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Mookodi Integration Project

Geology and Geohydrology Specialist Report – EIA Phase

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Executive Summary

Except for a short section in the northern part of the proposed new distribution line, the area traversed by the new proposed transmission line is underlain by geologically very old hard rock terrain comprising predominantly of lava, and granite-gneiss. Over the northern section, the area is covered by recently deposited aeolian (wind-blown) sand and is generally less than 15m in thickness. Around the town of Vryburg, the substations and short sections of the power line will be constructed on a thin cover of diamictite, a glacially derived rock type, which is again underlain by dolomitic type rocks. Except for the dolomitic type rocks, the area is generally characterized by low groundwater yielding aquifers and the water quality has an electrical conductivity in the range of 70 to 300 mS/m. Elevated fluoride and nitrate concentrations are often present in water from individual boreholes.

During the Scoping phase of the project, four potential groundwater related impacts were identified for the construction, operation and decommissioning phases of the project. These are

- Existing boreholes directly underneath transmission lines;
- Impacts caused by construction camps, workshops and storage areas;
- Impacts at substations caused by the handling of transformer oils; and
- Impacts caused by waste products generated during the project.

These potential impacts were evaluated using the prescribed impact assessment methodology and impact rating system. All the above mentioned potential impacts were rated as having a Low Negative impact score (8 to 20) and therefore, these are considered to have negligible negative effects that will require little to no mitigation. The average post mitigation significance rating is also regarded to be of low negative impact. The negative impacts are of a practical nature and should be easily achievable.

A summary of impacts prior and post-mitigation are shown in the table below.

Environmental parameter	**Issues**	**Rating prior to mitigation**	**Average**	**Rating post-mitigation**	**Average**
Groundwater	Borehole availability	20		6	
	Spillages	20		6	
	Transformer oils	18		6	
	Waste disposal	8		6	
			17		6
			Low negative impact		Low negative impact

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1 INTRODUCTION

Eskom are planning the construction of a 132 kV power line with associated substations in the area between the towns of Vryburg, passing Stella some 45 km NNE of Vryburg) and then turning NW to a new substation called Kalplats. Kalplats is situated some 70 km directly north of Vryburg. The proposed power line ends at the existing Edwards Dam Substation site.

This specialist study focuses on the geological and geohydrological aspects associated with the construction and operation of this new 132kV power line and the different proposed alternative routes for the power line and associated substations that could impact on the groundwater situation along the route.

1.1 Specialist Qualifications

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BSc (Geology, Physics), Univ. Stellenbosch 1968.
MSc (Geology, Geophysics), Univ. Stellenbosch, 1974.
MSc and PhD Courses in Geohydrology and Geophysics, University of Arizona, Tucson, Arizona, USA, 1976 – 1977.
Researcher at CSIR, Pretoria, 1969 to 2007 involved in geological, geophysical and geohydrological research and practical application in the fields of geophysics and geohydrology. Extensive experience in the groundwater component of EIA projects. Since 2007 acting as private geohydrological consultant.

1.2 Assumptions and Limitations

In compiling this report it is assumed that the depth to the base of the pylons to be used in the construction of the line will not extend to the static water table over the entire length of the route. It is further assumed that the unsaturated zone will extend to a depth of about 20m below ground level thereby providing an effective delay in the time for any contaminants to reach the ground water table.

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Site Location and Description

According to the available geological map of the area (CGS, 1993), the town of Vryburg is developed on shale and diamictite of the Dwyka Group, Karoo Supergroup, that unconformably overlie various dolomite, shale, quartzite, conglomerate and lava rock types of the much older Chuniespoort Group of the Transvaal Supergroup. Apart from a short section near Vryburg, most of the power line to Stella will be constructed on outcrops of basaltic lava of the Allanridge Formation, Ventersdorp Supergroup (van der Westhuizen *et al*., 2006). At Stella, the alternative routes turn in a NW to NNW directions towards Mookodi. For the initial approximately 10 km the routes traverse outcrops of the Allanridge lava formation and greenstone of the Stella Belt forming part of the Kraaipan Greenstone Terrane (Brandl *et al*, 2006). Further towards the Kalplats area, the power lines and proposed alternatives will be constructed on geologically young aeolian sands of the Gordonia Formation, Kalahari Group. These sands are presumably underlain over most of the area by granitic type rocks of the Kraaipan Group.

According to Vegter (2000) the power lines and proposed alternative routes and substations will traverse across Groundwater Region 18 referred to as the Western Highveld with the principal ground water bearing rocks being the lava of the Allanridge formation. The Hydrogeological map sheet 2522 (Vryburg, DWAF 2000) indicates that the aquifer type in the rock types traversed by the power lines is described as intergranular and fractured (secondary aquifers) with an average borehole yield of 0.1 to 0.5 l/s. The quality of the ground water as indicated by the electrical conductivity (EC) complies generally to the National Drinking Water Standard (SABS 241: 2006) with an EC range between 70 and 300 mS/m. Nitrogen concentration (as N) of ground water in the area often exceeds 10 mg/l (DWAF, 2000; Tredoux, *et al*., 2009).

