PALAEONTOLOGICAL DESKTOP ASSESSMENT OF THE PROPOSED MOOKODI – MAHIKENG 400KV LINE, NORTH WEST PROVINCE

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Client: Nemai Consulting
PGS Project No: 319PIA

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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 favourable 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 favourable 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 realise that a false declaration is an offence 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;

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ACKNOWLEDGEMENT OF RECEIPT

Report Title	Palaeontological Desktop Assessment of the proposed Mookodi – Mahikeng 400kV Line, North Wes		
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Client			Nemai

CLIENT: **Nemai Consulting**

CONTACT PERSON: **Kristy Robertson – Tel: 011 781 1730**

SIGNATURE: _____

The palaeontological desktop assessment report has been compiled taking into account the NEMA Appendix 6 requirements for specialist reports as indicated in the table below.

NEMA Regs (2014) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Page 2 of Report – Contact details and company
The expertise of that person to compile a specialist report including a curriculum vita	Section 2
A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 6
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
An identification of any areas to be avoided, including buffers	Section 6
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;	No sensitive areas identified refer to Figure 9
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6
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 7
Any mitigation measures for inclusion in the EMPr	Section 8
Any conditions for inclusion in the environmental authorisation	Section 8
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	Section 8
If the opinion is that the proposed activity 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	
A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable.
A summary and copies if any comments that were received during any consultation process	Not applicable.
Any other information requested by the competent authority.	Not applicable.

EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the Palaeontological Desktop Assessment Report for the proposed Mookodi – Mahikeng 400 kV line in North West. According to the National Heritage Resources Act (No 25 of 1999, section 38), a palaeontological impact assessment is key to detect the presence of fossil material within the proposed development footprint and it is thus necessary to evaluate the impact of the construction on the palaeontological resources.

The proposed development footprint is underlain by sediments of the Kalahari Group (*low Palaeontological sensitivity)*; the Allanridge Formation of the Ventersdorp Supergroup (*moderate Palaeontological sensitivity*); the Schmidsdrift Subgroup (Ghaap Group) and the Vryburg Formation (*both with a moderate Palaeontological sensitivity*) of the Transvaal Supergroup as well as the ancient metamorphic rocks of the Swazian Era. The overall impact is rated as *low*.

All four route alternatives were found to be in the above mentioned geological sediments and therefore none of the routes were preferred above the other and none were a no-go option.

As the Palaeontological sensitivity of the development footprint varies between *low to moderate* the proposed development is thus unlikely to pose a substantial threat to local fossil heritage.

However, should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted immediately. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist.

The specialist involved would require a collection permit from SAHRA. Fossil material must be curated in an approved collection (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

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TERMINOLOGY AND ABBREVIATIONS

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

- construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- carrying out any works on or over or under a place;
- subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- constructing or putting up for display signs or boards;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil

Fossil

Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa;

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Abbreviations	Description
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DWS	Department of Water and Sanitation
ECO	Environmental Control Officer
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Late Stone Age
LIA	Late Iron Age
MTS	Main Transmission Substation
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

1 INTRODUCTION

The present-day Watershed substation is currently un-firm and has inadequate capacity to support the estimated load in the Watershed Main Transmission Substation (MTS) area which comprises Lichtenburg and extends to Mahikeng town. Additional network expansion will comprise of the establishment of a new transmission substation in Mahikeng (the proposed Mahikeng substation will undergo a separate EIA Process). As part of establishing the site for the planned Mahikeng substation, the latter will be planned with an end state of 3x 500MVA 400/132kV transformers and install 2x 500MVA 400/132kV transformers at first. A 1x 160km Pluto – Mahikeng 400kV line will be established (during a separate EIA Process) and a 1x 180km Mookodi - Mahikeng400kV line will be established.

This proposed line is within the planned scope of work for the present EIA Process.

Eskom Holdings SOC Limited appointed Nemai Consulting to conduct the Environmental Impact Assessment (EIA), in terms of Government Notice (GN) No. R 982 of 4 December 2014 (as amended), for the proposed Mookodi- Mahikeng 400kV Line, which is approximately 180km in length. Four alternative routes are proposed and will be assessed. The origin of the line is at the existing Mookodi MTS, while the proposed alternative routes for the line lies in a north-east direction and end at the proposed Mahikeng substation site (Error! Reference source not found.**1-6**).

1.1 Project Description

The construction of a 400kV line from Mookodi substation to the future Mahikeng substation is proposed. The Mookodi – Mahikeng400kV line is approximately 180km in length, but the distance differs between the different alternative routes.

The following route alternatives are proposed:
1. Option 1 (WM1)
2. Option 2 (WM13)
3. Option 3 (WM4a)
4. Option 4 (WM9a)

Each of the four alternative routes are indicated in **Figure 1-4** with a combined map on **Figure 5**. A 2km servitude is included for each alternative route. As a standard practice and to comply with regulatory requirements, the option of not proceeding with the project is incorporated in the evaluation of the alternatives (the no-go option).

