Bon Espirange – Komsberg
132kV POWERLINE
TRANSPORT IMPACT ASSESSMENT

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REVISION 0

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SYNOPSIS

Preparation of a Traffic Impact Assessment for the proposed Bon Espirange – Komsberg 132kV powerline to be located in the Laingsburg Municipality (LM), Western Cape Province, and Karoo Hoogland Municipality (KHM), Northern Cape Province. The assessment pertains to all relevant traffic and transportation engineering aspects of the facility.

KEY WORDS:

Wind Energy Facility, WEF, Transport Impact Assessment, 132kV Powerline

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

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BON ESPIRANGE – KOMSBERG
132kV POWERLINE
TRANSPORT IMPACT ASSESSMENT

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1 INTRODUCTION & SCOPE OF WORK

1.1 Introduction

WSP appointed JG Afrika Pty (Ltd) to provide transport impact input for the development of the Bon Espirange – Komsberg 132kV overhead powerline. The overhead powerline is approximately 3 km long and is located in the Laingsburg Municipality (LM), Western Cape Province, and Karoo Hoogland Municipality (KHM), Northern Cape Province. No alternative routes are associated with the powerline as it follows existing powerlines from the Bon Espirange substation to the Komsberg substation. The powerline is required in order to evacuate the power generated by the Rietkloof and Brandvalley Wind Energy Facilities (WEFs) to the National Grid.

The following properties are affected:

- Bon Espirange 73 Portion 1 and Remainder.
- Aprils Kraal 105 Remainder
- Standvastigheid 210 Portion 2 (Komsberg Substation).

The powerlines will be a 132kV steel single or double structure with kingbird conductor (between 15 and 20m in height – above ground level). Standard overhead line construction methodology will be employed – drill holes (typically 2 – 3m in depth), plant poles, string conductor. The construction phase will extend over a period of 12 months and create ~30-50 employment opportunities.

This study will provide input into the basic assessment process. The location of the proposed powerline is shown in **Figure 1.1** below.

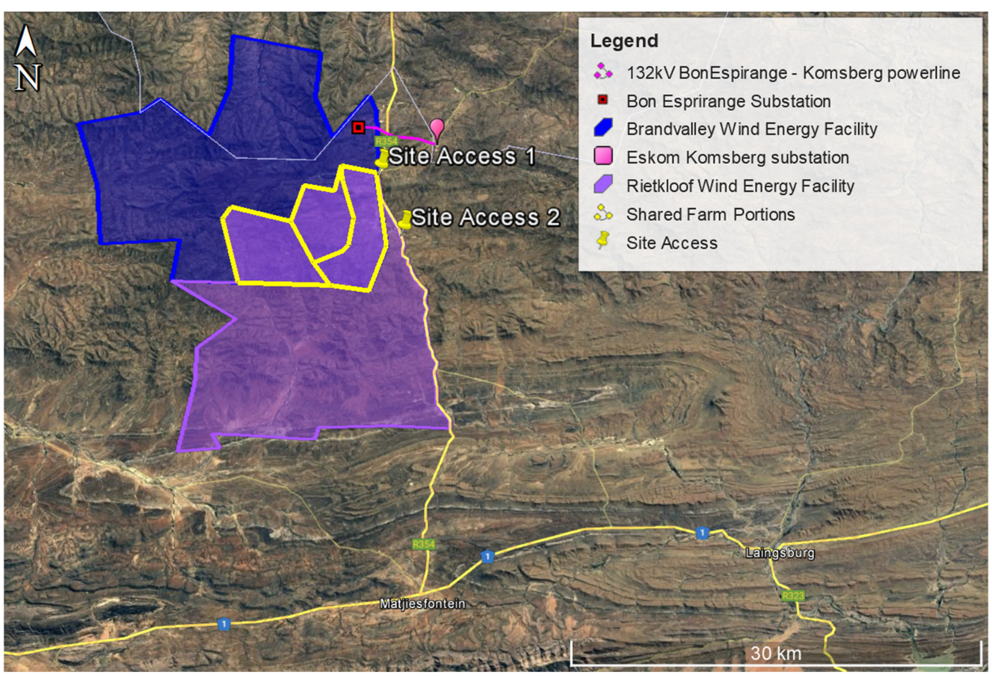

Figure 1-1:Locality Map

1.2 Scope of work

The TIA will assess the transport impact of the powerline on the existing transport network during the construction, operation and maintenance, as well as the decommissioning phases.

The report will deal with the items listed below and focuses on the surrounding road network that may be impacted by construction and maintenance of the site:

<u>Traffic and route assessment</u>

- Trip generation and potential traffic impact
- High-level feedback concerning possible travel routes
- Investigation of the impact of the development traffic generated during construction and operation.

<u>Access assessment</u>

High-level input on the following from a transport planning point of view:

- Feasible location of access point(s)
- Motorised and non-motorised access requirements if required
- Queuing analysis and stacking requirements as and if required
- Sight distances and required access spacing

1.3 Approach and Methodology

The report deals with the traffic impact on the surrounding road network in the vicinity of the site during the construction, operation and maintenance, as well as the decommissioning phases. of the powerline.