According to a map prepared by Vegter *et al*. (1995), static ground water levels in the lava (i.e. most of the power line route) are generally within the range of 10-20 m below ground surface, while around Vryburg in the Dwyka and dolomite formations, it could be somewhat deeper (20-30 m). Due to the relative depth of the water level (relative to the depth of pylon foundations) no immediate impact on ground water quality due to the construction and operation of the power line, would be expected.

2.2 Technical Project Description

This project includes the construction of two (2) substations and five (5) separate 132 KV power lines, with a total length of approximately 110km. The primary power line runs from the proposed Bophirima Substation to Kalplats Substation in the North West Province and is approximately 89 km. The Kalplats-Edwards Dam Ring Extension will consist of an additional ±35km 132kV power line, to be stepped down to 88kV at Edwards Dam existing Distribution Substation. A detailed project and route description is provided in the sections below.

2.2.1 Project Components

The proposed project consists of a number of components which are listed below:

Substations:

- the proposed Bophirima 132/88kV Distribution Substation; and
- the proposed Kalplats 132kV Distribution Substation.

132kV power lines:

- the proposed Bophirima Substation to Kalplats Substation 132kV servitude power line (~89km);
- the proposed Kalplats Substation to the existing Edwards Dam Substation 132kV servitude power line to be stepped down to 88kV at the Edwards Dam substation (~35km);
- the proposed Bophirima Substation to existing Vryburg Municipal Substation 132kV servitude power line (~7km);
- the proposed Bophirima Substation to existing Woodhouse 132kV servitude power line (~0.1km – temporary line until the decommissioning of Woodhouse Substation); and
- the proposed Bophirima Substation to Mookodi Transmission Substation 132kV servitude power line (~14km)[+].

[+] It should be noted that the Mookodi Transmission Substation does not form part of the scope of this project, as environmental authorisation for the substation has been obtained as part of a separate EIA process. However, a single alignment for the Mookodi Transmission Substation site to the proposed Bophirima Substation Alternatives is included as part of the component of this proposed project.

2.2.2 Substations

The proposed substations will occupy an approximate area of 100m X 100m (~10,000m^2 or 1ha). The substations will consist of a number of different components, including feeder bays, transformers, a central control room, lightning conductor mast (14m-high) and a bunded oil drainage area (into which transformer oil / liquids would drain in the event of a spillage). The substation would be enclosed by two levels of fencing to secure the area. The substations will also be lit at night (by a number of 400 Watt floodlights) for security and emergency operational maintenance reasons. A number of power lines will typically enter / leave the substation.

2.2.3 Tower Types and Servitudes

It is proposed that both monopole structures (Figure 3) and lattice structures (Figure 4) will be used where appropriate. Single-tern conductor power lines are proposed. Monopole and lattice tower types that are bird-friendly will be used for the proposed power lines. The monopole tower type is approximately 25m in height. The footprint will be unique for each tower based on the ground conditions such as slope etc. A diagram of the proposed tower types are indicated below. Strain towers will also be used (A strain tower is a larger tower utilised in bends and where reinforcement is required with regards to tower stability).

In most cases the land beneath the overhead lines can be used, as normal, by the landowners. Eskom, however, require that no dwellings or vegetation/crops higher than 4m be established within the servitude.

The minimum servitude width for each line will be 31m.

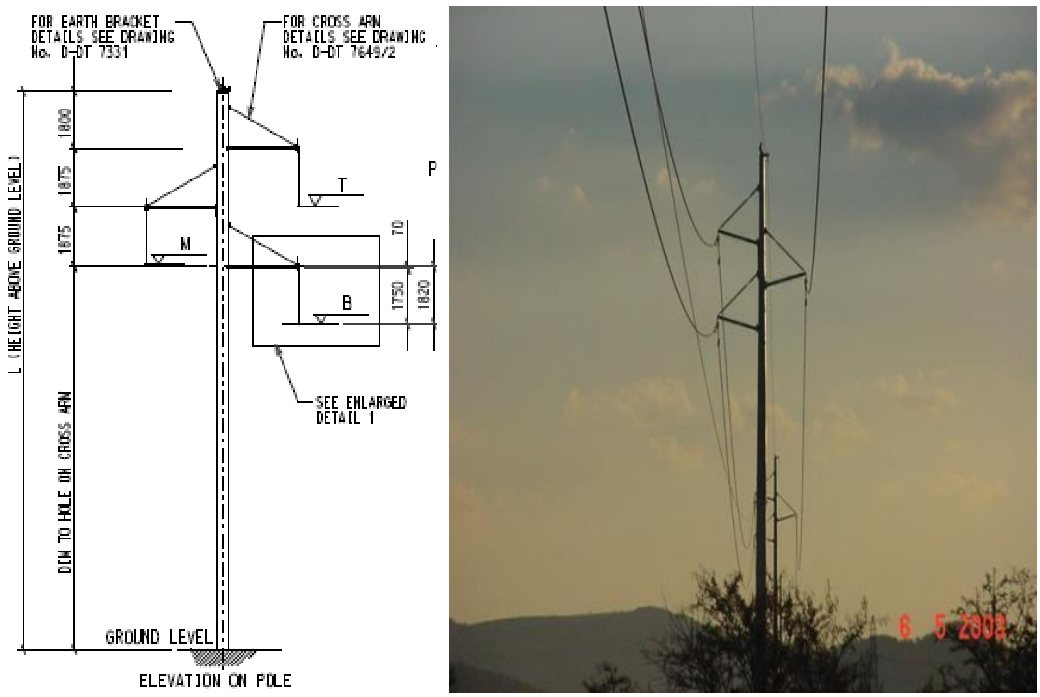
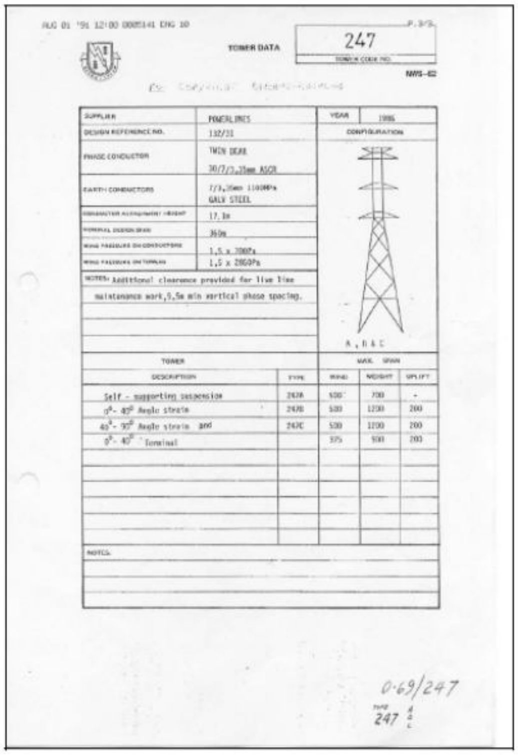


