PALAEONTOLOGICAL IMPACT ASSESSMENT

MERCURY POWER LINE

NEAR VILJOENSKROON

IN THE FREE STATE PROVINCE

2022

COMPILED FOR:

ENVIRONAMICS ENVIRONMENTAL

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and

- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

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SIGNATURE: 

The heritage impact assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1: NEMA Table

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 3 – refer to **Appendix A**	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 5 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 6 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1;10 & 12	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 8 Approach and Methodology	-
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 1;10 & 11	
(g) An identification of any areas to be avoided, including buffers	Section 1 & 12	
(h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 6 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 8.1 – Assumptions and Limitation	-
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 1 and 12	
(k) Any mitigation measures for inclusion in the EMPr	Section 13	
(l) Any conditions for inclusion in the environmental authorisation	Section 13	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 13	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 & 12	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 1 and 12	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
		regarding heritage resources that require input from a specialist have been raised.
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Environamics Environmental Consultants to conduct the Palaeontological Impact Assessment (PIA) to assess the Proposed Mercury Power Line near Viljoenskroon in the Free State.In accordance with the National Environmental Management Act 107 of 1998 (NEMA) and to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed Mercury power line is underlain by Quaternary sands in the east, the Precambrian dolomites and associated marine sedimentary rocks of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) underlies the northern portion of the line, while the eastern portion is underlain by the Vryheid Formation (Ecca Group, Karoo Supergroup) and Quaternary sands.

According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and that of the Vryheid Formation (Ecca Group, Karoo Supergroup) is Very High while that of the Quaternary aeolian sand is moderate (Figure 7, Table 5) (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 30 July 2022. No fossiliferous outcrop was detected in the proposed development area. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is therefore considered that the proposed development is deemed appropriate and feasible and will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Protocol must be implemented by the ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO/site manager must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Construction Stage Power line Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Power line Operational Phase	No Impact		No Impact		No Impact
Power Line Decommissioning Phase	No Impact		No Impact		No Impact
Substations (1-2) layout options Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Substations Operational Phase	No Impact		No Impact		No Impact
Substation Decommissioning Phase	No Impact		No Impact		No Impact

It is therefore considered that the proposed Mercury Power Line is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. Thus, the construction of the development may be authorised in its whole extent.

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1 INTRODUCTION

The Mercury Power line is proposed to connect the Authorised Paleso, Siyanda and Ngwedi Solar Power Plants (SPPs) to the electrical grid (Figure 1-4).

Table 2:General site information

Description of affected farm portion	Power Line Portion 23 of the farm Pretorius Kraal No. 53 Portion 24 of the farm Pretorius Kraal No. 53 Remaining Extent of the farm Pretorius Kraal No. 53 Remaining Extent of the Farm Grootdraai No. 468 Remaining Extent of Portion 1 of the Farm Grootdraai No. 468 Mispah No. 274 Kleinfontein No. 472 Chrystalkop No. 69 Remaining Extent of the Farm Doornkom-West No. 446 Edom No. 277 Moab No. 279 Portion 1 of the Farm Zuiping No. 394 Portion 3 of the Farm Zuiping No. 394 Portion 4 of the Farm Zuiping No. 394 Portion 5 of the Farm Zuiping No. 394 Remaining Extent of the Farm Zuiping No. 394 Portion 2 of the Farm Zaaiplaats No. 190 Portion 3 of the Farm Zaaiplaats No. 190
Province	Free State
District Municipality	Fezile Dabi District Municipality
Local Municipality	Moqhaka Local Municipality
Ward numbers	22
Closest towns	The town of Viljoenskroon is located approximately 27 km south-east of the proposed development.
21 Digit Surveyor General codes	Power Line Portion 23 of the farm Pretorius Kraal No. 53 F03600000000005300023 Portion 24 of the farm Pretorius Kraal No. 53 F03600000000005300024 Remaining Extent of the farm Pretorius Kraal No. 53 F03600000000005300000 Remaining Extent of the Farm Grootdraai No. 468 F03600000000046800000 Remaining Extent of Portion 1 of the Farm Grootdraai No. 468 F03600000000046800001 Mispah No. 274 F03600000000027400000 Kleinfontein No. 472 F03600000000047200000

	Chrystalkop No. 69 F03600000000006900000 Remaining Extent of the Farm Doornkom-West No. 446 F03600000000044600000 Edom No. 277 F03600000000027700000 Moab No. 279 F03600000000002790000 Portion 1 of the Farm Zuiping No. 394 F03600000000039400001 Portion 3 of the Farm Zuiping No. 394 F03600000000039400003 Portion 4 of the Farm Zuiping No. 394 F03600000000039400004 Portion 5 of the Farm Zuiping No. 394 F03600000000039400005 Remaining Extent of the Farm Zuiping No. 394 F03600000000039400000 Portion 2 of the Farm Zaaiplaats No. 190 F03600000000019000002 Portion 3 of the Farm Zaaiplaats No. 190 F03600000000019000003
Type of technology	132 kV single circuit/ double circuit overhead power line
Structure Height	Power lines ~32m
Length of the power line	Approximately 11km
Grid connection corridor width	200m wide on average (and up to 800m in some instances)
Collector Substation capacity	132kV
Collector Substation footprint	2.5 hectare
Servitude width	Approximately 32m
Surface area to be covered	Approximately 373 hectares
Service road	Twin track gravel road up to 5m wide

1.2 TECHNICAL DETAILS

For the authorised Paleso, Siyanda and Ngwedi Solar Power Plants (SPPs) to connect to the electrical grid, requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation (i.e., collector substation) will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. A substation has been authorised to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the new proposed collector substation and the power line. The existing Eskom Mercury Substation is considered as the feasible connection point.

- Construction Phase:

  The proposed 132kV overhead power line will be approximately 11km long and will be constructed within the identified grid connection corridor. The minimum vertical clearance to buildings, poles and structures not forming part of the power line must be 3.8m, while the minimum vertical clearance between the conductors and the ground is 6.7m. The minimum distance between trees and shrubs and any bare phase conductor of a 132kV power line must be 4m, allowing for the possible sideways movement and swing of both the power line conductor and the tree or shrub. The structure to be utilised for the power line towers will be informed by the local geotechnical and topographical conditions as well as by specific requirements from Eskom.

  The construction of the proposed overhead power line and collector substation(s) will take approximately 12 months to complete. Following the Commercial Operation Date (COD) of the authorised Paleso SPP, Siyanda SPP and Ngwedi SPP, the applicant will hand over the powerline and the associated infrastructure (i.e. substation and service road) to Eskom Holdings SOC Ltd (Eskom) to operate and maintain. This is in line with Eskom's well-established Self Build Grid Connection Strategy for Renewable Energy Projects developed under the REIPPP Procurement Programme.

- Operation Phase:

  The proposed power line and associated servitude will require routine maintenance throughout the operation period.

- Decommissioning Phase:

  The photovoltaic solar power plant has a lifespan of between 20 and 25 years from where the facility and its associated infrastructure will be decommissioned or upgraded. If the solar plant is not decommissioned the power line is expected to have a lifespan of more than 40 years (with maintenance) and the infrastructure will only be decommissioned once it has reached the end of life, or if no longer required. Upon decommissioning, the power line would be disassembled, and the components removed from site, and recycled where possible, in line with the Environmental Management Programme EMPr.

1.3 CONSIDERATION OF ALTERNATIVES

The DEAT 2006 guidelines on 'assessment of alternatives and impacts' proposes the consideration of four types of alternatives namely, the no-go, location, activity, and design alternatives. It is however, important to note that the regulation and guidelines specifically state that only 'feasible' and 'reasonable'

alternatives should be explored. It also recognizes that the consideration of alternatives is an iterative process of feedback between the developer and EAP, which in some instances culminates in a single preferred project proposal.

The grid connection corridor proposed for the development is considered to be the preferred alternative for development based on the location of the connection point into the national grid in relation to the authorised SPPs, the need to identify the shortest and most feasible route for the connection. The developer also considers the grid connection corridor as being preferred from a technical perspective.

The following sections explore different types of alternatives in relation to the proposed power line in more detail.

No-go alternative

This alternative considers the option of 'do nothing' and maintaining the status quo. The grid connection corridor and the surrounding areas is currently zoned for agricultural land uses. Should the proposed activity not proceed, the corridor will remain unchanged and will continue to be used for agricultural purposes. The purpose of the proposed 132kV power line is to connect the authorised Paleso, Siyanda and Ngwedi Solar Power Plants with the National Grid. If the status quo is maintained, the potential opportunity costs in terms of the successful operation of the SPPs would be lost, since it will not be able to operate without the power line, which in turn will result in job losses and loss of economic growth in the area.

Location alternatives

This alternative asks the question, if there is not, from an environmental perspective, a more suitable location for the power line. Only one route alternative is being considered since this is considered as the most feasible and shortest route to connect the SPPs to the National Grid. The proposed power line is approximately 11km long, and the proposed route of the power line is the shortest route from the authorised on-site substation(s) to the National Grid.

Design and layout alternatives

1. Collector Substation Alternative Locations:

Within the grid connection corridor, two collector substation location options are being considered for development. These are all located within the northern section of the grid connection, and each has a capacity of 132kV and will be ~2.5ha in extent. Refer to the Figure below.