This transport study includes the following tasks:

<u>Project Assessment</u>

- Overview of project background information including previous studies, location maps, component specs and any resulting abnormal loads to be transported
- Research of all available documentation and information relevant to the proposed windfarm and substations

<u>Traffic and Route Assessment</u>

- Trip generation and potential traffic impact
- Possible material and plant delivery routes to the site
- Estimation of construction and maintenance (operational) vehicle trips
  - Generated vehicles trips
  - Abnormal load trips
  - Access requirements
- Investigation of the impact of the development traffic generated during construction and operation.
- Access requirements and recommendations

<u>Report (Documentation and Figures)</u>

- Reporting on all findings and preparation of the report.

1.4 General assumptions

The following assumptions were made:

- According to the Eskom Specifications for Power Transformers, the following dimensional limitations need to be kept when transporting the transformer – total maximum height 5 000mm, total maximum width 4 300mm and total maximum length 10 500mm.
- Maximum vertical height clearances along the haulage routes is 5.2 m for abnormal loads.
- The imported elements will be transported from the most feasible port of entry, which is deemed to be Port of Saldanha.
- All haulage trips will occur on either surfaced national and provincial roads or existing gravel roads.
- Material for the construction of internal access roads will be sourced locally as far as possible.
- The decommissioning phase will have a similar transport impact as the construction phase.

1.5 Source of information

Information used in a transport study includes:

- Project information provided by the Client
- Google Earth. kmz provided by the Client
- Google Earth Satellite Imagery
- Chief surveyor general website
- TRH11, Dimensional and mass limitations and other requirements for abnormal loads, August 2009
- The Technical Recommendations for Highways (TRH 11): “Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads”, 2000
- National Road Traffic Act, Act 93 of 1996
- National Department of Transport (NDoT), Manual for Traffic Impact Studies, October 2005
- Department of Transport (DoT), Geometric Design of Rural Roads, 1988
- SANS 10280/NRS 041-1:2008 Overhead Powerlines for Conditions Prevailing in South Africa
- Manual for Traffic Impact Studies, Department of Transport, 1995
- TRH26 South African Road Classification and Access Management Manual, COTO
- TMH 16 South African Traffic Impact and Site Traffic Assessment Manual (Vol 1), COTO, August 2012
- TMH 16 South African Traffic Impact and Site Traffic Assessment Manual (Vol 2), COTO, February 2014

2 SITE DESCRIPTION

2.1 General

The site is located approximately 49 km north of Matjiesfontein in the Laingsburg Municipality (LM), Western Cape Province, and in the Karoo Hoogland Municipality (KHM), Northern Cape Province. The powerline will connect from the Bon Espirange substation to the Komsberg substation. This will allow for the connection of the Rietkloof and Brandvalley WEFs to the National Grid.

2.2 Site access points

The proposed powerline can be accessed from the Rietkloof and Brandvalley WEF site access points closest to the powerline. The closest site access roads are the OP08042 and OP08044 which connect to the R354 located at the eastern end of the site. The R354 is a Class 2 minor arterial route running in a north-south- direction from Matjiesfontein to the R356 in the Northern Cape. The road is a surfaced single carriageway with one lane per direction.

Since the access roads are located along existing registered roads, access spacing restrictions are not envisaged. It should be noted that road upgrades may be required along the existing access roads to accommodate expected vehicles. Additional roads may need to be established to access the full powerline route.