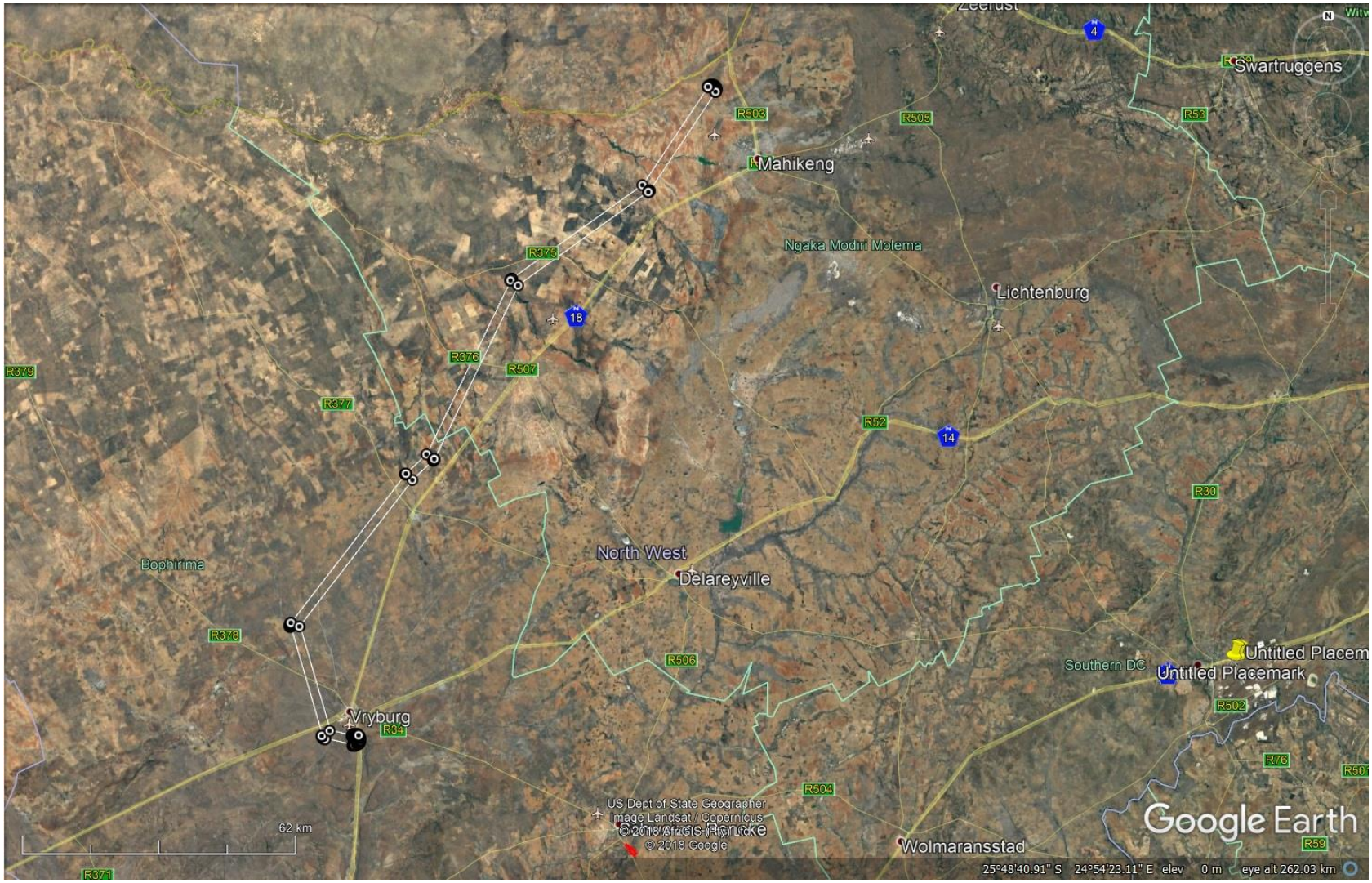

Figure 1. Google Earth Image of the location of the proposed Mookodi – Mahikeng 400kV line in North West: Option 1-including the 2 km corridor. Scale bar represents 62 km.

Figure 2. Google Earth Image of the location of the proposed Mookodi – Mahikeng 400kV line in North West: Option 2-including the 2 km corridor. Scale bar represents 51 km.