Figure 1: Proposed Monopole Structures



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TOWER DATA

247

TOWER CODE NO.

NWS-02

SUPPLIER	POWERLINES	YEAR	1986
DESIGN REFERENCE NO.	132/33	CONFIGURATION	
PHASE CONDUCTOR	TWIN BEAR 30/7/3,35mm ACSR		
EARTH CONDUCTORS	7/3,35mm 1100MPa GALV STEEL		
CONDUCTOR ATTACHMENT HEIGHT	17,3m		
NOMINAL DESIGN SPAN	360m		
WIND PRESSURE ON CONDUCTORS	1,5 x 700Pa		
WIND PRESSURE ON TOWER	1,5 x 2850Pa		

NOTES: Additional clearance provided for live line maintenance work, 5,5m min vertical phase spacing.

A, B & C

TOWER		MAX. SPAN		
DESCRIPTION	TYPE	WIND	WEIGHT	UPLIFT
Self - supporting suspension	247A	500	700	-
0°- 40° Angle strain	247B	500	1200	200
40°- 90° Angle strain and	247C	500	1200	200
0°- 40° Terminal		375	500	200

NOTES.

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247

Figure 2: Proposed Lattice Structures

2.2.4 Assessment Corridor

A 300m-wide corridor is currently being investigated to allow some flexibility during construction, and to take any site-specific environmental sensitivities into account. The corridor will allow for numerous route alternatives within its width to potentially be selected, and thus forms part of the location alternative assessment. The 31m servitude will be placed within this corridor, unless the EIA studies identify the need to re-route the proposed alignment to avoid sensitive environmental or no-go areas.

2.3 Route Description

A number of proposed components have been included as part of the Mookodi Integration Project. These components are illustrated in the figures in Section 5.1 above and are described in detail below.

2.3.1 Proposed Bophirima Distribution Substation - Alternatives 1 and 2:

The general area of the proposed Bophirima Distribution Substation is located beyond the south-eastern outskirts of Vryburg close to the Bernauw smallholdings. The two substation alternative sites are located to the south of the R34 road, relatively close to the farmstead Constantia and the existing Woodhouse Substation. Alternative 1 and 2 are located in relatively close proximity to one another, with Alternative 1 being located immediately adjacent to the Woodhouse Substation and Alternative 2 being situated further to the south west from Alternative 1.

2.3.2 Proposed Kalplats Distribution Substation - Alternatives 1 and 2:

The general area of the proposed Kalplats Distribution Substation is located approximately 28.5km to the north of the town of Stella. The nearest settlement is the hamlet of Papiesvlakte located 8km to the south-east of the Alternatives locations. The two substation alternative sites are situated on agricultural land on the farm Gemsbokpan, to the west of the Môrester farmstead. Alternative 1 is located to the north of a district road, and Alternative 2 is located 500m to the south, on the southern side of the road.

2.3.3 Mookodi Transmission Substation to Bophirima Substation 132kV Power Line Route

The Mookodi Transmission Substation site is located approximately 6km to the south of the town of Vryburg, to the west of the N18 road on the farm Rosendal 673-IN. A single alignment for the 132kV lines that will link the Mookodi Transmission Substation and the proposed Bophirima Distribution Substation have been provided for assessment. The alignment runs from the Mookodi Transmission Substation site in a north easterly direction. It crosses the N18 road and a railway line, running in a north-easterly direction across open natural veld, passing north of the Georgia farmstead. The alignment then follows parallel to two existing distribution power lines in this area, as well as parallel to the initial section of the proposed Bophirima Substation to Vryburg Municipal Substation 132kV route alignment.