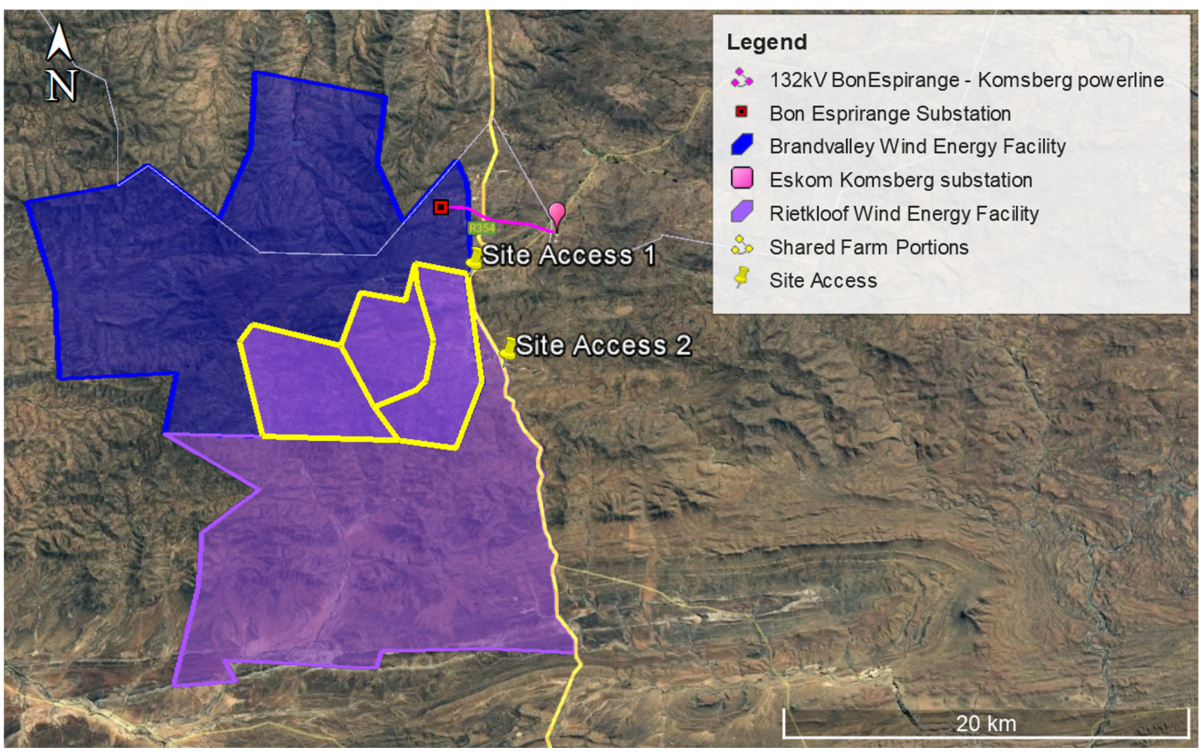

Figure 2-1:The Proposed Site

3 TRANSPORTATION ROUTES

3.1 Main Route for the Transportation of Materials and Plant to the proposed Site

Building materials will most likely be sourced from Worcester approximately 160km form the site or alternatively from Cape Town approximately 300 km from the site. A significant reduction in heavy vehicle trips can be achieved by using mobile batch plants. In addition to this, temporary construction material stockpile yards could be commissioned on vacant land near the proposed site. Delivery of materials to the mobile batch plant and the stockpile yard could be staggered to minimise traffic disruptions.

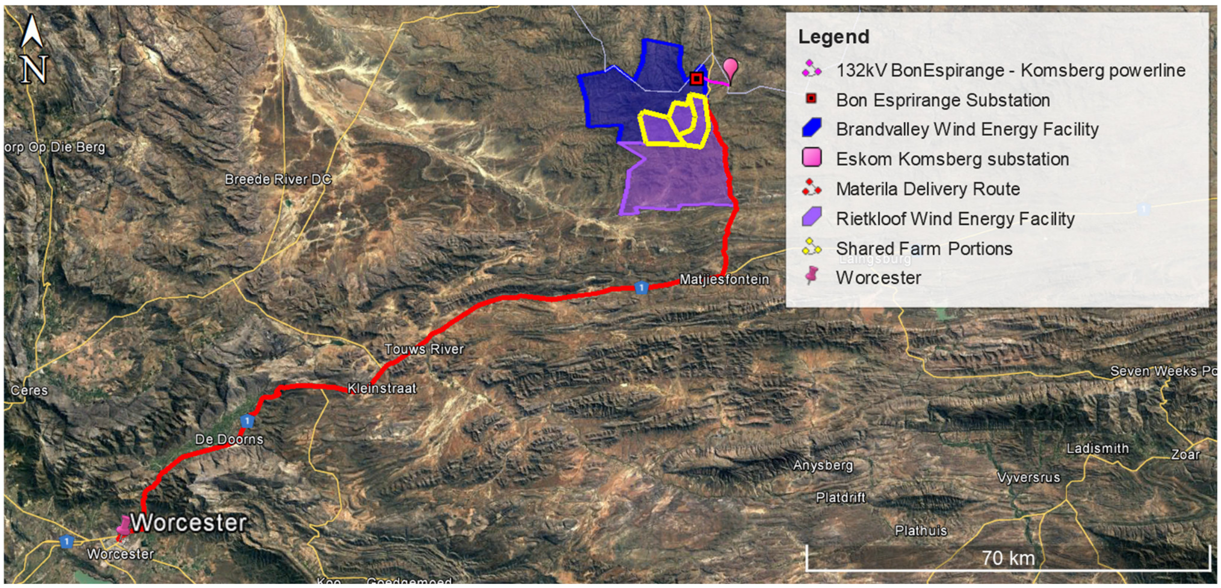

Figure 3-1: Envisaged route for material delivery

3.2 Main route for the transportation of site workers

It is envisaged that the workforce will most likely reside in Sutherland, Matjiesfontein, Touws River or Laingsburg as the closest communities. These towns connect to the site via the N1 and the R354.Due to a lack of public transport near the site, it is recommended that a majority of construction personnel be transported to and from the site by means of busses or minibus taxis. This will reduce the number of trips bound for the site.