***Please note that the two substations are not considered as alternatives and both options should be assessed, as they will connect different plants to the national grid. Which SPPs will make use of this power line will only be determined once a cost estimate letter from Eskom has been obtained.*

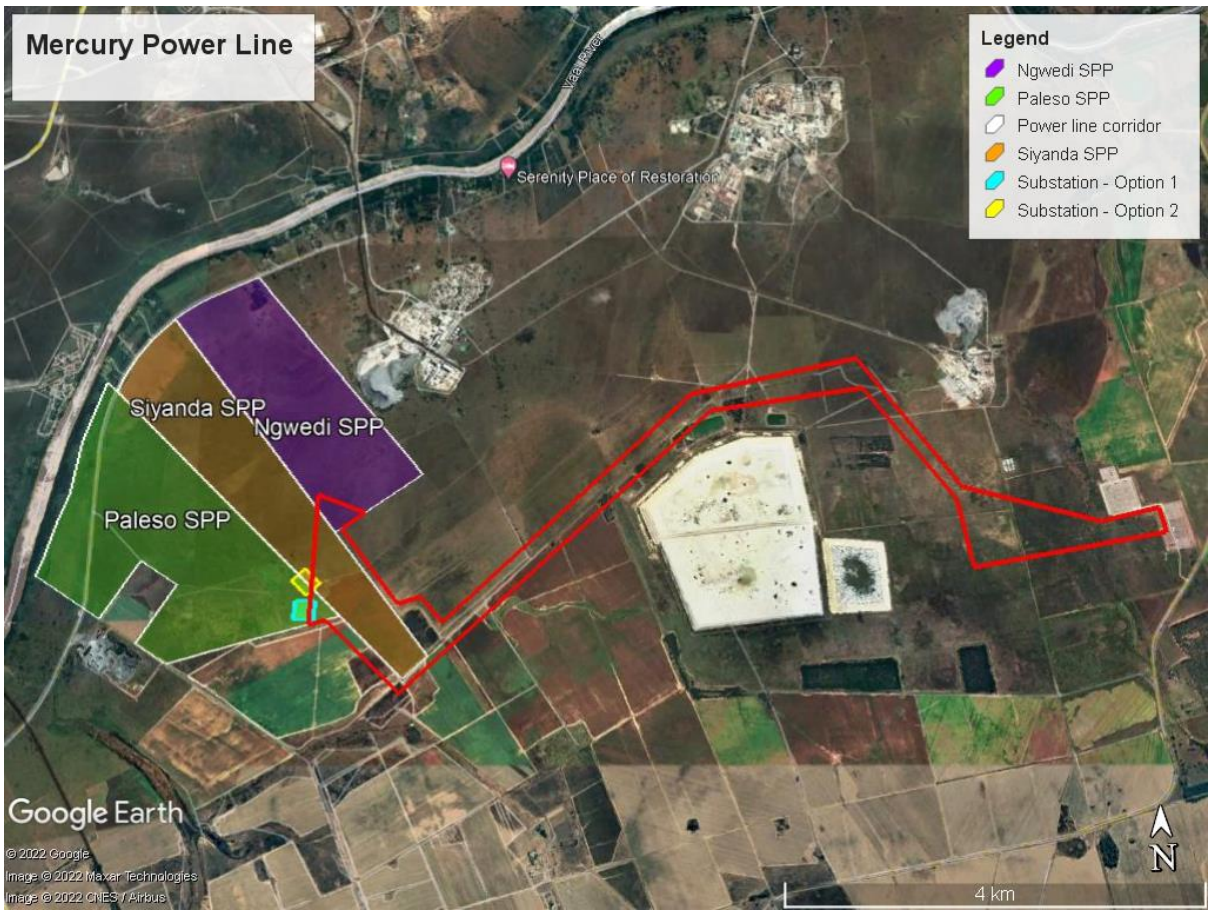


***Figure** 1:* Mercury Power Line Corridor route and Substation alternatives

The choice of pylon structure to be used for the power line will be determined in consultation with Eskom and does not significantly affect the environmental impacts of the proposed development as provision has already been made for the visual, avifauna, ecological and heritage impacts of erecting a power line. No defined structure has been confirmed at this stage and will depend on Eskom's technical requirements. The proposed 132kV line must be constructed according to the authorised standards for a power line approved by Eskom Holdings SoC Ltd. The structure to be utilised for the power line towers will also be informed by the local geotechnical and topographical conditions. The following alternatives are considered with regards to the proposed structures:

2. <u>Steel lattice towers:</u>

The steel lattice towers provide the following advantages over the other tower types available:

- Enables multipath earthing which enhances the overall electrical performance of the power line.
- Is visually less obtrusive than the mono-pole options.
- Is more practicable that other options i.e. more cost effective and more practical to construct and maintain.
- Is safer to work on than the monopole and wood pole structures.

- Is more durable than the wood pole structures.

3. Steel monopoles:

The steel monopole is considered less suitable than the steel lattice towers for the following reasons:

- Is visually more intrusive than the lattice towers.
- Is more expensive than the lattice towers.
- Requires more steel than the lattice towers.
- Is more difficult to erect.
- Is not as safe to work on as the lattice towers.

4. Wood poles:

Wood pole structures are only used in extreme circumstances where a visual impact needs to be avoided. Wood pole structures may be cheaper to produce and to construct, but they have one tenth of the lifespan of the metal counterparts and are far more susceptible to weather conditions which makes them less efficient and practicable. The wood pole structure is also more susceptible to having the cross arms burnt off by electrical faults as well as being susceptible to deformation with height.

Technology alternatives

The power line will be constructed within the identified grid connection corridor towards the existing Eskom Mercury Substation. The 132kV overhead power line is the only preferred alternative for the evacuation of the generated electricity due to the following reasons:

2. Overhead Transmission Lines - Overhead lines are less costly to construct than underground lines. Therefore, the preference with overhead lines is mainly on the grounds of cost. Overhead lines allow high voltage operations and the surrounding air provides the necessary electrical insulation to earth. Further, the surrounding air cools the conductors that produce heat due to lost energy (Swingler et al, 2006).

   The overall weather conditions in the Free State Province are less likely to cause damage and faults on the proposed overhead transmission power line. Nonetheless, if a fault occurs, it can be found quickly by visual means using a manual line patrol. Repair to overhead lines is relatively simple in most cases and the line can usually be put back into service within a few days. In terms of potential impacts caused by overhead transmission lines include visual intrusion and threats to sensitive habitat (where applicable).

   The choice of structure to be used for the power line will be determined in consultation with Eskom once the Engineers have assessed the geotechnical and topographical conditions and decided on a suitable structure which meets the prescribed technical requirements. The choice of structures to be

used will not have any adverse impacts on the environment. The line will be constructed according to the authorised standards for a power line approved by Eskom Holdings SoC Ltd.

3. Underground Transmission Lines - Underground cables have generally been used where it is impossible to use overhead lines for example because of space constraints. Underground cabling of high voltage power lines over long distances is not considered a feasible or environmentally practicable alternative for the following reasons:
    - Underground cabling will incur significantly higher installation and maintenance costs.
    - It is more difficult and takes longer to isolate and repair faults on underground cables.
    - There is increased potential for faulting at the transition point from underground cable to overhead power line.
    - Underground cables require a larger area to be disturbed during construction and maintenance operations and hence have a bigger environmental disturbance footprint.
    - Underground cabling requires the disturbance of a greater area when it comes to agriculture and other compatible land uses as the entire servitude becomes available for use as opposed to just the area around the towers.

    The use of an underground power line is not feasible for the proposed project due to the length of the line, which is ~11km long.

The following alternatives may be considered for the overhead power line:

1. Single Circuit Overhead Power Line

The use of single circuit overhead power lines to distribute electricity is considered the most appropriate technology and has been designed over many years for the existing environmental conditions and terrain as specified by Eskom Specifications and best international practice. Based on all current technologies available, single circuit overhead power lines are considered the most environmentally practicable technology available for the distribution of power. This option is considered appropriate for the following reasons:

- More cost-effective installation costs
- Less environmental damage during installation
- More effective and cheaper maintenance costs over the lifetime of the power line.

The use of a single-circuit power line is considered for the proposed project as it will meet the requirements to evacuate the generated solar electricity from the one SPP to the national grid.

2. Double Circuit Overhead Power Line

Where sensitive environmental features are identified, and there is sufficient justification, Eskom will consider the use of double circuit (placing 2 power lines on either side of the same tower structure) to minimize impacts. However, the use of double-circuiting has a number of technical disadvantages:

- Faults or problems on one power line may mean that the other power line is also disabled during maintenance, and this will affect the quality of supply to an area. Larger and taller towers as well as more towers are required for double-circuit power lines.

The double-circuit overhead power line proves more feasible since the single circuit may not have the capacity to transmit the large amount of electricity generated from the plant and during maintenance the entire plant would not have to be off-line as one of the double circuit lines would still be able to supply electricity. The double circuit would also be able to accommodate more than one SPP.