2.3.4 Bophirima Distribution Substation to Vryburg Municipal Substation 132kV power line route

From the proposed Bophirima Substation alternative sites the route of the proposed alignment runs to the south-west across open vacant land, running parallel to two existing distribution power lines and parallel to the alignment for the proposed Mookodi to Bophirima 132kV power line route. The route turns north west before an unsurfaced district road. The route runs parallel with the unsurfaced district road until it meets with the N14. The route then crosses the N14 and runs in a north westerly direction for approximately 400m before turning north east for a short distance of approximately 100m, and then turns to the north-west behind a BP filling station / truck stop-over complex. The alignment heads back towards the N14 and crosses the Leeuspruit wetland. The alignment then runs towards the Vryburg town centre running through a light industrial area. The proposed power line will then run parallel to the N14 in the road reserve to where the existing Vryburg Municipal Substation is located.

2.3.5 Bophirima Distribution Substation to Kalplats Distribution Substation 132kV Power Line Route

Alternative alignments have been provided for comparative assessment along a part of the alignment to the north of the town of Stella. Both alternatives follow the same alignment between Vryburg (Bophirima) and Stella.

The route is proposed to exit the proposed Bophirima Substation, running north-east from the substation site and crossing the R34 road into the Bernauw smallholdings. The alignment crosses mostly open vacant grazing land in this area and is proposed to run parallel to a set of existing distribution power lines. To the south of the farmstead Helena, the alignment turns and runs in a north-westerly direction along a cadastral boundary between the farms Bernauw and Welgelegen. The alignment runs across open natural veld used for livestock grazing to where it crosses the N14 road near the farmstead Oppie Koppie. The route continues in a north-westerly alignment, crossing a railway, across open grazing land. The route intersects the Paradise unsurfaced local access road, running parallel to it before intersecting the N18 road.

To the north of this point the alignment turns to run parallel to the N18 in a north-easterly direction towards Stella. The alignment passes the Boereplaas Resort and the turn-off to Devondale, traversing the farms Elma, Thabanchu, Mabula, Weltevreden, Pan Plaats and Spitz Kop. The route traverses open veld and pastures which are used mainly for grazing through this area. Approximately 3km to the south of Stella the route turns away to the north-west from the N18, following a farm access road to the Chwaing farmstead. The alignment then moves away from the farm access road to follow a cadastral boundary, thus running to the east of the Chwaing farmstead. The route continues to run across open grazing pastures along the cadastral boundary of Zoutpansfontein to where it intersects with a local district road. The route turns to the north-east to run parallel to the road, then running across more pastures to the south of the Stroebelsrus farmstead. The route traverses the R377 (unsurfaced) road to the point where Alternative 1 and 2 split.

The proposed Bophirima Substation to Kalplats Substation Alternative 1 runs to the north east for a short distance along the boundary of the Farm Wilgemoed 344 consisting mainly of dry land maize cultivation before turning predominantly northwards. The proposed power line route runs through the farms Wilgemoed 344 (close to the Gelboer farmstead), Wonderklip 339 (close to the Waterval farmstead), and Koodos Rand near the Paardepan farmstead. The alignment traverses a mix of natural bushveld vegetation and cleared pastures and cultivated fields as it passes the farms Wonderklip and Koodoos Rand. From this point, the proposed route turns to the northwest, traversing a district road and the farm boundary of the Koodoos Rand and Gemsbok Pan for a relatively short distance. The proposed route then turns to the west where it eventually meets with the two proposed Kalplats Substation Sites.

Bophirima Substation to Kalplats Substation Alternative 2 leaves Alternative 1 to the north of Stella, running across maize fields before intersecting, and then running parallel to the R377 in a north-westerly direction. It crosses a mix of farming land (maize fields) and natural thornveld, traversing the farms Welgemoed, Koodoos Dam, Blink Klip and Koodoos Rand. At the intersection of the R377 and a district road, the route turns away from the R377 in a northerly direction for a short distance before following the cadastral boundary of the farm Koodoos Rand to the north east. The route intersects the district road still running in a north easterly direction until meeting up with the Bophirima Substation to Kalplats Substation Alternative 1 where the proposed alignment follows the same route to the Kalplats Substation Sites.

2.3.6 Proposed Kalplats Substation Alternatives 1 and 2 to existing Edwards Dam Substation 132kV power line route

Alternative 1 exits the proposed Kalplats substation and heads west over agricultural/ cultivated land for approximately 3.7kms until it meets with a district road. The route then turns north, following the district road alignment across the farm Groot Gewaagd to Klip Pan, and then heads north-west towards Heeferslust. Just south of Heeferslust, the route turns west and then south-west following an existing power line servitude all the way to Edwards Dam situated adjacent to the Provincial Road R377. This last sector of the route travels across cultivated lands comprising the farms Heefers Lust, Kinderdam, Houmoed and Helpmekaar.