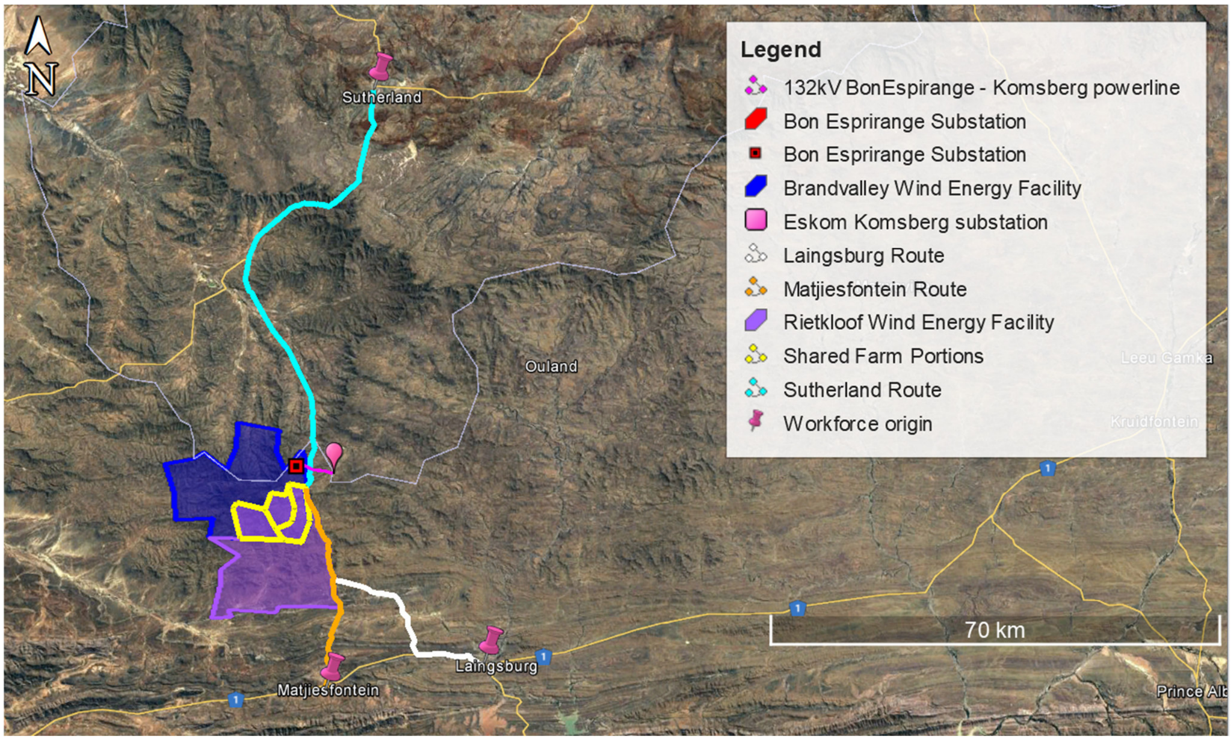

Figure 3-2:Routes from the nearest towns to site

4 DESCRIPTION OF PROJECT ASPECTS RELEVANT TO THE TRANSPORT STUDY

4.1 Transportation requirements

4.2 Transporting Material and Equipment

Powerlines are a system of overhead transmission lines and underground cables. Their main function is to transfer power from an electrical generation source to a substation from which distribution to the consumer will occur.

The materials/components required for powerlines include:

- Towers/poles to support the electrical cables. These can be made from wood, steel, aluminium, concrete or reinforced plastic options,
- Wire conductors typically made of aluminium,
- foundations for towers/poles,
- Dampers,
- Ground wires,
- Insulators, and
- Transformer.

Components are expected to be locally sourced and transported to site using appropriate National and Provincial routes. It is expected that the components will generally be transported to site with normal heavy load vehicles.

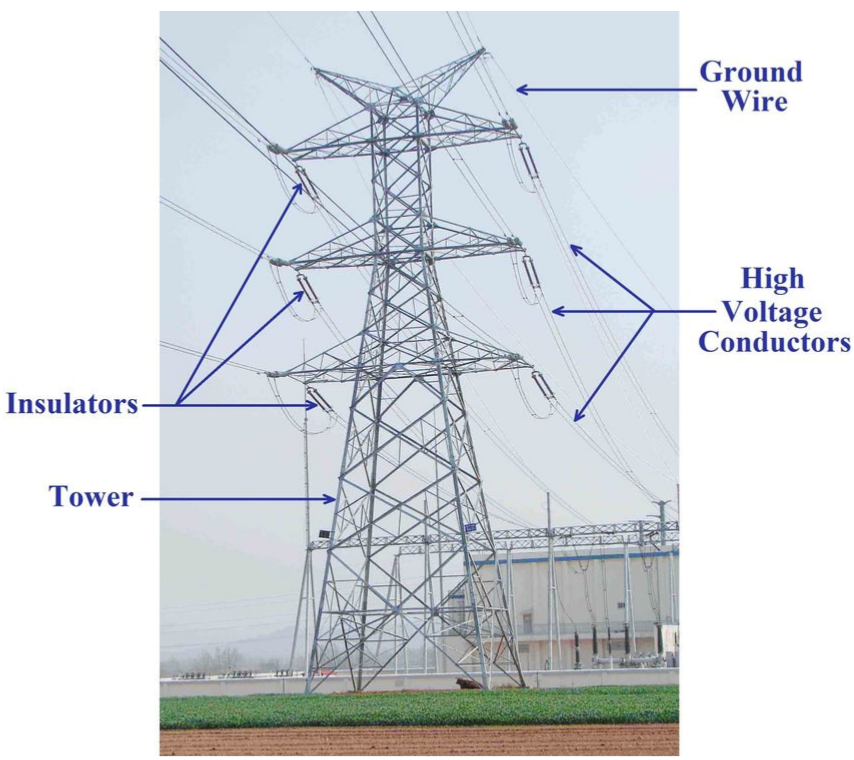

Figure 4-1:Typical High voltage Power Transmission system (Chakraborty, 2017)