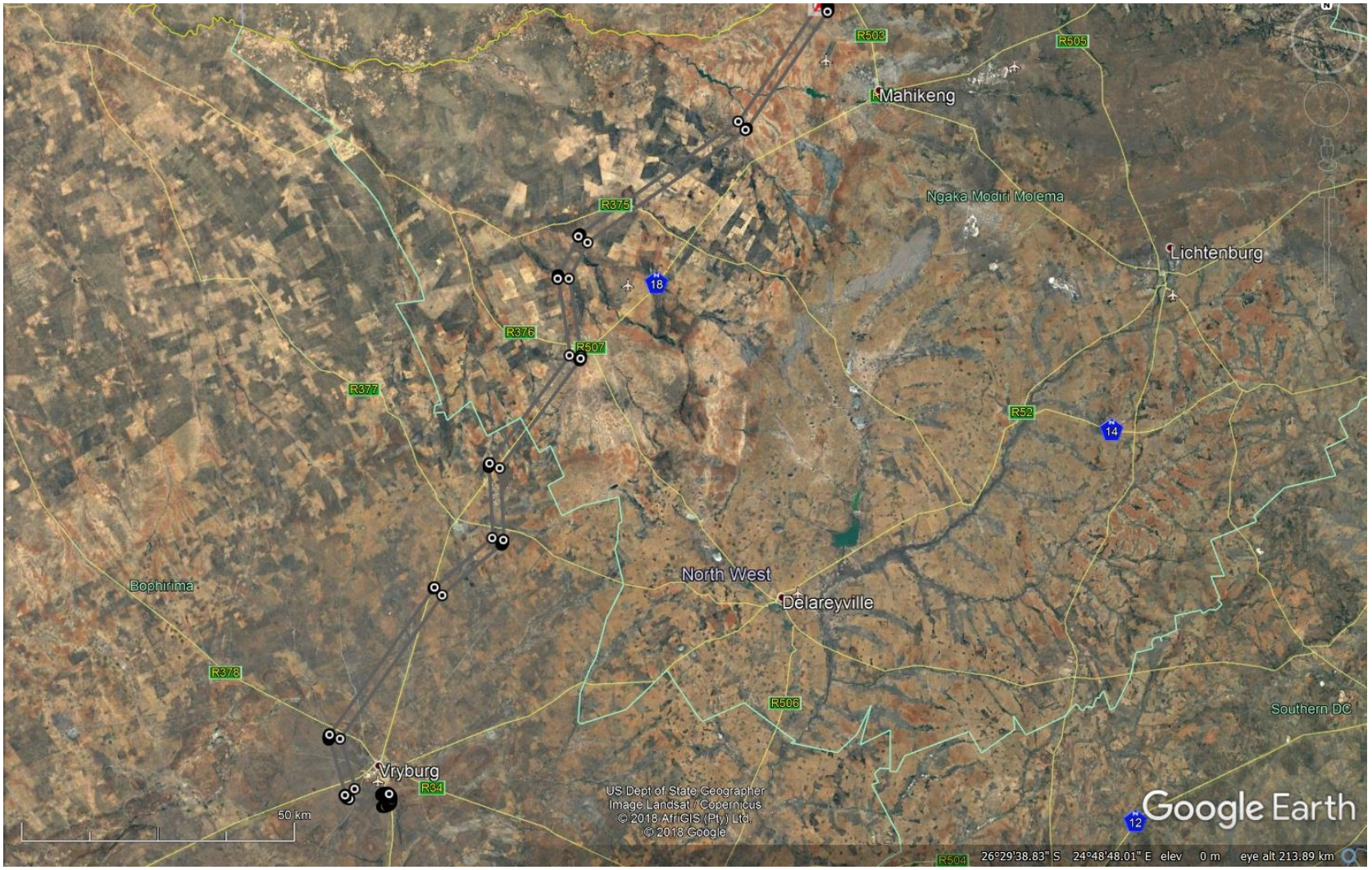

Figure 3. Google Earth Image of the location of the proposed Mookodi – Mahikeng 400kV line in North West: Option 3-including the 2 km corridor. Scale bar represents 50 km.

