, an alignment to the east of the tar road (B1) is preferred in order to avoid the saline grasslands. Where this route reaches settled areas it bends westwards to cross the tar road (B1). It then follows the margins of the settled areas, where the density of settlement is still low – thus avoiding the grasslands and areas that are prone to periodic flooding over an extensive area.

From the air, the salinity levels appear to be higher in the south than further north. This was confirmed by B. Strobach (pers comm) who has undertaken mapping of soils and vegetation in these areas. Higher concentrations of salts in the south is consistent with the southward flowing Cuvelai drainage system. As the water evaporates it precipitates it's dissolved load. The salinity factor therefore also appears to favour the proposed northern alternative route, as high salinity corrodes concrete foundations.

The route marked H-I-J-K-L-M-N-O-P-Q has a number of advantages over the original proposed route: -

- It avoids the saline grasslands and Oponono area and therefore avoids the greatest areas of risk for large birds,
- It avoids the worst areas of saline soils,
- Areas with a high density of human settlements are avoided,
- While avoiding dense human settlements, the route nevertheless passes through the low density fringes of human settlements, a fact that is likely to further reduce the risks to large birds because they tend to avoid human settlements.
- The route was designed to allow access by existing roads and tracks.
    - For example, the section north of Andoni Flats to south of Oshakati has a number of minor roads or tracks that are not shown on the topographic map but were available from GIS data sets at a scale of 1: 250 000. Where possible the route follows these existing access routes. By doing so, it not only makes access easier for construction and maintenance, but it also avoids opening up new access to areas of ecological sensitivity. (The creation of new access often leads to settlement along the new access route.)
    - The route also follows an east-west section of the newly tarred road between Oshakati and Okahao.
    - West of Outapi, the route follows the tar road (B1) and existing power lines to the proposed new sub-station at Lifa (near Ruacana),
- The route avoids communal conservancies, particularly the Uukwaluudhi Conservancy – which has the aim of developing tourist facilities in due course.

A number of issues will be taken into account in the final alignment of the power line, and for this reason, a broad band is shown (red shading) on the map. An alignment anywhere within this band would be environmentally acceptable – subject to the following constraints.

- The line may not pass over any dwellings. All dwellings must be outside the 55m servitude. Where it is not possible for the servitude to avoid all houses, a few may have to be rebuilt outside of the servitude and compensation paid by NamPower.
- It would also be desirable, but not essential to avoid passing directly over animal kraals in case of the unlikely event of breakages on the line that may affect livestock.

- The alignment should be designed to avoid large trees as far as possible, particularly large fruiting trees such as Baobabs, Marula's, Brown Ivory (*Berchemia discolor*), clumps of Makalani Palms, and any other large trees providing food, shade, medicinal properties or products that are used by the local people.
- It will obviously be desirable to avoid pans as far as possible for reasons of founding conditions, and ease of access for maintenance.
- Proximity to existing tracks should also influence the final alignment of the power line.
- Where the power line crosses the Onesi Dam, it should do so on the north side of the road where the dam is narrowest.
- The preferred alternative route also facilitates a link between the new line and the existing sub-station at Ongwediva.

The above-mentioned constraints will be taken into account at the next stage of investigation, the EA, when sets of 1: 50,000 orthophoto maps will be used to determine the best alignment within the broad corridor (red-shaded area) already established. The resolution of the available orthophoto maps is high enough to permit the identification of dwellings, large trees, roads etc.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
337.75	333.75	4.0
The alternative route is thus approximately 4 km shorter than the original proposed route.		

Link (R – S) to the Ongwediva Sub-station (Figure 2h)

A link from the preferred alternative route to the existing sub-station at Ongwediva has been investigated on the 1: 250,000 maps and from the helicopter. The sub-station is situated at the northern end of Ongwediva. The area is not ecologically sensitive and is already very disturbed. The alignment of this link is constrained by areas of relatively dense to very dense settlement around Oshakati and Ongwediva. To avoid the densest areas, the proposed route passes Oshakati on the west side, and then turns eastwards to the substation. There is a landing strip close to this alignment, just north of Oshkati, that will need to be looked at more closely in the next phase of this study, to determine whether the power line could represent a hazard to aircraft using the landing strip.

Original Proposed Route: Approximate Distance (km)	Preferred Alternative Route: Approximate Distance (km)	Difference (km)
19.0	Not applicable	Not applicable
To connect Ongwediva to the original proposed route would have been a minimum distance of 49km.		

6 CONCLUSION: THE PREFERRED ROUTE

The main purpose of this scoping phase of the project has been to consult with the public and to select the best route for the power line based on environmental and technical considerations.

The route originally proposed by NamPower (blue route) has been subjected to a preliminary environmental investigation and has been assessed in terms of a number of criteria. The main criteria were: -

- Vegetation types,
- Hilly or mountainous terrain,
- Potential impacts on birds,
- Saline soils,
- Access via existing tracks,
- Density of settlements,
- Relation to existing infrastructure, especially roads, power lines, airfields,
- The need to follow straight lines,
- Cost constraints,
- The need to link to the existing sub-stations,
- Aesthetic impacts,
- Input from the public participation programme
- A preliminary archaeological survey was also carried out but was found not to have any significant influence on the power line route.

In response to all the above considerations, a number of alternative alignments have been put forward. These are shown in red on the 1: 250,000 maps. Wherever both red and blue routes are shown, it is the red route that is preferred for environmental reasons, and which will be the subject of the full Environmental Assessment.

North of Etosha National Park, the original proposed route was found to be fatally flawed due to the likely impacts on large birds. However, a more suitable alternative route was found further to the north, which satisfies NamPower's requirements and is environmentally sound.

At this stage of the investigation, no fatal flaws have been identified on the preferred (red) route alternatives.

This Scoping Report will be made available for public comment before the study progresses to the next phase of the study – the Environmental Assessment of the preferred route.

During the next phase, an Environmental Assessment will be carried out only on the preferred route. Mapping will be undertaken at a more detailed scale of 1: 50 000. Topographic and orthophoto maps will be used to check and "fine tune" the preferred routes. Through areas that are particularly sensitive or where there are tight constraints, ground investigations will be carried out. Where necessary, minor adjustments may be made.

In places where it has not been possible to avoid environmental problems by adjusting the power line alignment, certain mitigation measures will be recommended where possible (for example, bird flappers can be installed).

In order to address potential impacts relating to at the construction and operation phases, an Environmental Management Plan will also be devised. As far as possible, the concerns of I&APs will be addressed in the EMP which will include Environmental Specifications to be included in contract documents and enforced on site.

Not only are the alternative routes environmentally preferred, but they should also lead to cost savings. Comparison of the distances involved from Auas to Lifa (A – Q) shows that, if all the preferred alternative (red) routes are selected, the total distance would be approximately **7.5km shorter** than the original (blue) proposed route. A link from the preferred alternative (red) route to the sub-station at Ongwediva would save an additional 49km or more compared with the original proposal.

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