Alternative 3 exits the proposed Kalplats substation and heads west across the District Road following the alignment of a local road for approximately 2kms through agricultural land. The route then runs along the northern boundary of the farm Gemsbok Pan heading in a westerly direction where it then follows the Groot Verdriet 310 farm boundary until it meets up with the R377. The proposed route then follows the alignment of the Provincial Road R377 to Edwards Dam crossing the farms Bont Bok 259 and Helpmekaar.

3 ASSESSMENT METHODOLOGY

The section below outlines the assessment methodologies utilised in the study.

3.1 Methodology for Impact Assessment

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

3.1.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 2.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

3.1.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

- Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 1: Impact Rating Table

<table>
<tr><th colspan="3">NATURE</th></tr>
<tr><td colspan="3">Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><th colspan="3">GEOGRAPHICAL EXTENT</th></tr>
<tr><td colspan="3">This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.</td></tr>
<tr><td>1</td><td>Site</td><td>The impact will only affect the site</td></tr>
<tr><td>2</td><td>Local/district</td><td>Will affect the local area or district</td></tr>
<tr><td>3</td><td>Province/region</td><td>Will affect the entire province or region</td></tr>
<tr><td>4</td><td>International and National</td><td>Will affect the entire country</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><th colspan="3">PROBABILITY</th></tr>
<tr><td colspan="3">This describes the chance of occurrence of an impact</td></tr>
</table>

1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).

2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.

4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability+ duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant

		positive effects.

Table 2: Rating of impacts

IMPACT TABLE FORMAT		
Environmental Parameter	*A brief description of the environmental aspect likely to be affected by the proposed activity e.g. Surface water*	
Issue/Impact/Environmental Effect/Nature	*A brief description of the nature of the impact that is likely to affect the environmental aspect as a result of the proposed activity e.g. alteration of aquatic biota The environmental impact that is likely to positively or negatively affect the environment as a result of the proposed activity e.g. oil spill in surface water*	
Extent	*A brief description of the area over which the impact will be expressed*	
Probability	*A brief description indicating the chances of the impact occurring*	
Reversibility	*A brief description of the ability of the environmental components recovery after a disturbance as a result of the proposed activity*	
Irreplaceable loss of resources	*A brief description of the degree in which irreplaceable resources are likely to be lost*	
Duration	*A brief description of the amount of time the proposed activity is likely to take to its completion*	
Cumulative effect	*A brief description of whether the impact will be exacerbated as a result of the proposed activity*	
Intensity/magnitude	*A brief description of whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily*	
Significance Rating	*A brief description of the importance of an impact which in turn dictates the level of mitigation required*	
	Pre-mitigation impact rating	
Extent	4	Extent
Probability	4	Probability
Reversibility	4	Reversibility
Irreplaceable loss	4	Irreplaceable loss
Duration	4	Duration
Cumulative effect	4	Cumulative effect
Intensity/magnitude	4	Intensity/magnitude
Significance rating	-96 (high negative)	Significance rating
Mitigation measures	*Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. Describe how the mitigation measures have reduced/enhanced the impact with relevance to the impact criteria used in analyzing the significance. These measures will be detailed in the*	

IMPACT TABLE FORMAT	
	EMP.

The 2010 regulations also specify that alternatives must be compared in terms of an impact assessment.

4 CURRENT STATUS QUO

During the Scoping phase of the project and from a geological and geohydrological perspective, potential impacts as described below have been identified and were reported. However, due to the depth of the water level relative to the depth of pylon foundations, no immediate impact on ground water quality or conditions due to the construction and operation of the power line, would be expected. Furthermore, no impact on the availability of groundwater resources is foreseen.

Potential groundwater related impacts identified were:

Planning phase:

No impacts identified.

Construction phase:

- *Existing boreholes directly underneath the power line.* The power line and towers do not pose any impact to the ground water resources of the area. Where existing boreholes are positioned directly underneath the power line, arrangements with the owner may have to be made to either close or replace the boreholes as future servicing of these boreholes is not allowed under current South African safety regulations.
- *Construction camps, storage areas and workshops.* Adequate provision needs to be made that no spillages of oil, diesel and other harmful effluents do occur and provision has to be made to contain any spillages should these occur.
- *Transformer oils at existing and new substations.* Transformers contain toxic fluids that need replacement from time to time. Provision has to be made that no spillages of such fluids occur during servicing of these transformers within substations or other storage facilities. During the construction phase the existing Woodhouse Substation is also to be decommissioned that will involve the removal/dismantling of transformers.
- *Domestic and industrial waste disposal.* Provision has to be made for the responsible collection and disposal of waste generated at construction sites and substations. Such waste has to be disposed of at waste disposal facilities approved to accept the specific type of waste.

Operational and decommissioning phases:

- *Transformer oils at existing and new substations.* Transformers contain toxic fluids that need replacement and maintenance from time to time. Provision has to be made that no spillages of such fluids occur during servicing of these transformers within substations or other storage facilities.