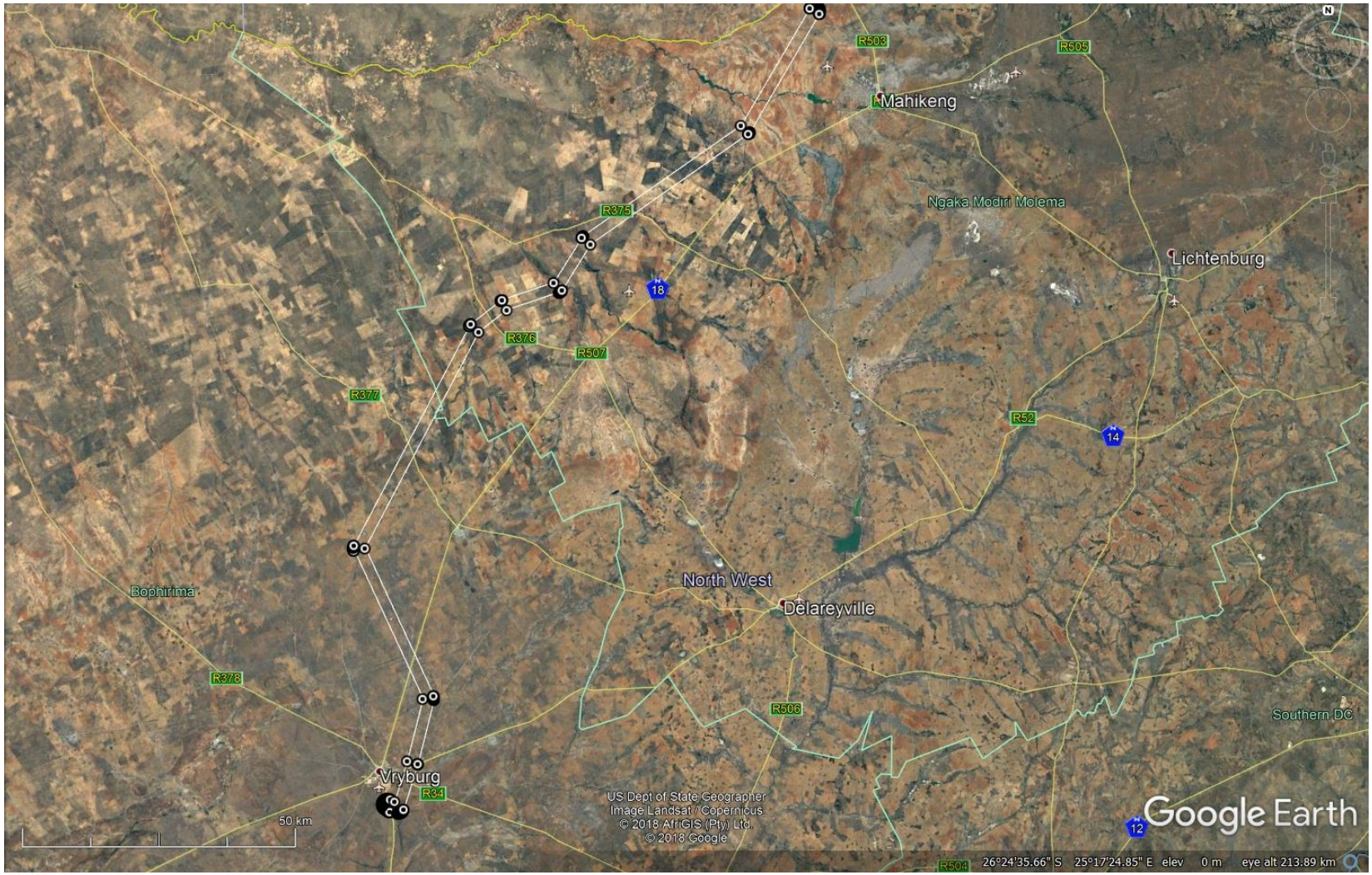

Figure 4. Google Earth Image of the location of the proposed Mookodi – Mahikeng 400kV line in North West: Option 4-including the 2 km corridor. Scale bar represents 50 km.

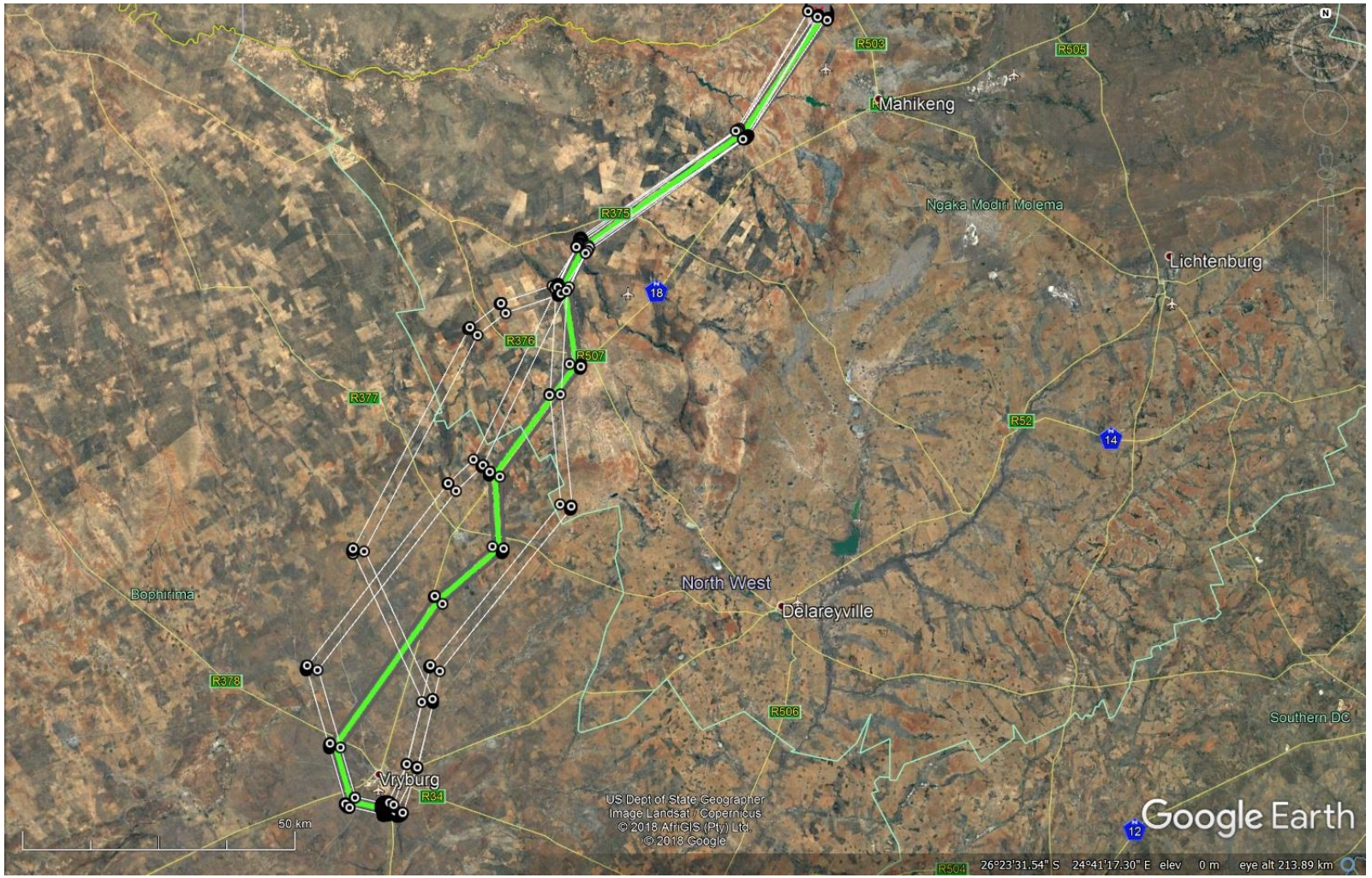

Figure 5. Google Earth Image of the location of the proposed Mookodi – Mahikeng 400kV line in North West: All four options -including the 2 km corridor. Scale bar represents 50 km.