4.3 Transporting equipment

The expected abnormal vehicles will comprise of lifting equipment required to off-load and assemble the components. Crane technology has developed rapidly, and several different heavy lifting options are available on the market. For this assessment, a mobile crane is considered.
Mobile cranes are classified as non-load carrying vehicles. Mobile cranes usually exceed mass and legal dimension limits and must therefore be operated under permit.

Figure 4-2: Mobile Crane (Plant equipment, n.d.)

4.3.1 Abnormal Load Considerations

Abnormal permits are required for vehicles exceeding the following permissible maximum dimensions and mass on road freight transport in terms of the Road Traffic Act (Act No. 93 of 1996):

- Length: 22m for an interlink, 18.5m for truck and trailer, and 13.5m for a single unit truck,
- Width: 2.6m,
- Height: 4.3m measured from the ground. Possible height of load – 2.7m,
- Weight: Gross vehicle mass of 56t resulting in a payload of approximately 30t,
- Axle unit limitations: 18t for dual and 24t for triple-axle units, and
- Axle load limitation: 7.7t on the front axle and 9t on single or rear axles,

Any dimension/mass exceeding the above will be classified as an Abnormal Load and will necessitate an application to the Department of Transport and Public Works for a permit that will give authorisation for the conveyance of said load. A permit is required for each Province that the haulage route traverses.

4.3.2 Further Guideline Documentation

The Technical Recommendations for Highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and other Events on Public Roads" outlines the rules and conditions that apply to the transport of abnormal loads and vehicles on public roads and the detailed procedures to be followed in applying for exemption permits are described and discussed. Legal axle load limits and the restrictions imposed on abnormally heavy loads are discussed concerning the damaging effect on road pavements, bridges, and culverts.

The general conditions, limitations, and escort requirements for abnormally dimensioned loads and vehicles are also discussed and reference is made to speed restrictions, power/mass ratio, mass distribution, and general operating conditions for abnormal loads and vehicles. Provision is also made for the granting of permits for all other exemptions from the requirements of the Road Traffic Act and the relevant regulations.

4.4 Permitting – General Rules

The limits recommended in TRH 11 serve as a guide to the Permit Issuing Authorities. Each Administration has the right to refuse a permit application or modify the conditions to grant a permit. It is understood that:

a. A permit is issued at the sole discretion of the Issuing Authority. The Issuing Authority may refuse a permit because of the condition of the road, the culverts, and bridges, the nature of road traffic, excessive heavy traffic during specific periods, or for any other reason.

b. A permit can be withdrawn if the vehicle is inspected and found unfit for operation.

c. During specific periods, such as school holidays or long weekends, an embargo may be placed on the issuing of permits. Embargo lists are compiled annually and are obtainable from the Issuing Authorities.

4.4.1 Load Limitations

The maximum load that a road vehicle or combination of vehicles will be allowed to carry legally under permit on a public road is limited by:

- the vehicle capacity as rated by the manufacturer,
- the load which may be carried by the tyres,
- the damaging effect on pavements,
- the structural capacity on bridges and culverts,
- the power of the prime mover(s),
- the load imposed by the driving axles, and
- the load imposed by the steering axles.

4.4.2 Dimensional Limitations

A load of abnormal dimensions may cause an obstruction and danger to other traffic. For this reason, all vehicle loads must, as far as possible, conform to the legal dimensions. Permits are only considered for indivisible loads (i.e., loads that cannot be divided into two or more loads for transport on public roads, without disproportionate effort, expense, or risk of damage). Each of the characteristics below has legally permissible limits on what is allowed under the permit.

- Width
- Height
- Length
- Front Overhang
- Rear Overhang
- Front Load Projection
- Rear Load Projection
- Wheelbase
- Turning Radius
- Stability of Loaded Vehicles

5 IDENTIFICATION OF TRAFFIC IMPACT

5.1 Activities with potential traffic impact

The traffic expected to be generated by the proposed powerline can be divided into three phases outlined as follows.

5.1.1 Construction phase

Construction traffic will include vehicles for deliveries, removal of materials and construction staff.

1. **Material and component delivery:** Vehicle trips from material and component delivery vary depending on the construction task/program, fuel supply arrangements, as well as distance from the material source to the site. Not enough detail about the powerline is known at this stage to provide an estimated trip generation volume for material and component traffic.

   The materials and components expected for the powerline construction can generally be transported by normal heavy load vehicles. Project planning can be used to reduce delivery trips during peak hours. In addition to this, using a mobile batch plant as well as temporary construction material stockpile yards near the proposed site can also reduce peak hour trips.