5 IMPACT ASSESSMENT

5.1 Potential Impacts during construction phase

The following potential impacts were identified during the scoping phase:

- *Existing boreholes directly underneath the power line.* The power line and towers will not pose any direct impact to the ground water resources of the area. Where existing operational or potentially useable boreholes are positioned directly underneath the overhead power lines, arrangements with the owner may have to be made to either close or replace the boreholes as future servicing of these boreholes is not allowed under existing safety regulations.
- *Construction camps, storage areas and workshops.* Adequate provision needs to be made that no spillages of oil, diesel and other harmful effluents occur and provision has to be made to contain any spillages should these occur.
- *Transformer oils at existing and new substations.* Many transformers contain toxic fluids that need replacement and servicing from time to time. Provision has to be made that no spillages of such fluids occur during servicing of these transformers within substations or other storage facilities. The same conditions apply when substations and transformers will be decommissioned.
- *Domestic and industrial waste disposal.* Provision has to be made for the responsible collection and disposal of waste generated at construction sites and substations. Such waste has to be disposed of at waste disposal facilities approved to accept the specific type of waste.

5.2 Potential Impacts during Operation and Decommissioning

The following potential impact was identified during the scoping phase:

- *Transformer oils at existing and new substations.* Transformers contain toxic fluids that need replacement and servicing from time to time. Provision has to be made that no spillages of such fluids occur during servicing of these transformers within substations or other storage facilities.

5.3 Impact Matrix

Table 1: Rating Matrix for impacts in the Construction phase: Continued borehole availability

IMPACT TABLE		
Environmental Parameter	Continued borehole availability	
Issue/Impact/Environmental Effect/Nature	No environmental impact, but possible impact on long term sustainability of water supply from boreholes directly under power lines. Existing boreholes directly underneath high voltage overhead power lines may not be serviced by drilling rigs or any form of high lifting crane. Safety regulations prohibit the erection of drilling rigs or cranes below high voltage power lines to, for example service boreholes or the pumping equipment installed in a borehole.	
Extent	Only applicable to existing or operating boreholes directly below the overhead distribution lines.	
Probability	A replacement borehole with a similar minimum sustainable yield could be drilled outside the restricted area.	
Reversibility	No environmental impact, but a possible impact on the continued availability of groundwater from that specific borehole to provide water for the original use.	
Irreplaceable loss of resources	Unlikely that groundwater resource will be irreplaceably lost.	
Duration	Within approximately 2 to 4 weeks a replacement borehole could be sited, drilled, tested and equipped.	
Cumulative effect	The provision of an alternative borehole (or source) for groundwater could be done before existing borehole is to be decommissioned.	
Intensity/magnitude	Only a temporary service interruption from the water resource could be expected.	
Significance Rating	As mitigation, a replacement of an existing borehole could be expected where a borehole is located exactly below the transmission line.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	2	1

IMPACT TABLE		
Intensity/magnitude	2	1
Significance rating	20 (Negative low impact)	6 (Negative low impact)
Mitigation measures	Replacement of borehole(s) with a new borehole to the same status (in terms of installed equipment and delivering similar or higher yield) as the one being replaced.	

Table 2: Rating Matrix for impacts in the Construction phase: Construction camps

IMPACT TABLE		
Environmental Parameter	*Construction camps, storage areas and workshops.* Adequate provision needs to be made that no spillages of oil, diesel and other harmful substances and/or effluents do occur that could potentially contaminate the soil and groundwater resources.	
Issue/Impact/Environmental Effect/Nature	Potential of soil and groundwater contamination.	
Extent	In such cases, the area impacted is usually small.	
Probability	Low	
Reversibility	Contaminated soil can be recovered and treated before the deeper groundwater aquifer may be impacted	
Irreplaceable loss of resources	Unlikely that soil and groundwater resources will be lost.	
Duration	Short term	
Cumulative effect	Possible impact will not impact negatively on existing groundwater quality.	
Intensity/magnitude	No temporary or permanent negative impact on groundwater expected.	
Significance Rating	Low significance.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	2	1
Cumulative effect	1	1
Intensity/magnitude	2	1
Significance rating	20 (Negative low impact)	6 (Negative low impact)

IMPACT TABLE	
Mitigation measures	Vehicle service bays have to be provided with oil collection traps. All storage facilities for fuel, oil, solvents and other chemicals, and possibly also herbicide, that can potentially contaminate groundwater, have to be provided with collection trays to contain spillages or leakages.

Table 3: Rating Matrix for impacts in the Construction phase: Transformer oil

IMPACT TABLE		
Environmental Parameter	*Transformer oils at existing substations that will be decommissioned.* Transformers contain toxic fluids that may possibly be drained before dismantling and/or transport. Provision has to be made that no spillages of such fluids occur during draining such transformers within substations or other storage facilities.	
Issue/Impact/Environmental Effect/Nature	Soil and/or groundwater contamination.	
Extent	Low, provided provision is made to contain possible spillages.	
Probability	Should a spillage occur, all affected soil must be immediately removed and stored for future proper disposal or rehabilitation. This will ensure minimal impact to soil and groundwater resources.	
Reversibility	Soil and groundwater quality.	
Irreplaceable loss of resources	Unlikely that irreplaceable resources will be lost.	
Duration	For shallow soils, contamination will be immediate, while groundwater contamination will depend on the depth of the water table and the migration path characteristics. Groundwater contamination is expected to manifest itself only after a relatively long period following a spill.	
Cumulative effect	Unlikely that the impact will substantially increase with further spills.	
Intensity/magnitude	Impact not expected to impact the soil and groundwater quality permanently.	
Significance Rating	Should the groundwater in the immediate vicinity of the spill be used extensively, groundwater quality will be jeopardised and immediate remediation would be required.	
	Pre-mitigation impact	Post mitigation impact