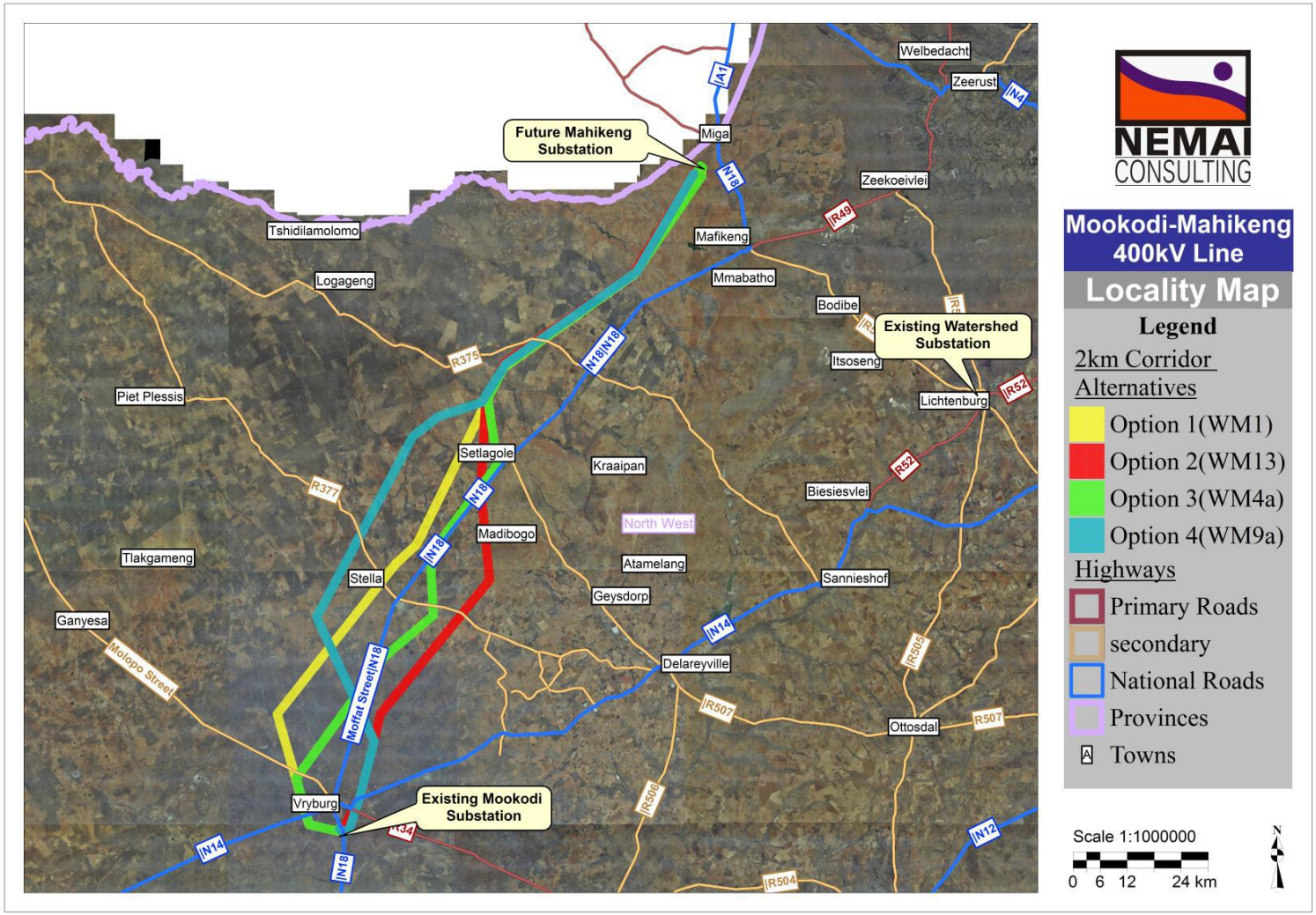

Figure 6. Mookodi – Mahikeng 400kV line as well as route alternatives in North West. Map provided by Nemai Consulting.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-four years. She has extensive 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 for 12 years. She has been conducting Palaeontological Impact Assessments since 2014.

3 LEGISLATION

3.1 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**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, moved, broken 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 Desktop 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 m^2 in extent;

- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The objective of a Palaeontological Desktop Assessment 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 palaeontological impact assessment are: 1) to identify the palaeontological importance of the exposed and subsurface rock formations in the development footprint 2) to evaluate the palaeontological importance of the formations 3) to determine the impact of the development on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontological desktop study is compiled, the potentially fossiliferous rocks (i.e. groups, formations, etc.) present within the study area are established from 1:250 000 geological maps. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within each rock section is obtained from previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations specifically in areas close to the development area). The palaeontological importance of each rock unit of the development area is then calculated. The possible impact of the proposed development footprint on local fossil heritage is established on the following criteria: 1) the palaeontological importance of the rocks and 2) the type and scale of the development footprint and 3) quantity of bedrock excavated.

In the event that rocks of moderate to high palaeontological sensitivity are present within the study area, a field-based assessment by a professional palaeontologist is required. Based on both the desktop data and field examination of the rock exposures, the impact significance of the planned development is measured with recommendations for any further studies or mitigation. In general, destructive impacts on palaeontological heritage only occur during construction. The excavations will transform the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation comprises the sampling, collection and recording of fossils and may precede construction or, more ideally, occur during construction when potentially fossiliferous bedrock is exposed. Preceding the excavation of any fossil heritage a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Mookodi-Mahikeng 400 kV line is underlain by various geological sediments (**Figure 7** and **Figure 9**) and can also be seen in the 1: 250 000 geological map 2624 Vryburg (Council for Geoscience, Pretoria)

The geology of the development consists of the following:

- Kalahari Group
- Ventersdorp Supergroup: Allanridge Formation
- Transvaal Supergroup
    - Schmidtsdrif Subgroup, (Ghaap Group)
    - Vryburg Formation (Transvaal Supergroup)
- Swazian Era

5.1 Kalahari Group (Late Cretaceous to Recent; 90 Ma to 0 Ma)

The central of southern Africa was dominated by two major Basins during the Cenozoic namely the Kalahari and Bushveld Basins. The sediments of the Kalahari Basin precede the Cenozoic deposits. The wide-ranging terrestrial sediments of the Kalahari Group was deposited in the Kalahari Basin to the north of the Orange River (Northern Cape) and western part of the North West Province, while the younger Cenozoic deposits are largely confined to the coastal areas. The sediments of the Kalahari Group consist of fluvial gravels, sands, lacustrine and pan mudrocks, diatomites and diatomaceous limestones, evaporates (a natural salt or mineral deposit left after the evaporation of a water body), consolidated to unconsolidated aeolian sands, pedocretes (especially calcrete).