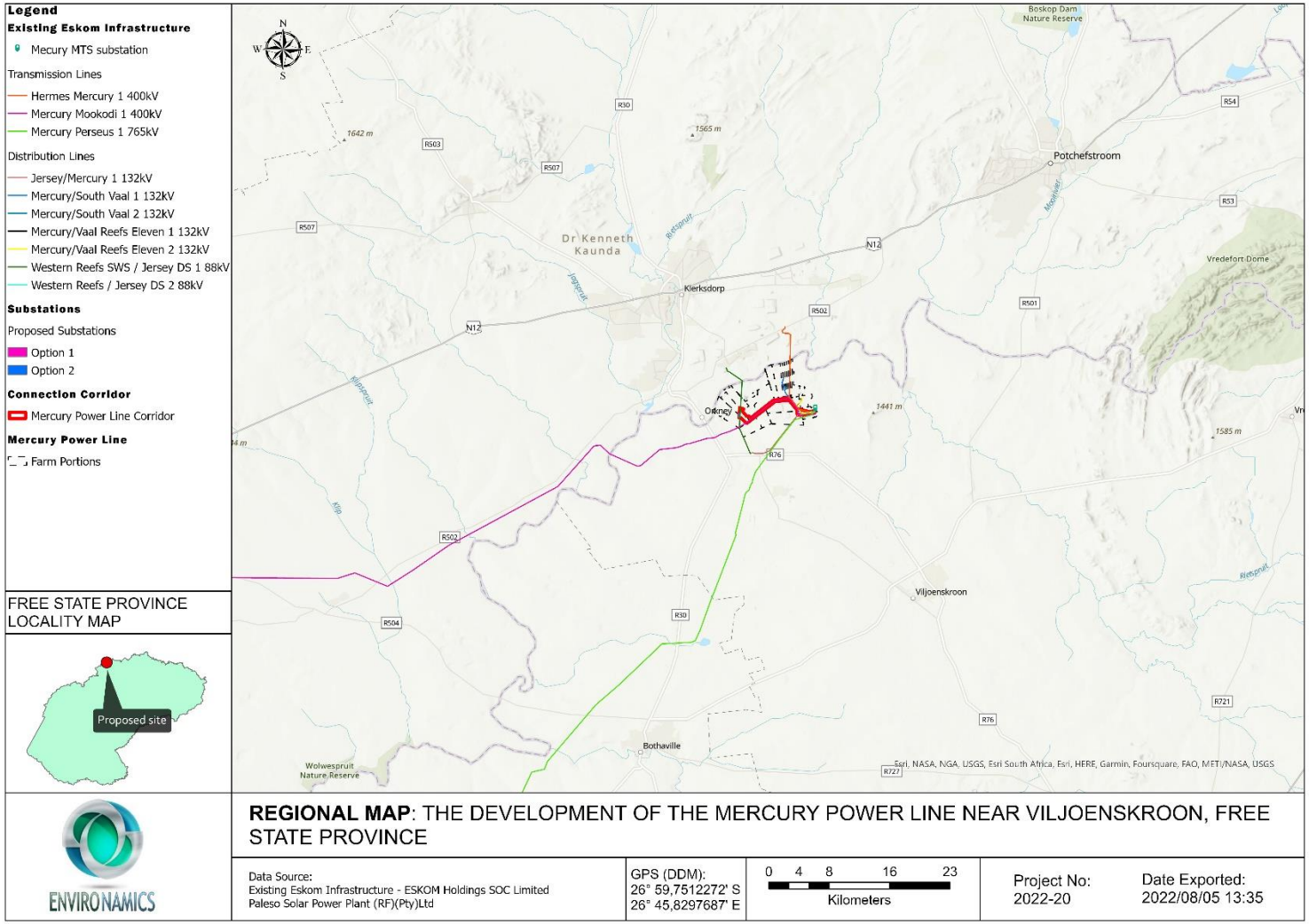


Figure 2:*Regional Locality of the proposed Mercury Power Line near Viljoenskroon in the Free State.*