IMPACT TABLE		
	rating	rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	1	1
Intensity/magnitude	2	1
Significance rating	18 (Negative low impact)	6 (Negative low impact)
Mitigation measures	During servicing of or oil replacement at transformers provision should be made to collect all oil in suitable containers and to contain any accidental spillage.	

Table 4: Rating Matrix for impacts in the Construction phase: Domestic and industrial waste disposal

IMPACT TABLE		
Environmental Parameter	*Domestic and industrial waste disposal.* Provision has to be made for the responsible collection and disposal of waste generated at construction sites and substations.	
Issue/Impact/Environmental Effect/Nature	Such waste has to be disposed of at waste disposal facilities approved to accept the specific type of waste. Uncontrolled disposal could result in groundwater contamination over the long term.	
Extent	Area likely to be impacted is small due to the small volume of waste that is expected to be generated.	
Probability	Likelihood of groundwater contamination is low and with regular groundwater recharge the groundwater quality is expected to return to its long term natural quality.	
Reversibility	Groundwater quality may only be slightly negatively impacted, but this should return to an acceptable quality in a relatively short period.	
Irreplaceable loss of resources	Contamination of groundwater to the extent that the resource will be permanently lost is unlikely.	
Duration	Contamination could occur over a few years, but will depend on local geohydrological conditions.	
Cumulative effect	Impact mot expected to increase significantly over the duration of the construction period.	
Intensity/magnitude	Only a slight and temporary negative impact on the groundwater quality could be expected.	
Significance Rating	The impact is expected to be of low significance.	
	Pre-mitigation impact rating	Post mitigation impact rating

IMPACT TABLE		
Extent	1	1
Probability	1	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	8 (Negative low impact)	6 (Negative low impact)
Mitigation measures	All waste products (domestic, general and hazardous waste) have to be collected in suitable containers for disposal at licences waste disposal facilities registered to accept the specific waste type.	

Table 5: Rating Matrix for impacts in the Operation phase: Transformer maintenance at substations.

IMPACT TABLE	
Environmental Parameter	*Transformer oils at existing substations to be decommissioned.* Transformers contain toxic fluids that may possibly be drained before dismantling and/or transport. Provision has to be made that no spillages of such fluids occur during draining such transformers within substations or other storage facilities. Suitable containers should be used to collect, remove and transport the collected oil.
Issue/Impact/Environmental Effect/Nature	Potential soil and groundwater contamination in the vicinity of transformers when an oil spill occurs during the required replacement of oil or servicing of transformers at substations during the regular maintenance intervals.
Extent	Transformers used in substations contain toxic PCBs or other suitable hydrocarbons which can cause soil and ground and surface water contamination if servicing of transformers is not responsibly done or inadequate storage and containment facilities are not provided.
Probability	Low, provided provision is made to contain possible spillages.
Reversibility	Should a spillage occur, all affected soil must be immediately removed and stored for future proper disposal or rehabilitation. This will ensure minimal impact to soil and groundwater resources.
Irreplaceable loss of resources	Soil and groundwater quality.
Duration	Unlikely that irreplaceable resources will be lost.

IMPACT TABLE		
Cumulative effect	For shallow soils, contamination will be immediate, while groundwater contamination will depend on the depth of the water table and the migration path characteristics. Groundwater contamination is expected to manifest itself only after a relatively long period following a spill.	
Intensity/magnitude	Unlikely that the impact will substantially increase with further spills.	
Significance Rating	Impact not expected to impact the soil and groundwater quality permanently. If groundwater in the immediate vicinity of the spill is used extensively, groundwater quality may be jeopardised and immediate remediation could be required.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	1	1
Intensity/magnitude	2	1
Significance rating	18 (Negative low impact)	6 (Negative low impact)
Mitigation measures	During servicing of or oil replacement at transformers provision should be made to collect all oil in suitable containers and to contain any accidental spillage.	

Table 6: Rating Matrix for impacts on Decommissioning phase: Decommissioning of transformers at substations

IMPACT TABLE	
Environmental Parameter	Transformer oils at existing substations to be decommissioned. Transformers contain toxic fluids that may possibly be drained before dismantling and/or transport. Provision has to be made that no spillages of such fluids occur during draining such transformers within substations or other storage facilities. Suitable containers should be used to collect, remove and transport the collected oil.
Issue/Impact/Environmental Effect/Nature	Potential soil and groundwater contamination in the vicinity of transformers when an oil spill occurs during the required replacement of oil or servicing of transformers at substations during the regular maintenance intervals.