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 Cenozoic superficial deposits although they sometimes comprise of significant fossil biotas. Fossils assemblages may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells and freshwater stromatolites 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). These fossils are usually associated with ancient pans, lakes and river systems.

5.2 Ventersdorp Supergroup (3000 -2100 Million years ago)

After the stabilization of the Kaapvaal Craton a succession of four basins developed of which the Ventersdorp Supergroup was the second last to develop. This ancient Supergroup provides a

remarkable volcano-sedimentary supracrustal record that comprises the largest and widespread volcanic rocks on the Kaapvaal Craton. This Supergroup unconformably overlies the Witwatersrand Supergroup and in turn is unconformably overlain by the Transvaal Supergroup. The uppermost formation of the Ventersdorp Supergroup is the **Allanridge Formation**. This formation consists of basaltic lava and tuff and is not known to be fossiliferous.

5.3 Transvaal Supergroup

The Transvaal Supergroup (Late Archaean to Early Proterozoic) is preserved within three structural basins on the Kaapvaal Craton of southern Africa namely the Transvaal and Griqualand West Basins in South Africa and the Kanye Basin in Botswana.

The Ghaap Group of the Griqualand West Basins is divided in the following subgroups: Schmidsdrift, Asbestos Hills and Koegas Subgroup (from the youngest to the oldest).

5.4 Schmidtsdrif Subgroup, (Ghaap Group, Transvaal Supergroup) (Fig 8-9).

The Schmidstrift Subgroup can be divided in two formations, namely the Boomplaas and Clearwater Formations. These formations comprise of carbonates with siliciclastics, iron Formations Late Archaean / Early Proterozoic c. 2.56 Ga. As well as various shallow marine and lacustrine stromatolites (some specimens are very large), oolites, pisolites in carbonates, filamentous and coccoid organic walled microfossils (e.g. cyanobacteria) in siliciclastics/ carbonates and cherts of banded iron formations.