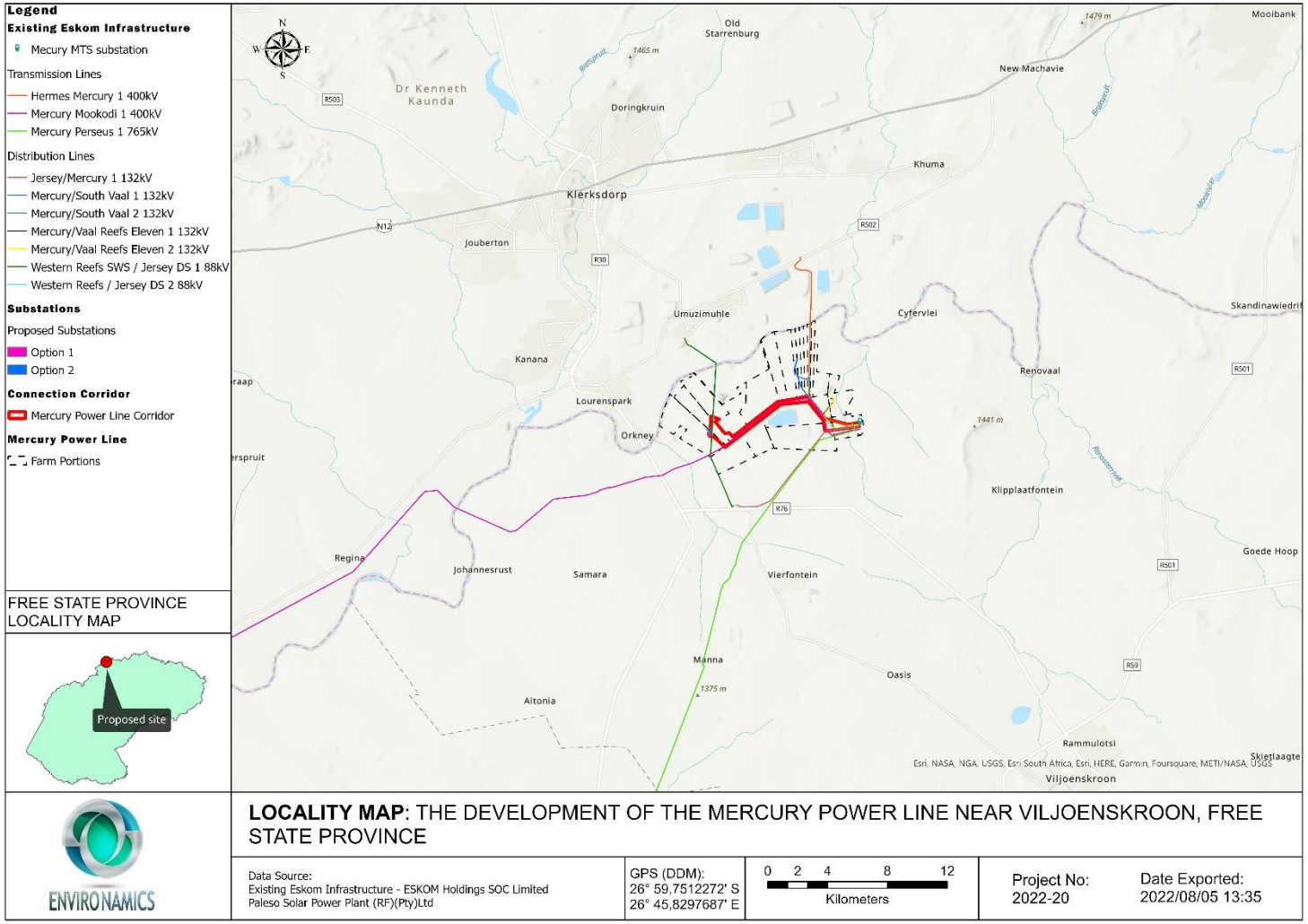


***Figure 3**:Locality of the proposed Mercury Power Line near Viljoenskroon in the Free State.*

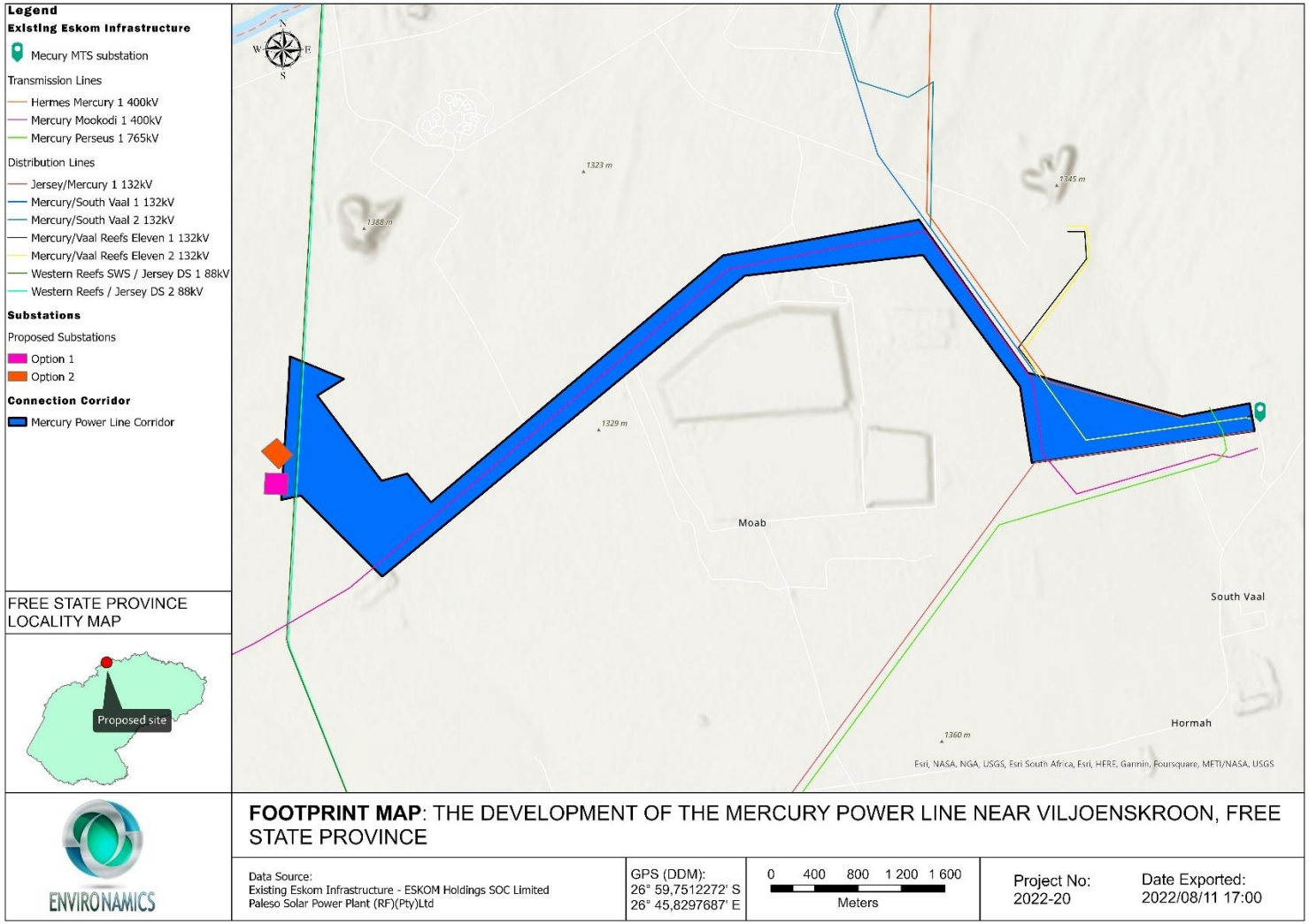


***Figure 4**:Footprint of the proposed Mercury Power Line near Viljoenskroon in the Free State.*

2 LEGAL MANDATE AND PURPOSE OF THE REPORT

The National Environmental Management Act identifies listed activities (in terms of Section 24) which are likely to have an impact on the environment. These activities cannot commence without obtaining an EA from the relevant competent authority. Sufficient information is required by the competent authority to make an informed decision and the project is therefore subject to an environmental assessment process which can be either a Basic Assessment Process or a full Scoping and Environmental Impact Assessment process.

The EIA Regulations No. 324, 325, and 327 outline the activities that may be triggered and therefore require EA. The following listed activities with special reference to the proposed development is triggered:

Table 3: Listed activities (SPPs)

Relevant notice:	**Activity No (s)**	**Description of each listed activity as per project description**:
GNR. 327 (as amended in 2017)	Activity 11(i)	• *"The development of facilities or infrastructure for the transmission and distribution of electricity (i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts."* • The development of a 132kV double circuit power line (and two 132kV collector substations) is required to enable the connection of the authorised Paleso, Siyanda and Ngwedi SPPs (DFFE ref.: 14/12/16/3/3/1/2365, 14/12/16/3/3/1/2369 and 14/12/16/3/3/1/2535) to the national grid network. A 200m (up to 800m wide in some instances) wide and ~11km long grid connection corridor is being assessed for the placement of the power line route and substation. The power line is proposed to connect into the existing Eskom Mercury MTS substation.
GNR. 327 (as amended in 2017)	Activity 27	• *"The clearance of 1 hectares or more, but less than 20 hectares of indigenous vegetation."* • The development of the two 132kV collector substations proposed as part of the project will require the clearance of 2.5 hectares each of indigenous vegetation each. The total vegetation clearance required for the two collector substations is 5 hectares.
GNR. 324, 07 April 2017	Activity 4(b)(i)(ee)(gg)	• *"The development of a road wider than 4 metres with a reserve less than 13,5 metres, in the (b) Free State Province, (i) outside urban areas, within (ee) a Critical biodiversity area as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans and (gg) areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified*

		in terms of NEMPAA or from the core areas of a biosphere reserve, excluding disturbed areas." • A service road with a width of approximately 5 metres and a length of approximately 11km will be required during the construction and operational phase of the project. The project is located within the Free State province and outside urban areas. A portion of the power line corridor falls within a CBA1. The road is located within 5km of a protected area as identified in terms of NEMPAA. The power line will traverse the property on which the Mispha Game farm is located as per the South Africa Protected Area Database (SAPAD) of the Department of Forestry, Fisheries and the Environment.
GNR. 324, 07 April 2017	Activity 10(b)(i)(ee)(gg)	• *"The development and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres, in (b) the Free State Province, (i) outside urban areas, within (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve."* • The two collector substations and power line will require the infrastructure for the storage and handling of dangerous goods, with a combined capacity of 80 cubic metres. The capacity of dangerous goods that will be stored on site will be between 80 and 90 cubic meters. The project is located in the Free State province and outside urban areas. A portion of the power line corridor is located within a CBA1. The power line and the two collector substations are located within 5km of a protected area as identified in terms of NEMPAA. The power line will traverse the property on which the Mispha Game farm is located as per the South Africa Protected Area Database (SAPAD) of the Department of Forestry, Fisheries and the Environment.
GNR. 324, 07 April 2017	Activity 12(b)(i)(ii)(iv)	• *"The clearance of an area of 300 square meters or more of indigenous vegetation in the (b) Free State Province, (i) within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004, (ii) within a Critical biodiversity area as identified in systematic biodiversity*

		plans adopted by the competent authority or in bioregional plans." • The power line, substation and the associated service road will require more than 300 square meters of vegetation clearance within a vegetation type classified as endangered. A portion of the grid connection corridor is located within a CBA1.

The activities triggered under Listing Notice 1 and 3 (Regulation 327 & 324) for the project implies that the development is considered as potentially having an impact on the environment and therefore require the implementation of appropriate mitigation measures. Based on the location of the entire extent of the project within the Klerksdorp REDZ (Figure 5), the process to be followed will be as per GNR 114, as gazetted on 16 February 2018. Therefore, PL is subject to a Basic Assessment process and not a full EIA process, as well as a shortened timeframe for the processing of the Application for Environmental Authorisation by the Department of Forestry, Fisheries and the Environment (DFFE).

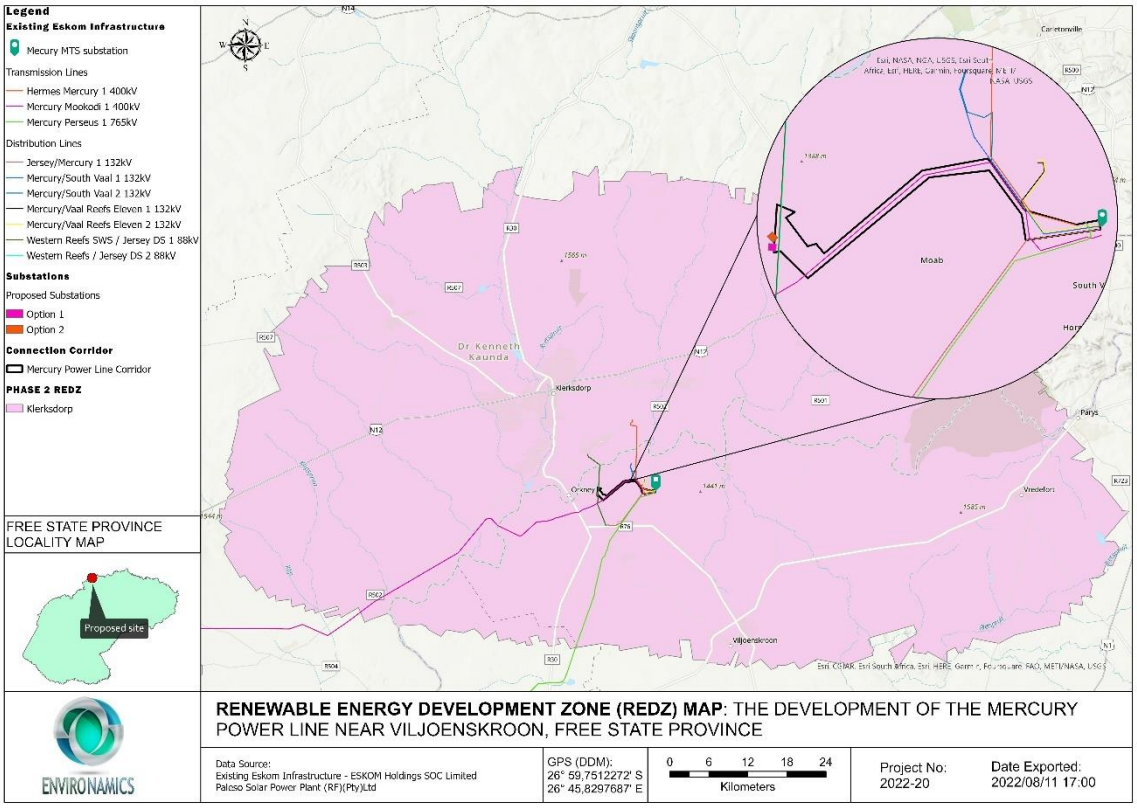


***Figure 5**: Location of the Mercury Power Line in relation to the Renewable energy development zone (REDZ).*

3 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern,

Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-eight years. She has experience in locating, collecting, and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

4 LEGISLATION

National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50
- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

The NEMA (No 107 of 1998) states that an integrated EMP should (23:2 (b)) "*…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*".

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies the following comprehensive and legally compatible PIA report have been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to Section 38 (1), an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m² in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

5 OBJECTIVE

The objective of a Palaeontological Impact Assessment (PIA) is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to identify the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the palaeontological importance of the formations 3) to determine the impact on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area.
- Identification of sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.

- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

6 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Mercury Power Line near Viljoenskroon in the Free State is depicted on the 1: 250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria). According to these geological maps the proposed Mercury power line is underlain by Quaternary sands in the east (yellow, Qs), the Precambrian dolomites and associated marine sedimentary rocks of the Malmani Subgroup (blue, Vma) (Chuniespoort Group, Transvaal Supergroup) underlies the northern portion of the line, while the eastern portion is underlain by the Vryheid Formation (khaki, Pv; Ecca Group, Karoo Supergroup) and Quaternary sand (Figure 6, Table 4).

According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and that of the Vryheid Formation (Ecca Group, Karoo Supergroup) is Very High while that of the Quaternary aeolian sand is moderate (Figure 7, Table 5) (Almond *et al*, 2013; SAHRIS website).

The geology has recently been updated (Council of Geosciences, Pretoria) and indicates that the proposed Mercury power line is underlain by the following sediments (Figure 8) alluvium, colluvium, eluvium and gravel as well as the Rietgat Formation (Platberg Group, Ventersdorp Supergroup) in the west and the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and Vryheid Formation (Ecca Group, Karoo Supergroup) in the east

The Quaternary superficial deposits are the youngest geological deposits formed during the most recent period of geological time (approximately 2.6 million years ago to present). The rocks and sediments can be found at or near the surface of the Earth. Most of the superficial deposits are unconsolidated sediments and consist of gravel, sand, silt, and clay, and they form relatively thin, often discontinuous patches of sediments or larger spreads onshore.

The Quaternary deposits are of most importance due to the palaeoclimatic changes that are reflected in the different geological formations (Hunter et al., 2006). During the climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa where formed (Maud, 2012). Barnosky (2005) indicated that various warming and cooling events occurred in the Cenozoic but states that climatic changes during the Quaternary Period, specifically the last 1.8 Ma, were the most drastic climate changes relative to all climate variations in the past. Climate variations that occurred

in the Quaternary Period were both drier and wetter than the present and resulted in changes in river flow patterns, sedimentation processes and vegetation variation (Tooth et al., 2004).

Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil deposits. These fossil assemblages resemble modern animals and may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

The Vryheid Formation is known to contain a rich assemblage of Glossopteris flora (spathulate, reticulate-veined leaves) which is the source vegetation for the Vryheid Formation. Gymnospermous glossopterids (Figure 9) dominated the peat and non-peat accumulating of Permian wetlands after continental deglaciation took place (Falcon, 1986c, Greb *et al*., 2006).

Recent palaeobotanical studies include that of Adendorff (2005), Bordy and Prevec (2008) and Prevec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) has described numerous plant fossils from this formation (e.g., *Azaniodendron fertile*, *Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Hirsutum* sp., *Scutum* sp., *Ottokaria* sp., *Estcourtia* sp., *Arberia* sp., *Lidgetonnia* sp., *Noeggerathiopsis* sp., *Podocarpidites* sp as well as more than 20 Glossopteris species. In the past, palynological studies have focused on the coal-bearing successions of the Vryheid Formation and include articles by Aitken (1993, 1994, 1998), and Millsteed (1994, 1999), while recent studies were conducted by Götz and Ruckwied, (2014).

Bamford (2011) is of the opinion that only a small amount of data has been published on these potentially fossiliferous deposits and that most likely good material is present around coal mines while in other areas the exposures are poor and of little interest. When plant fossils do occur, they are usually abundant. Bamford suggests that it is not feasible to preserve all the fossiliferous sites but in the interests of science these sites ought to be well documented and researched. Fossils collected must be housed in an accredited institution (e.g., Iziko Museum, Ditsong Museum, Evolutionary Studies Institute (ESI) Wits, Grahamstown Museum, National Museum Bloemfontein).

To date no fossil vertebrates have been collected from the Vryheid formation. The occurrence of fossil insects is rare, while palynomorphs are diverse. Non-marine bivalves and fish scales have also been reported from this formation. Trace fossils are abundantly found but the diversity is low. The mesosaurid reptile, *Mesosaurus* (Figure 10) has been found in the southern parts of the basin but

may also be present in other areas of the Vryheid formation. Although fossils are rare in this biozone, a single fossil may be of scientific important as many fossil taxa are known from only a single fossil.

The Malmani Subgroup carbonates of the Transvaal Basin (Figure 11) comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes (Eriksson *et al.* 2006). Stromatolites are layered mounds, columns and sheet-like sedimentary rocks**.** These structures were originally formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. These algae photosynthesised in the low oxygen atmosphere and deposited layer upon layer of calcium sulphate, magnesium sulphate and calcium carbonate as well as other compounds to form these domes. Researchers have examined and classified the stromatolite structures but seldomly find preserved algal cells. The oxygen atmosphere that we depend on today was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

Stromatolites and oolites from the Transvaal Supergroup have been described by various authors (Eriksson and Altermann, 1998). Detailed descriptions of South African Archaean stromatolites are available in the literature (Altermann, 2001; Buick, 2001; and Schopf, 2006). The Malmani stromatolites literature includes articles by Truswell and Eriksson (1972, 1973, 1975), Eriksson and MacGregor (1981), Eriksson and Altermann (1998), Sumner (2000), Schopf (2006).

The Malmani Subgroup succession is about 2 km-thick and consists of a series of formations of oolitic and stromatolitic carbonates (limestones and dolomites), black carbonaceous shales and minor secondary cherts. The Malmani Dolomites also consist of historic lime mines, and palaeocave fossil deposits. Dolomite (limestone rock) forms in warm, shallow seas from slow gathering remainders of marine microorganisms and fine-grained sediment. Dolomites of the Malmani Subgroup has a higher magnesium content than other limestones. These materials contain high levels of calcium carbonate and are often referred to as *carbonates*.

Currently very few palaeontologists study stromatolites but geologists find the stromatolites interesting because they reveal the change from a reducing environment (that is an oxygen-poor) to an oxidizing environment (oxygen--rich). This transition is known as the Great Oxygen Event (Eroglu et al., 2017).

The Ventersdorp Supergroup comprise of the biggest and most wide-spread system of volcanic rocks in the Kaapvaal Craton. This Supergroup unconformably overlies the Witwatersrand Supergroup and is also unconformably overlain by the Transvaal Supergroup. The elliptical basin is approximately 300 000km^2 in extent. The type-area is located between Klerksdorp (North West), and

Welkom and Bothaville (Free State). This Supergroup mantles most of the distribution area of the Witwatersrand Supergroup as well as the Dominion Group.

The best exposures of the Ventersdorp Supergroup are in the North West Province as well as in the Northern Cape Province, Gauteng, and southern Botswana. This Supergroup is divided in the Klipriviersberg Group (oldest) which is overlain by the Platberg Group followed by the sedimentary Bothaville Formation and the volcanic Allanridge Formation (uppermost Ventersdorp unit, youngest Formation) (Figure 5).

The Platberg Group is subdivided in four formations namely the Kameeldoorns-, Goedgenoeg-, Makwassie-, and Rietgat Formations. These formations consist of heterogenous rock varying from chemical and classic sediments, to felsic and mafic volcanics. These rocks were deposited in linear vault troughs during grabed developments (Visser et al, 1975-1976, Buck, 1980). These deep intermontane grabens formed in older underlying andesitic terranes and formed areas of alluvial fan deposits and debris as well as scree flows. Ooids and stromatolites accumulated under lacustrine conditions in fine-grained chemical and terrigenous sediments. (Buck, 1980) Stromatolites were identified in the Rietgat Formation between Prieska and Britstown. In time fluvial processes prevailed causing widespread prograding of alluvial fans across basins (Buck, 1980).

The Platberg is mostly absent in the north-east of the Ventersdorp depository while the outcrops are erratic with changes in thickness. The type-area of the Platberg Group is between Welkom and Klerksdorp and was described by Winter (1976), while the Klerksdorp area was described by J.M. Myers (1990). The Rietgat Formation crops out in the, north, northwest, and southwest of Vryburg, south-southeast of Douglas, Taungs-Hartswater area, west of Klerksdorp, T'Kuip in the Northern Cape Province and southwest of Ventersdorp. The Rietgat Formation consist of alternating sedimentary and volcanic rocks which varies in thickness across the basin and is present in the development footprint.

The uppermost volcanic Allanridge Formation crops out in the North West, Northern Cape, and Free State Provinces. Witmer (1976) came to the conclusion that the Allanridge Formation has a conformable relationship with the Bothaville Formation (deeper parts of the basin) while Keyser (1998), found a very prominent unconformable relationship in the direction of the northwestern boundary of the Ventersdorp depository. The Allanridge formations consists primary of light green–grey porphyritic lava and pyroclastic rocks as well as dark-green amygdaloidal lava. The dark-green lava is the thickest unit in the Allanridge Formation. Both lava types consist of amygdales but is more widespread in the dark-green lava. The Allanridge is igneous in origin and thus unfossiliferous.