2. **Construction machinery:** Cranes for pylon/tower assembly, heavy vehicles required for earthworks etc. These vehicles are expected to have negligible traffic impact as they will arrive on site in preparation for construction. Once on site, these vehicles will produce internal site traffic with minimal effect on the external road network.

3. **Site personnel and workers:**

Based on information obtained from similar projects the following trip generation assumptions are made for construction personnel:

	Activity	traffic comments	Approx. team size	Approx. duration at a point (i.e., tower location)
1	Centre line pegging and identification of new gates	(light vehicle access)	3	1 day
2	Access Negotiations	(light vehicle access)	1	1 day
3	Tower Pegging	(light vehicle access)	5	1 days
4	New gate installation	(light vehicle access)	5	1 days
5	Foundation nominations (for main structure and anchors)	(heavy vehicle access)	5	2 days
6	Excavation of foundation	(heavy vehicle access)	10	2 days
7	Foundation steelwork (reinforcing)	(heavy vehicle access)	10	2 days
8	Foundation (concrete) pouring	(heavy vehicle access)	20	2 days
9	Delivery of tower steelwork	(heavy vehicle access)	5	1 day
10	Assembly team / Punching and painting	(light vehicle access)	10	3 days
11	Erection	(abnormal load vehicle access)	20	2 days
12	Stringing	(abnormal load vehicle access) (intensive vehicle activity likely within the working area)	50	7 days
13	Sag and tension	(heavy vehicle access)	10	3 days
14	Rehabilitation	(heavy and light vehicle access)	5 to 15	2 – 10 days

It is assumed that the same team will move together from one construction location to the next. Based on this assumption a maximum of 50 to 70 workers can be expected on site per workday.

Based on traffic station data sourced from the Western Cape Government Road Network Information System, there are no taxis or busses operating along the R354. It is recommended that the majority of construction personnel be transported to and from site by means of busses or minibus taxis.

Busses have an average of 60 passenger capacity while minibus taxis have an average passenger capacity of 15. Assuming approximately 20% highly skilled personnel will travel by means of passenger vehicles the following trips are assumed:

- for the skilled personnel a maximum of 14 trips are expected.
- The remaining 56 workers can travel by bus (i.e., 1 bus trip) or 4 (four) minibus taxi trips.

Depending on the construction schedule, a maximum of 18 peak hour site personnel trips is assumed for the purposes of this assessment. This volume is deemed to generate an insignificant traffic impact.

The potential transport impacts imposed by the construction traffic are temporary, short term in nature, and can be mitigated to an acceptable level.

5.1.2 Operation and maintenance phase

Traffic during the operational phase will consist of maintenance staff maintaining the proposed facility. The trips generated during this phase are deemed low as the operational trips will only be for occasional maintenance requirements. To take into account a worst-case scenario, between 5 to 15 peak hour staff trips are assumed at this stage.

5.1.3 Decommissioning phase

The decommissioning phase will generate construction related traffic including transportation of people, construction materials, water and equipment. It is therefore expected that the decommissioning phase will generate the same impact as that of the construction phase.

6 ASSESSMENT OF TRAFFIC RELATED ENVIRONMENTAL IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

6.1 Potential Impact (Construction Phase or Decommissioning Phase)

The decommissioning phase will generate construction related traffic including transportation of people, construction materials, water and equipment (abnormal trucks transporting turbine components). It is therefore expected that the decommissioning phase will generate the same impact as that of the construction phase.

Nature of the impact

- Noise and dust pollution associated potential traffic congestion

Table 6-1: Impact Assessment Table (Construction Phase)

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Traffic	Dust and noise pollution due to traffic	Construction	Negative	Moderate	3	1	3	2	4	**36**	**N3**	2	1	3	2	3	**24**	**N2**
Significance						**N3 - Moderate**							**N2 - Low**						

Proposed mitigation measures

1. The delivery of components to the site can be staggered and trips can be scheduled to occur outside of peak traffic periods.
2. Dust suppression of gravel roads during the construction phase, as required.
3. Regular maintenance of gravel roads is required by the Contractor during the construction phase and by the Owner/Facility Manager during the operational phase.
4. The use of mobile batch plants and quarries near the site would decrease traffic on the surrounding road network.
5. Staff and general trips should occur outside of peak traffic periods as far as possible.

6.2 Potential Impact (Operation Phase)

Nature of the impact

- Noise and dust pollution associated potential traffic congestion

Table 6-2:Potential Impact (Operation Phase)

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Traffic	Dust and noise pollution due to traffic	Operational	Negative	High	2	1	3	1	3	**21**	**N2**	1	1	3	1	2	**12**	**N1**
Significance						**N2 - Low**							**N1 - Very Low**						

Proposed mitigation measures

1. Consider scheduling shift changes to occur during off peak hours.
2. Regular maintenance of gravel roads by the Contractor during the construction phase and by the Owner/Facility Manager during the operational phase.