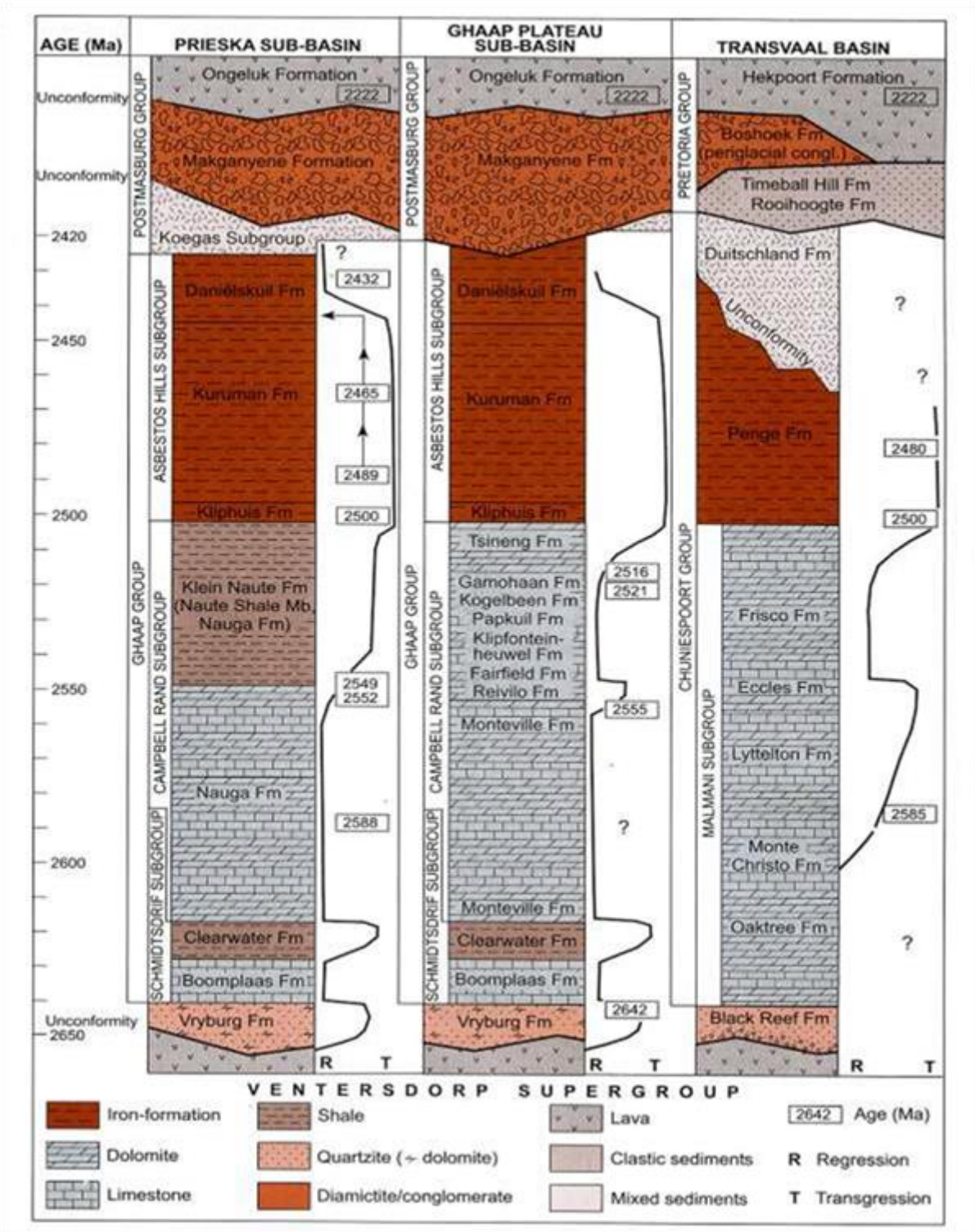

Figure 7. Stratigraphy of the Transvaal Supergroup of the Ghaap Plateau Basin. The middle column (Schmidsdrift Supergroup and Vryburg Formation) shows the rock units represented in the proposed site (Eriksson, et al. 2006).

Figure 8. Example of a well-preserved stromatolite from the Archaean Era.

Stromatolites (**Figure 8**) are layered mounds, columns and sheet-like sedimentary rocks. Originally, they were 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. The oxygen atmosphere that we depend on was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

5.5 Vryburg Formation (Transvaal Supergroup)

The Vryburg Formation forms part of the lower Griqualand West Basin of the Transvaal Supergroup.

5.6 Swazian Era

Rocks of the Swazian Era is older than 3100 million years and are highly metamorphosed rocks, comprising banded ironstone and chert

5.7 Kraaipan Group

These cherts and volcanic glasses also present in the similar-aged Barberton Greenstone Belt may contain microbial fossils and microbial trace fossils .