IMPACT TABLE		
Extent	Transformers used in substations contain toxic PCBs or other suitable hydrocarbons which can cause soil and ground and surface water contamination if servicing of transformers is not responsibly done or inadequate storage and containment facilities are not provided.	
Probability	Low, provided provision is made to contain possible spillages.	
Reversibility	Should a spillage occur, all affected soil must be immediately removed and stored for future proper disposal or rehabilitation. This will ensure minimal impact to soil and groundwater resources.	
Irreplaceable loss of resources	Soil and groundwater quality.	
Duration	Unlikely that irreplaceable resources will be lost.	
Cumulative effect	For shallow soils, contamination will be immediate, while groundwater contamination will depend on the depth of the water table and the migration path characteristics. Groundwater contamination is expected to manifest itself only after a relatively long period following a spill.	
Intensity/magnitude	Unlikely that the impact will substantially increase with further spills.	
Significance Rating	Impact not expected to impact the soil and groundwater quality permanently. If groundwater in the immediate vicinity of the spill is used extensively, groundwater quality may be jeopardised and immediate remediation could be required.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	1	1
Intensity/magnitude	2	1
Significance rating	18 (Negative low impact)	6 (Negative low impact)
Mitigation measures	During decommissioning of transformers, all oil should be removed from the transformer and collected in suitable containers for future storage and transport. Provision should also be made to contain all accidental and other possible spillages during the oil removal process.	

5.4 Confidence in Impact Assessment

The overall risk to impact on groundwater resources during the construction and operational phases of the project is relatively low and therefore the confidence in the impact assessment described in the preceding sections is high. Proposed mitigation measures are practical believed to be easily attainable.

5.5 Cumulative Impacts

5.5.1 Construction Phase

No cumulative impacts to the groundwater environment are foreseen during the construction phase of the project.

5.5.2 Operation Phase

No cumulative impacts to the groundwater environment are foreseen during the operational phase of the new distribution line and associated infrastructure.

5.5.3 Decommissioning phase

No cumulative impacts to the groundwater environment are foreseen during the decommissioning phase of the new transmission line and associated infrastructure.

5.6 Reversibility of Impacts

All identified possible impacts are generally considered to be of low impact. Should such impacts occur, the impact should be easily remediated when and if acted upon as soon as it has been noticed or reported.

6 MITIGATION MEASURES

6.1 Construction

Mitigation measures are described in the Impact Table (Section 5.3) for each identified impact.

6.2 Operation

Mitigation measures are described in the Impact Table (Section 5.3) for each identified impact.

6.3 Achievability of Mitigation Measures

The proposed mitigation measures described in Section 5.3 are practical and should be easily achievable.

7 COMPARATIVE ASSESSMENTS

In view of the low significance rating of all impacts identified, (1) no preference is given to any of the alternative power line routes and substation positions, (2) no concerns from a groundwater perspective have been identified, and therefore (3) no fatal flaws have been identified. This is reflected in the table below.

Alternative	Preferred/Not preferred/ No Preference	Specialist Concerns	Fatal Flaws (Yes/No)
Bophirima Substation to Kalplats Substation Corridor Alternative 1	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Bophirima Substation to Kalplats Substation Corridor Alternative 2	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Kalplats Substation to Existing Edwards Dam Substation Corridor Alternative 1	No preference	No concerns from a groundwater perspective other than impacts decsribed in impact tables.	No
Kalplats Substation to Existing Edwards Dam Substation Corridor Alternative 3	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Bophirima Substation Alternative 1	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Bophirima Substation Alternative 2	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Kalplats Substation Alternative 1	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No
Kalplats Substation Alternative 2	No preference	No concerns from a groundwater perspective other than impacts described in impact tables.	No

8 CONCLUSIONS AND RECOMMENDATIONS

Except for a short section in the northern part of the proposed new transmission line, the area traversed by the line is underlain by geologically old hard rock terrain comprising of diamictite, dolomite, chert, quartzites, lava, and granite-gneiss. Over the northern section the area is covered by recently deposited aeolian (wind-blown) sand.

With the exception of the small area around Vryburg where dolomitic rocks are present, the groundwater yield from boreholes is in general low and the different rock types are not regarded to host high yielding aquifers. Groundwater levels are generally in the 20m to 30m depth range. The groundwater has an electrical conductivity in the range of 70 to 300 mS/m, while elevated fluoride and nitrate concentrations are often present in water from individual boreholes.

During the Scoping phase of the project and from a geological and geohydrological perspective, four potential groundwater related impacts were identified for the construction, operation and decommissioning phases of the project. These are

- Existing boreholes directly underneath transmission lines;
- Impacts caused by construction camps, workshops and storage areas;
- Impacts at substations caused by the handling of transformer oils; and
- Impacts caused by waste products generated during the project.

These potential impacts were evaluated using the prescribed impact assessment methodology and impact rating system. All the abovementioned potential impacts were rated as having a Negative Low impact score (8 - 20) and therefore, these are considered to have negligible negative effects that will require little to no mitigation. The mitigation measures proposed are also of a practical nature and should be easily achievable should these be required.

Due to the low significance rating of all impacts identified, no preference is given to any of the alternative power line routes and substation positions, and therefore no concerns and/or fatal flaws from a groundwater perspective have been identified.

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