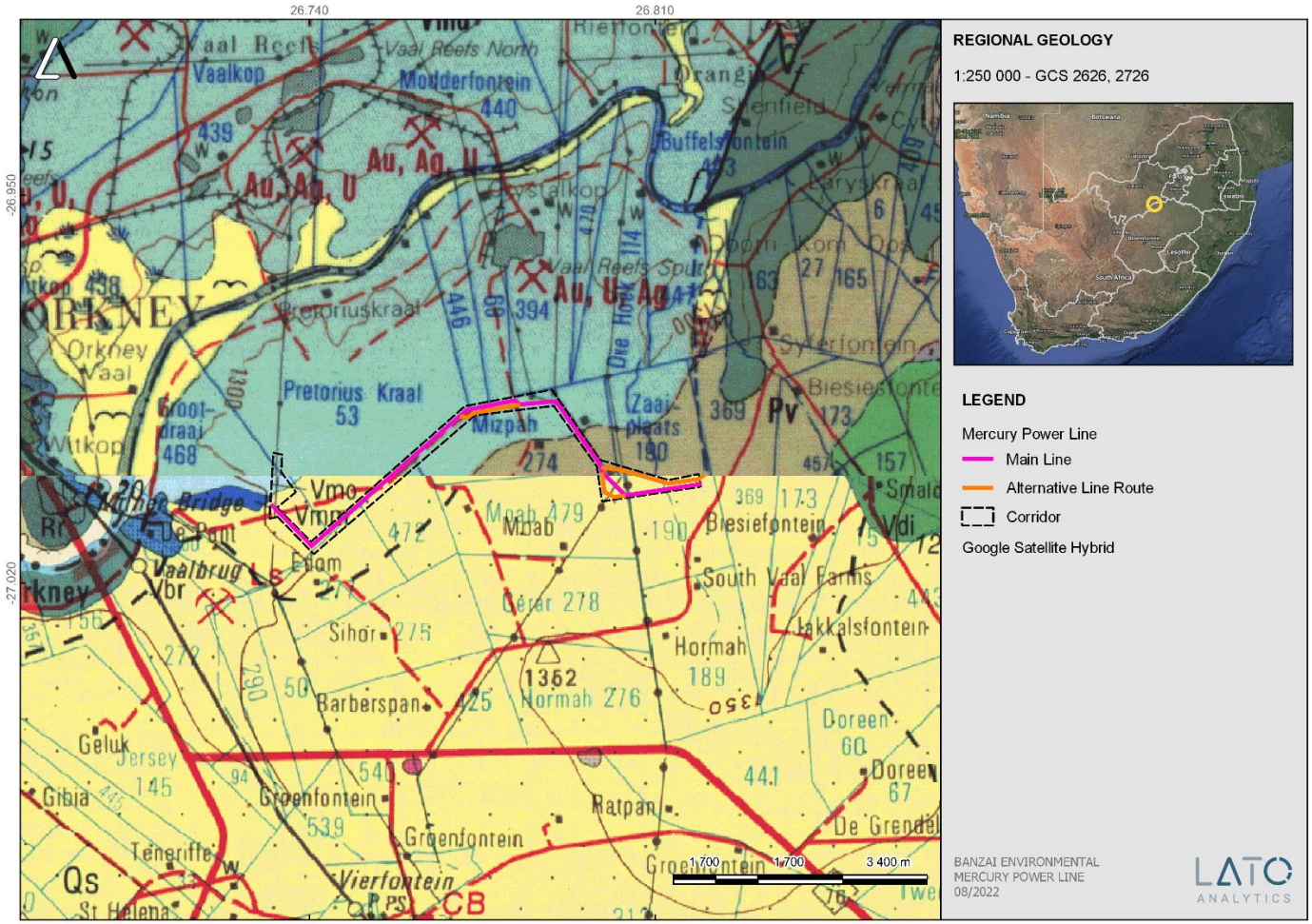


Figure 6: *Extract of the 1:250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria) indicating the proposed Power Line as part of the Paleso Solar Power Plant near Viljoenskroon in the Free State.*

Table 4: Legend to the 2626 Wes-Rand (1986) Geological Map (Council for Geoscience, Pretoria).

Relevant sediments are indicated in a red block

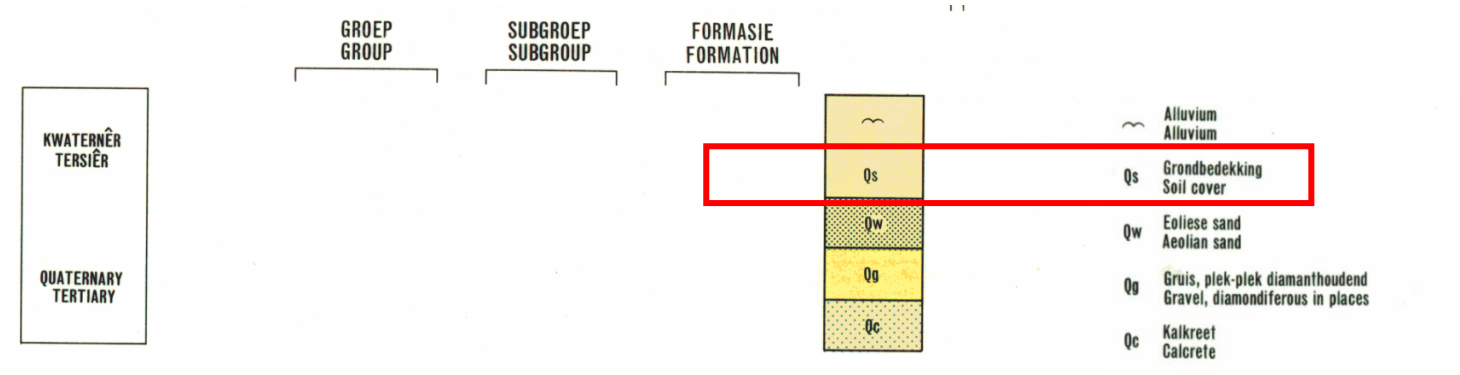
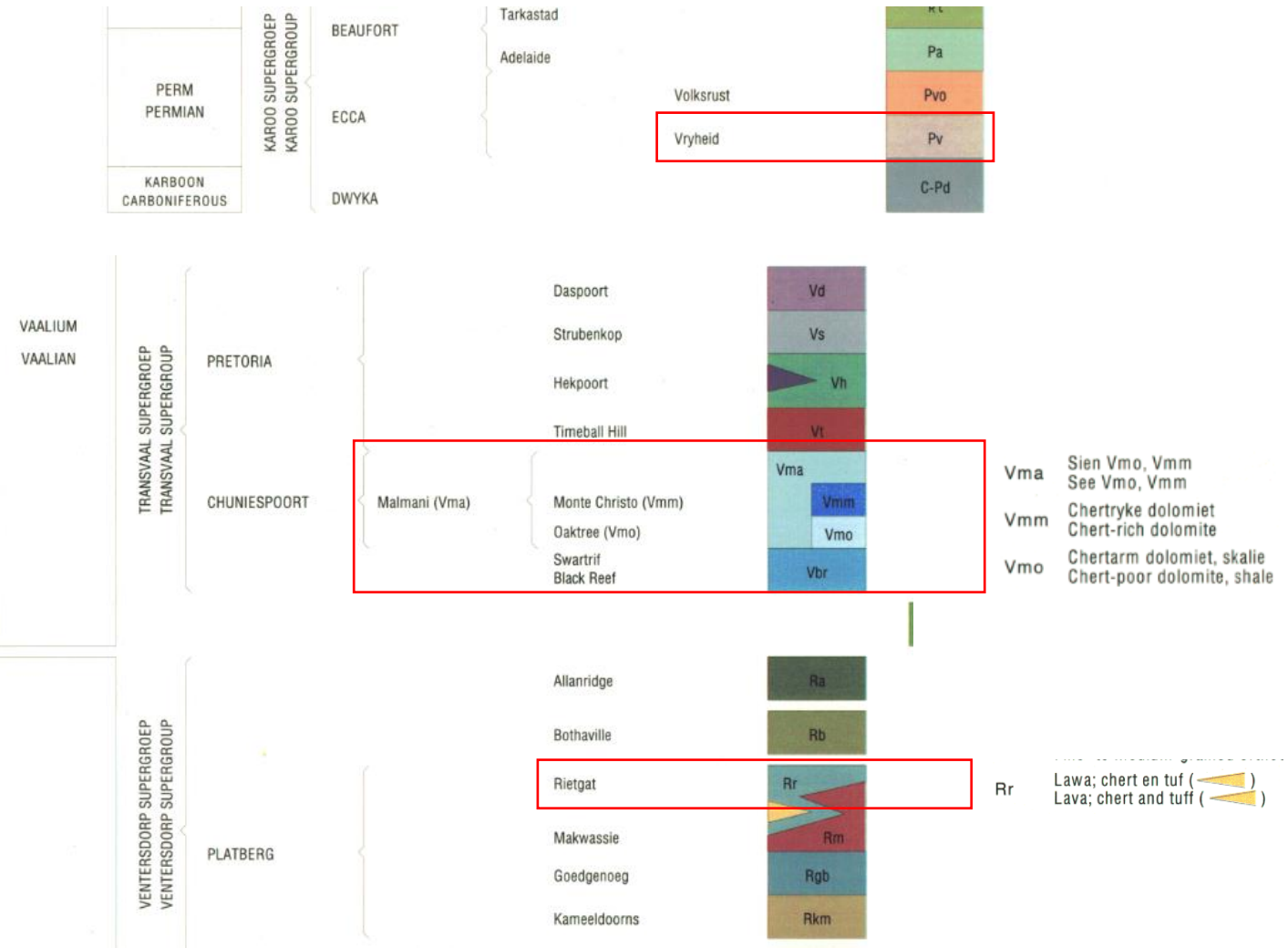


Table 5:Legend to the 2726 Kroonstad (2000) Geological Map (Council for Geoscience, Pretoria).