6.3 Potential cumulative Impact (Construction Phase or Decommissioning Phase)

The cumulative impact assumes that all wind farms within 50km currently proposed and/or approved, would be constructed at the same time. It must be noted that this is a conservative approach

Nature of the impact

- Noise and dust pollution associated potential traffic

Table 6-3: Potential cumulative Impact (Construction Phase or Decommissioning Phase)

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Traffic	Dust and noise pollution due to traffic	Cumulative	Negative	Moderate	5	3	3	2	5	**65**	**N4**	3	2	3	2	4	**40**	**N3**
Significance						**N4 - High**							**N3 - Moderate**						

Proposed mitigation measures

1. The delivery of components to the site can be staggered and trips can be scheduled to occur outside of peak traffic periods.
2. Dust suppression of gravel roads during the construction phase, as required.
3. Regular maintenance of gravel roads is required by the Contractor during the construction phase and by the Owner/Facility Manager during the operational phase.
4. The use of mobile batch plants and quarries near the site would decrease traffic on the surrounding road network.
5. Staff and general trips should occur outside of peak traffic periods as far as possible.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 General

- The proposed Bon Espirange – Komsberg powerline is approximately 3 km long and is located in the Laingsburg Municipality (LM), Western Cape Province, and in the Karoo Hoogland Municipality (KHM), Northern Cape Province. It is proposed to construct a 132 kV powerline that will connect from the proposed Bon Espirange substation to the existing Eskom Komsberg substation.

- The powerline is required in order to evacuate the power generated by the Rietkloof and Brandvalley WEFs to the National Grid.

7.2 Access and internal circulation

- Two access points connecting with the R354 provide access to the project site.
- Additional access roads or tracks may be required to provide access to sections of the powerline route.
- For the access points, it is recommended that the road near the access point be kept clear of tall vegetation to allow for good sight lines.
- The access points are located off existing provincial roads and as such access spacing restrictions are not envisaged.
- It needs to be noted that all access and internal roads should be investigated for their topographical suitability, i.e., feasibility for plant and truck access and height clearance for any Eskom lines, Telkom lines or similar.

7.3 Preferred Route for Materials, Plant and Labour

It is envisaged that the majority of materials, will be sourced from Worcester approximately 160km form the site or alternatively from Cape Town approximately 300 km from the site. The travel route from Worcester to the site travels through the N1 and the R354.

It is envisaged that the workforce will most likely reside in Sutherland, Matjiesfontein, Touws River or Laingsburg as the closest communities. The travel routes form these towns to the site include the N1 and the R354. These are higher order routes as such geometric limitations are not envisaged.

7.4 Traffic impact

No intersection capacity improvements are considered necessary based on the following:

- The site gains access of the R354, which is a Class 2 road designed to accommodate large traffic volumes.
- The only notable generated traffic would occur during the construction and decommissioning phases. The trips generated during these phases will only occur for short periods of time and the following mitigation measures are recommended for consideration:
    i. The delivery of materials and components to the site can be staggered and trips can be scheduled to occur outside of peak traffic periods,
    ii. The use of mobile batching plants and any material sources in close proximity to the site would decrease the impact on the surrounding road network,
    iii. Staff and general trips should can outside of peak traffic periods,
    iv. Staff can be shuttled on scheduled busses to minimise the number of trips; and
    v. Stagger the removal of towers, foundations, conductors etc during the decommissioning phase.

7.5 Assessment of traffic related environmental Impacts and Identification of Management Actions

i. This phase includes the construction of the Facility, including construction of the roads, excavations, trenching and ancillary construction works. This phase will temporarily generate the most development traffic.

The nature of environmental impact expected with construction traffic is noise and dust pollution. It is estimated that the construction traffic will have a moderate significance rating pre mitigation and a low significance rating post mitigation.

Proposed mitigation measures

- The delivery of components to the site can be staggered and trips can be scheduled to occur outside of peak traffic periods.
- Dust suppression of gravel roads during the construction phase, as required.
- Regular maintenance of gravel roads is required by the Contractor during the construction phase and by the Owner/Facility Manager during the operational phase.
- The use of mobile batch plants and quarries near the site would decrease traffic on the surrounding road network.
- Staff and general trips should occur outside of peak traffic periods as far as possible.

ii. The operation and maintenance phase include the operation and maintenance of the WEF

The nature of environmental impact expected with operational traffic is noise and dust pollution. It is estimated that the operational traffic will have a low significance rating pre mitigation and a very low significance rating post mitigation.

Proposed mitigation measures

- Consider scheduling shift changes to occur during off peak hours.
- Regular maintenance of gravel roads is required by the Contractor during the construction phase and by the Owner/Facility Manager during the operational phase.

The decommissioning phase will generate construction related traffic including transportation of people, construction materials, water and equipment (abnormal trucks transporting turbine components). It is therefore expected that the decommissioning phase will generate the same impact as that of the construction phase.

iii. The cumulative impact assumes that all wind farms within 50km currently proposed and/or approved, would be constructed at the same time. It must be noted that this is a conservative approach.

The nature of environmental impact expected is noise and dust pollution. It is estimated that the construction traffic will have a high significance rating pre mitigation and a moderate significance rating post mitigation.