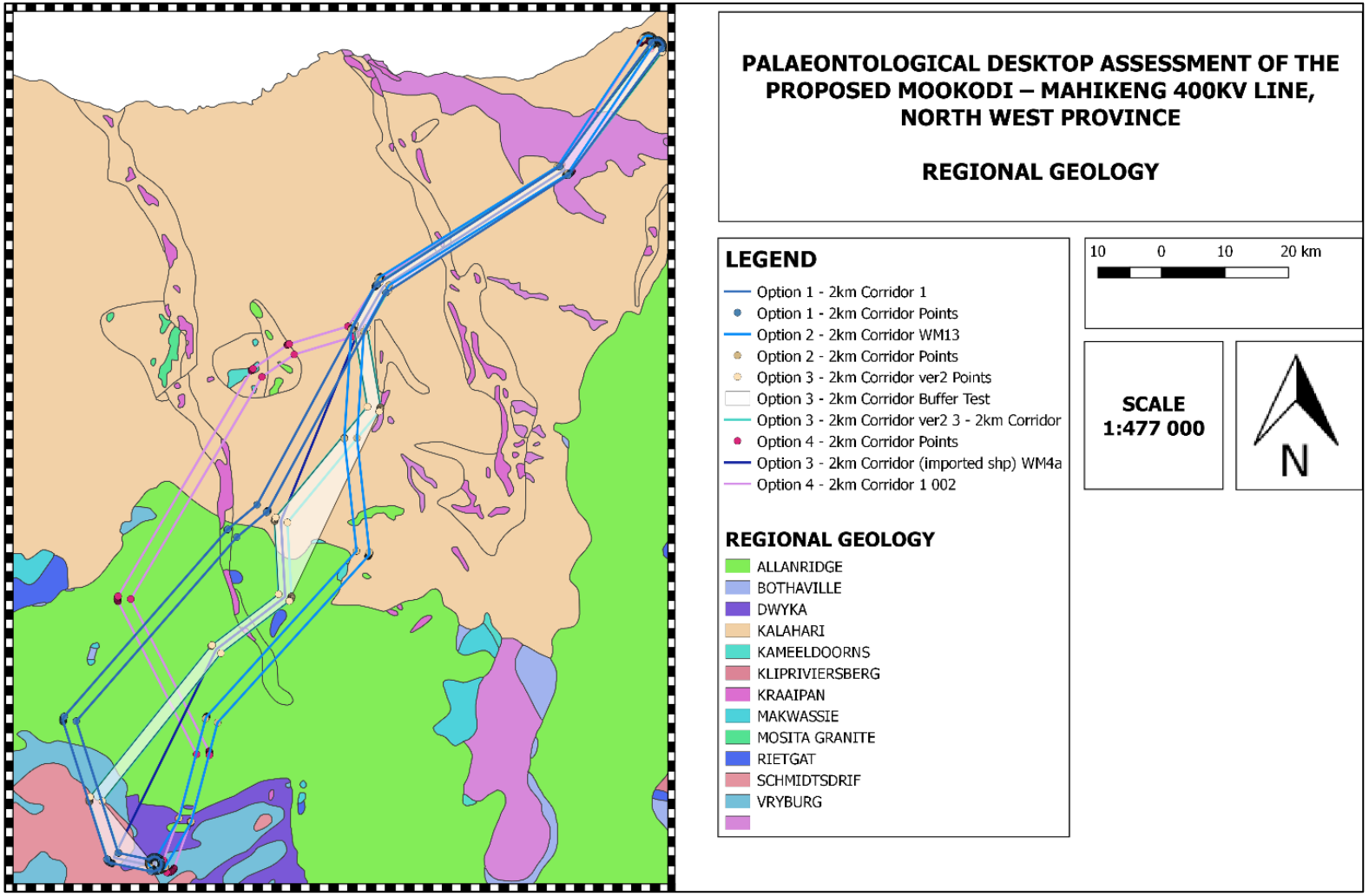

Figure 9. The surface geology of the proposed Mookodi – Mahikeng 400kV line as well as four route alternatives in North West. The proposed development is underlain by the Kalahari Group; the Allanridge Formation of the Ventersdorp Supergroup; the Schmidtsdrif Group, (GhaapP Group, Transvaal Supergroup); and the Vryburg Formation of the Transvaal Supergroup as well as rocks of the Swazian Era. Map drawn QGIS Desktop 2.18.14.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development site is situated within the Naledi-, Kagisano- Molopo and Mahikeng Local Municipalities on the North West Province. All route alternatives starts in Vryburg and lies in a north-east direction ending near Mahikeng (**Figure 1-Figure 6**). A servitude of 2 km (one km on each side) allows for possible deviations from the current proposed alignment of the power lines.

6.1 Methods

A Palaeontological desktop study was conducted to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed area of development. The author's experience, aerial photos (using Google, 2018), topographical and geological maps and other reports from the same area were used to assess the proposed area of the development. No consultations were undertaken for this PIA.

6.2 Assumptions and Limitations

The accurateness of Palaeontological Desktop Impact Assessments is reduced by old fossil databases that do not always include relevant locality or geological formations. The geology in various remote areas of South Africa may be less accurate because it is based entirely on aerial photographs. The accuracy of the sheet explanations for geological maps is inadequate as the focus was never intended to be on palaeontological material.

The entire South Africa has not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area. Thus, the accuracy of the Palaeontological Impact Assessment is improved by a field-survey.

6.3 Methodology for Impact Assessment

In order to ensure uniformity, a standard impact assessment methodology has been utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors, along with the equivalent quantitative rating scale for each of the aforementioned criteria, is given in **Table 1.**

Table 1: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated site/ proposed corridor*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

6.3.1 Significance Assessment

The Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these, since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of an area affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed, the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common.

A more detailed description of the impact significance rating scale is given in **Table 2** below.

Table 2: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	MODERATE	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial

		impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity are needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

6.3.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in the table below.

Table 3: Description of the Spatial significance rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of possible impacts, and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50 km from the proposed site.
3	Local	The impact will affect an area up to 5 km from the proposed site.
2	Study Area	The impact will affect an area not exceeding the boundary of the study area.
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the site.

6.3.3 Temporal/Duration Scale

In order to accurately describe the impact, it is necessary to understand the duration and persistence of an impact in the environment. The temporal or duration scale is rated according to criteria set out in **Table 4.**

Table 4: Description of the temporal rating scale

RATING		DESCRIPTION
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium-term	The environmental impact identified will operate for the duration of life of the project.
4	Long-term	The environmental impact identified will operate beyond the life of operation of the project.
5	Permanent	The environmental impact will be permanent.

6.3.4 Degree of Probability

The probability, or likelihood, of an impact occurring will be described as shown in **Table 5** below.

Table 5: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	Could happen
4	Very likely
5	It's going to happen / has occurred

6.3.5 Degree of Certainty

As with all studies, it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used, as discussed in **Table 6.** The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 6: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

6.3.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner, in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale, as described below:

$$\textbf{\textit{Impact Risk}} = \frac{(\text{SIGNIFICANCE}(2) + \textit{Spatial (2)} + \text{Temporal (5)})}{3} \times \frac{\text{Probability (2)}}{5}$$

An example of how this rating scale is applied is shown below:

Table 7: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	Low	**Study Area**	**Permanent**	**Unlikely**	**High**
Impact on heritage sites	2	2	5	2	1.2

Note: The significance, spatial and temporal scales are added to give a total of 9, which is divided by 3 to give a criterion rating of 3. The probability (2) is divided by 5 to give a probability rating of 0.4. The criteria rating of 3 is then multiplied by the probability rating (0,4) to give the final rating of 1.2

The impact risk is classified according to 5 classes as described in the table below.

Table 8: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High

Therefore, with reference to the example used for heritage resources above, an impact rating of 1.2 will fall in the Impact Class 2, which will be considered to be a LOW impact.

7 FINDINGS

The proposed development footprint is underlain by sediments of the Kalahari Group (*low Palaeontological sensitivity*); the Allanridge Formation of the Ventersdorp Supergroup (*moderate Palaeontological sensitivity*); the Schmidsdrift Subgroup (Ghaap Group) and the Vryburg Formation (*both with a moderate Palaeontological sensitivity*) of the Transvaal Supergroup as well as the ancient metamorphic rocks of the Swazian Era. The possible impact on palaeontological resources is rated as *low* (**Table 9**) All four route alternatives were found to be in the above mentioned geological sediments and therefore none of the routes were preferred above the other and none were a no-go option.

Table 9: Impact rating on palaeontological resources

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	Low	Study Area	Permanent	Unlikely	Low
Impact on palaeontology	2	2	5	2	1.2

8 RECOMMENDATIONS

As the Palaeontological sensitivity of the development footprint varies between *low to moderate* the proposed development is thus unlikely to pose a substantial threat to local fossil heritage. However, should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted immediately. Such discoveries ought to be protected (preferably in situ) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (e.g. recording, sampling or collection) can be taken by a professional paleontologist.

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