Relevant sediments are indicated in a red block



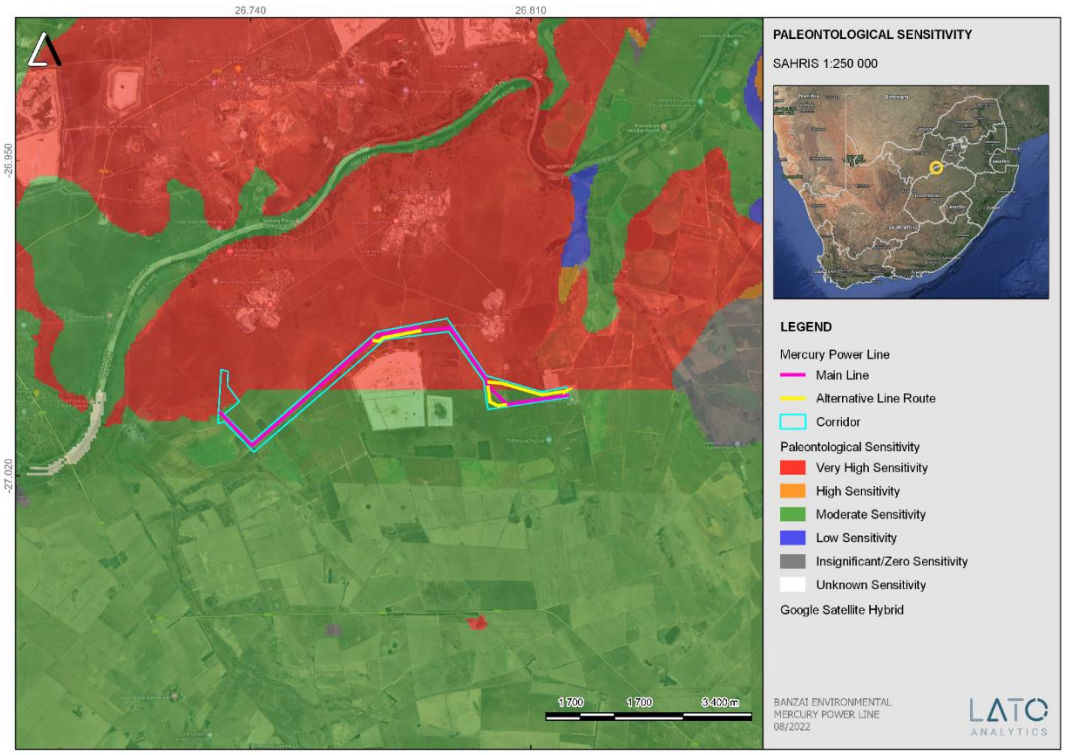


Figure 7: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the proposed Mercury Power Line near Viljoenskroon in the Free State.

Table 6:Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website

Colour	Sensitivity	Required Action
RED	**VERY HIGH**	**Field assessment and protocol for finds is required**
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	**MODERATE**	**Desktop study is required**
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required

GREY	INSIGNIFICANT/ZERO	No palaeontological studies are required
WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

According to the SAHRIS Palaeosensitivity map (**Figure 7**) the proposed development is underlain by sediments with a Very High (red) and moderate (green) Palaeontological Significance.

The colors on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

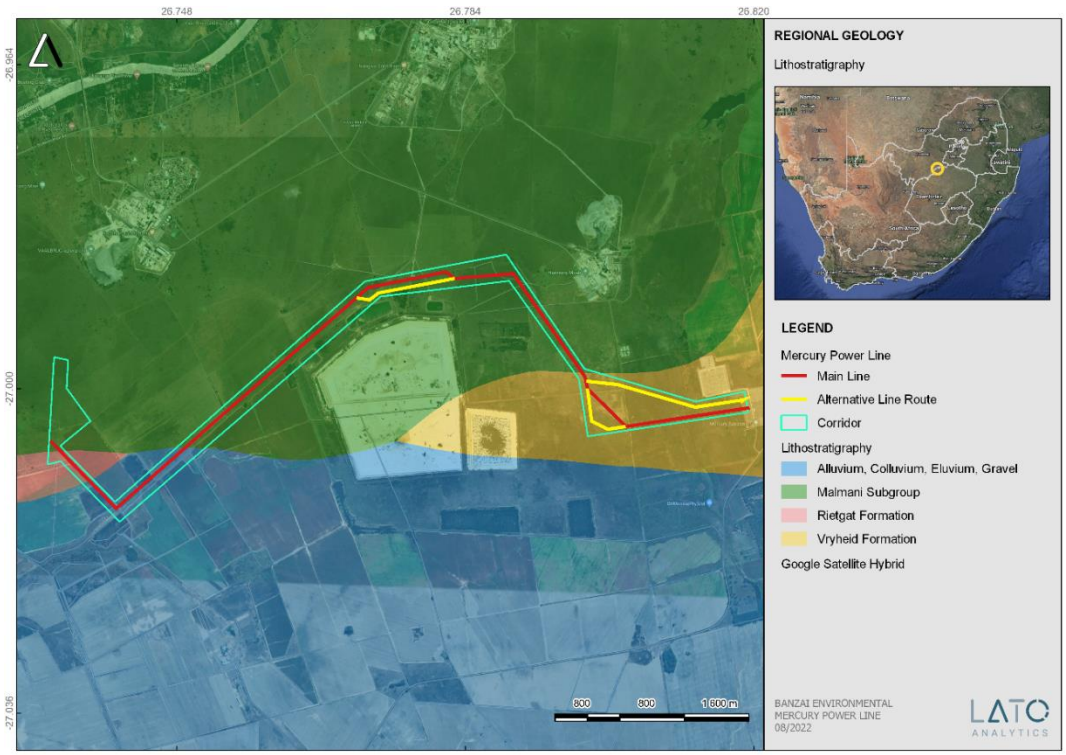


Figure 8:*Updated Geology (Council of Geosciences, Pretoria) of the proposed Mercury Power line indicates that development is underlain by alluvium, colluvium, eluvium and gravel as well as the Rietgat Formation (Platberg Group, Ventersdorp Supergroup) in the South as well as The Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and Vryheid Formation (Ecca Group, Karoo Supergroup)*

***Figure 9**:Examples of Glossopteris leaves (Prevec et al 2009).*

***Figure 10**: Mesosaurus sp. National Museum specimen NMQR3536*

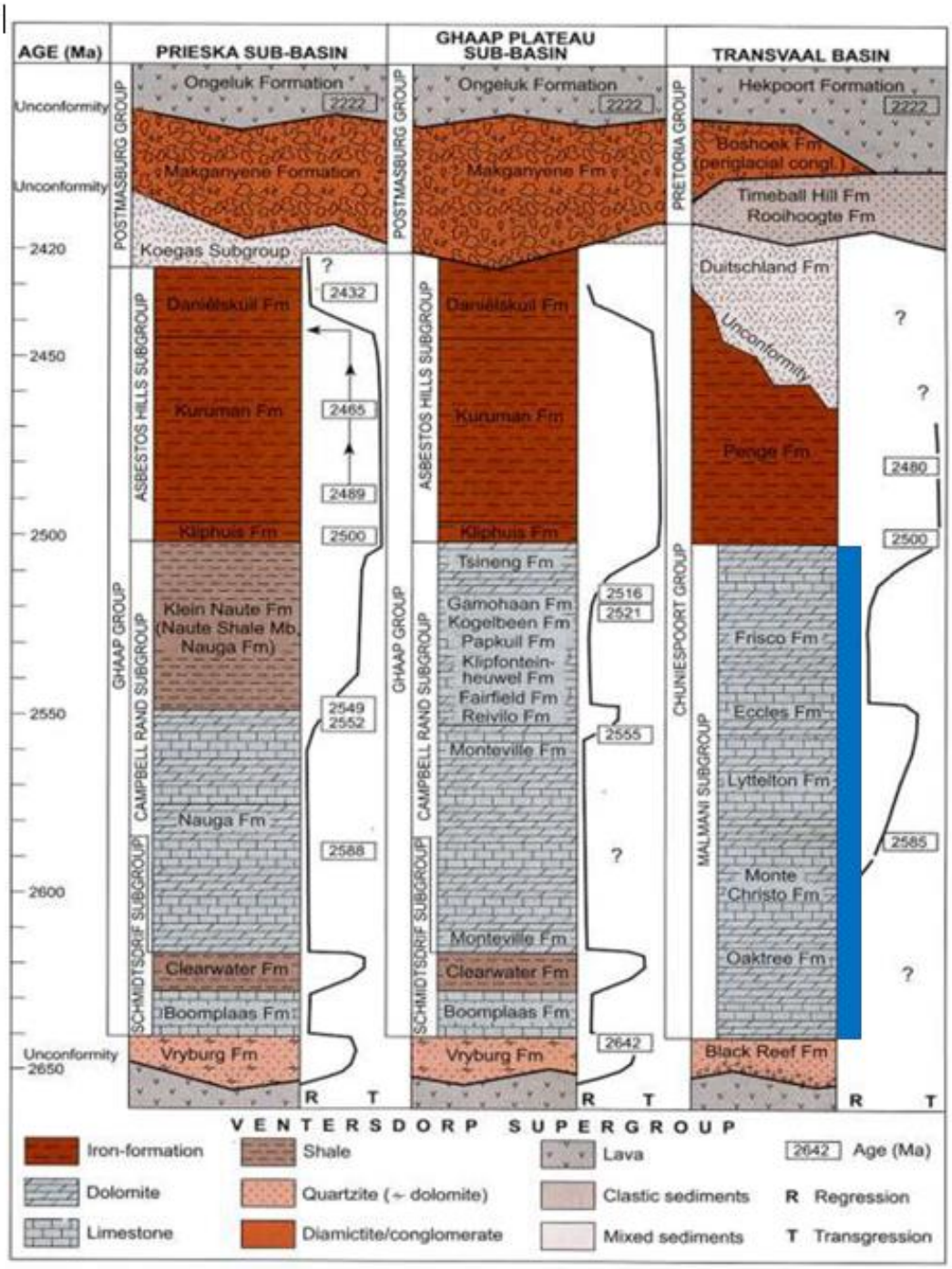


***Figure 11**:Stratigraphy of the Transvaal Supergroup of the Transvaal Basin. The proposed development is indicated in blue (Eriksson,* et al. *2006).*