The mitigation measures proposed for the construction phase are proposed for the cumulative impacts during the construction stage.

8 SUMMARY

The aim of this study was to investigate all traffic and transportation related matters pertaining to the Bon Espirange – Komsberg 132 kV powerline to be located in the Laingsburg Municipality (LM), Western Cape Province, and in the Karoo Hoogland Municipality (KHM), Northern Cape Province.

The construction, operation and maintenance, as well as the decommissioning phase of the powerline is not envisaged to generate a significant traffic impact on the surrounding road network. The development of this powerline is supported from a traffic engineering point of view, provided that the recommendations in this report are adhered to and are read in conjunction with the road design and environmental reports completed for this site.

9 REFERENCES

1. Chakraborty, R., 2017. *Studies on Silicone Rubber Insulators used for High Voltage Transmission.* [Online] Available at: https://www.researchgate.net/publication/324703849_Studies_on_Silicone_Rubber_Insulators_used_for_High_Voltage_Transmission [Accessed 17 August 2021].
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ANNEXURE A: IMPACT ASSESSMENT METHODOLOGY

IMPACT ASSESSMENT METHODOLOGY

Assessment of Impacts and Mitigation

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in **Table 10_1**.

Table 10_1: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries

1 Impacts that arise directly from activities that form an integral part of the Project.
2 Impacts that arise indirectly from activities not explicitly forming part of the Project.
3 Secondary or induced impacts caused by a change in the Project environment.
4 Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
5 The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

<u>Impact Mitigation</u>

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in **Figure 10_1** below.

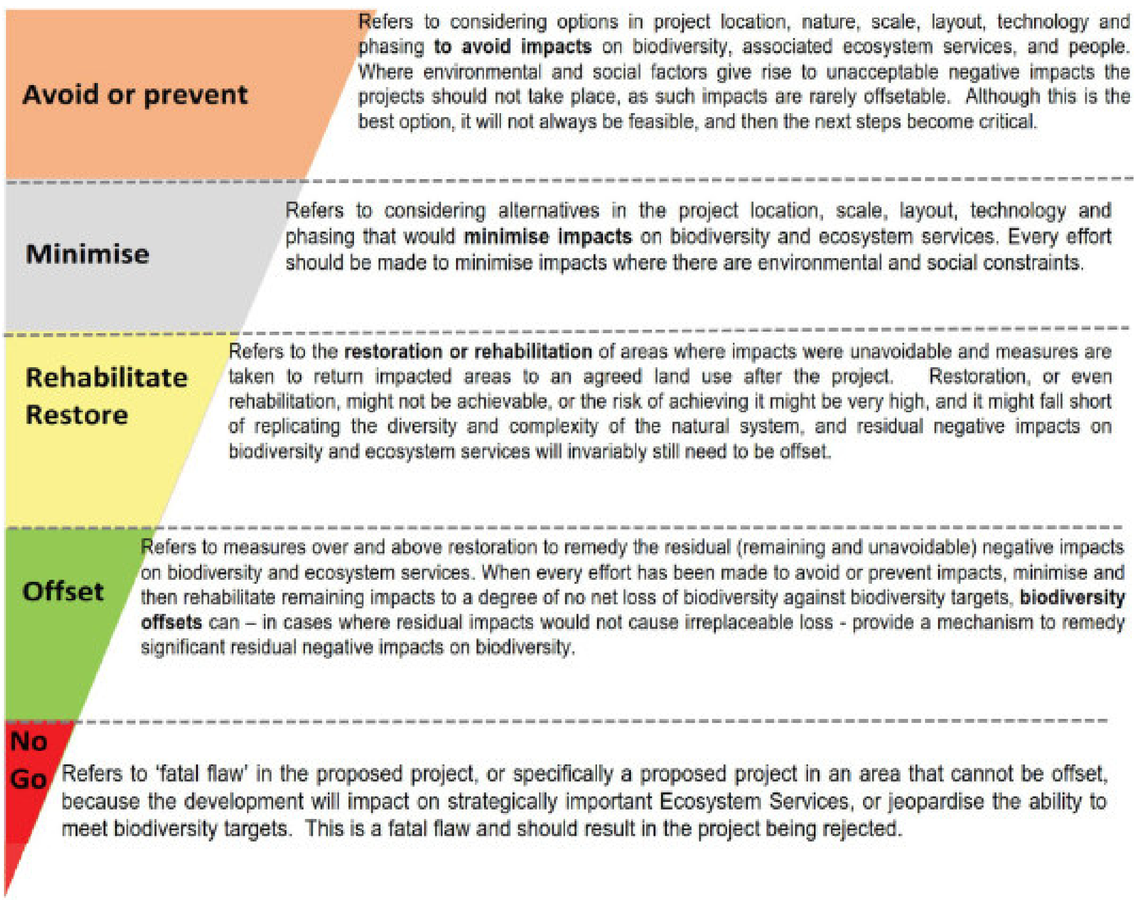

Figure 10_1: Mitigation Sequence/Hierarchy