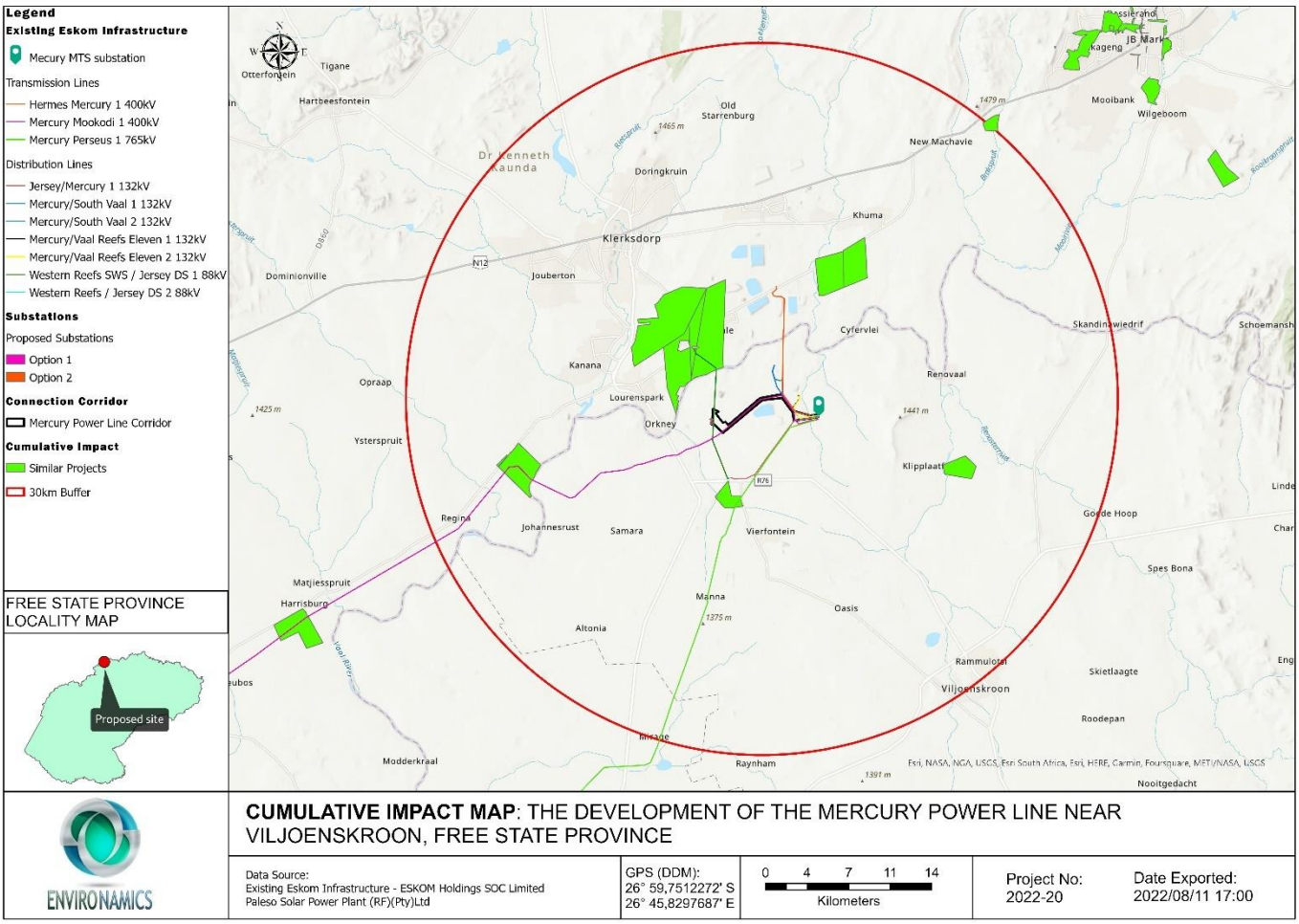


***Figure 12**: Cumulative Impact Map indicating the similar Solar Power plants and grid connections in a 30 km radius of Mercury Power Line*

Solar Facilities to the east of the Paleso Solar Power Line will have a Moderate to High Palaeontological Sensitivity and the facilities to the west will have a High to Zero moderate Palaeontological Sensitivity (see SAHRIS Palaeomap Figure 6). However, it is important to note that the quality of preservation of these different sites will most probably vary and it is thus difficult to allocate a Cumulative Sensitivity to the projects. If all the mitigation measures are carried out, a conservative estimate of the Cumulative impacts on fossil Heritage will vary between Low and Medium.

7 GEOGRAPHICAL LOCATION OF THE SITE

The town of Viljoenskroon is located approximately 27 km south-east of the proposed development. (Figure 2-4).

Table 7: GPS coordinates

	Latitude	Longitude
North western Border	26°59'47.91"S	26°43'57.20"E
North eastern border	27° 0'30.27"S	26°43'53.75"E
Southern border	27° 0'52.95"S	26°44'27.31"E
Northern Border	26°59'5.26"S	26°47'22.03"E
Eastern Border	27° 0'6.33"S	26°49'9.94"E
South eastern Border	27° 0'19.73"S	26°47'58.44"E

8 METHODS

The aim of a desktop study is to evaluate the possible risk to palaeontological heritage in the proposed development. This includes all trace fossils as well as all fossils in the proposed footprint. All possible information is consulted to compile a desktop study, and this includes the following: all Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical as well as geological maps.

8.1 7.1 Assumptions and Limitations

The focal point of geological maps is the geology of the area and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is also used to provide information on the existence of fossils in an area which has not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally assumed that exposed fossil heritage is present within the footprint. A field-assessment will thus improve the accuracy of the desktop assessment.

9 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from Environamics.

- 1:250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria)

10 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 30 July 2022. No fossiliferous outcrops were identified during the site visit.

***Figure 13**:Western margin of the development is mantled by thick vegetation in thick Quaternary sands.*

***Figure 14**:Southern border underlain by Quaternary sands utilized as agricultural land*

Figure 15:*Dolomites in the Malmani Subgroup*

Figure 16: *Northern border mantled by grass (Malmani Subgroup). No fossiliferous outcrops were detected*

Figure 17: *Eastern border of the Mercury Power Line development*

11 IMPACT ASSESSMENT METHODOLOGY

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

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 4.1.

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.

3.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the project phases:

- 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 should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

Table 8:The rating system

NATURE		
Loss of fossil heritage.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
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).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact

		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 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 – 30 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 indefinite.
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. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

REVERSIBILITY		
This describes the degree to which an impact 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.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative 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
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. 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 9:Summary of Impacts

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

	Extent	Duration	Magnitude	Reversibility	Irreplicable loss	Cumulative effect	Impact

Pre-Mitigation	1	4	3	4	4	3	48
Post-Mitigation	1	4	1	4	4	3	16

12 FINDINGS AND RECOMMENDATIONS

The proposed Mercury power line is underlain by Quaternary sands in the east, the Precambrian dolomites and associated marine sedimentary rocks of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) underlies the northern portion of the line, while the eastern portion is underlain by the Vryheid Formation (Ecca Group, Karoo Supergroup) and Quaternary sands.

According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and that of the Vryheid Formation (Ecca Group, Karoo Supergroup) is Very High while that of the Quaternary aeolian sand is moderate (Figure 7, Table 5) (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 30 July 2022 No fossiliferous outcrop was detected in the proposed development area. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is therefore considered that the proposed development is deemed appropriate and feasible and will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Protocol must be implemented by the ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO/site manager must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

13 CHANCE FINDS PROTOCOL

The following procedure will only be followed if fossils are uncovered during the excavation phase of the development.

13.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the National Heritage Resources Act (Act No 25 of 1999) (NHRA). According to Section 3 of the Act, all Heritage resources include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

13.2 Background

A fossil is the naturally preserved remains (or traces thereof) of plants or animals embedded in rock. These organisms lived millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

13.3 Introduction

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

13.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately stop working and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately report the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa.

Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within 24 hours of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. No attempt should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	29 years in Palaeontology
EDUCATION:	B.Sc Botany and Zoology, 1988 University of the Orange Free State
	B.Sc (Hons) Zoology, 1991 University of the Orange Free State
	Management Course, 1991 University of the Orange Free State
	M. Sc. *Cum laude* (Zoology), 2009 University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part-time laboratory assistant	Department of Virology

	University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant	National Museum, Bloemfontein
and Collection Manager	1998–currently

TECHNICAL REPORTS

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