PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR LEEUWBOSCH PV 3 NEAR LEEUDORINGSTAD IN NORTH WEST PROVINCE

MAY 2022

COMPILED ON BEHALF OF:

SiVEST

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

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE: 

This Palaeontological 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

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in 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 vitae	Section 2 – 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 4 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – 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		Desktop Assessment
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology	-
(f) details of an assessment of the specific 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 alternative;	Section 1 and 10	
(g) An identification of any areas to be avoided, including buffers	Section 5	No buffers or areas of sensitivity identified

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**	**Comment where not applicable.**
(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 5 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – 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 10	
(k) Any mitigation measures for inclusion in the EMPr	Section 11	
(l) Any conditions for inclusion in the environmental authorisation	Section 11	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 11	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 10	
(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 10	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	
(p) A summary and copies if any comments that were received during any consultation process	N/A	
(q) Any other information requested by the competent authority.	N/A	
(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 SiVEST to conduct the Palaeontological Desktop Assessment (PDA) to assess the proposed Leeuwbosch PV solar photovoltaic (PV) plant and associated infrastructure on Portion 37 of the Farm Leeuwbosch No. 44 near Leeudoringstad within the Maquassi Hills Local Municipality in the Dr Kenneth Kaunda District Municipality in the North West Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PDA is necessary to verify 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 development is underlain by the Allanridge Formation (Ventersdorp Supergroup). According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Allanridge Formation is LOW (Almond and Pether 2008, SAHRIS website). It is therefore considered that the proposed development is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological heritage of the area. Hence, the construction of the development may be authorised in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources

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 Environmental Control Officer (ECO) in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO 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 correct mitigation (recording and collection) can be carry out by a paleontologist.

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Appendix A:

Curriculum Vitae **Elize Butler**

Curriculum Vitae **Prof. WA van der Westhuizen**

1 INTRODUCTION

The construction of the Leeuwbosch PV solar photovoltaic (PV) plant and associated infrastructure on Portion 37 of the Farm Leeuwbosch No. 44 near Leeudoringstad within the Maquassi Hills Local Municipality, Dr Kenneth Kaunda District Municipality in the North West Province is proposed (Figure 1-2).

The following information was provided by **SiVEST**

"Leeuwbosch PV Generation (Pty) Ltd (hereafter referred to as "Leeuwbosch PV Generation") is proposing to construct a solar photovoltaic (PV) plant and associated infrastructure on Portion 37 of the Farm Leeuwbosch No. 44, approximately 6km north-east of the town of Leeudoringstad in the North West Province (hereafter referred to as the "proposed development") (Department Ref No.: To be Allocated). The proposed development will have a maximum export capacity of up to 15 megawatt (MW) and will be known as the Leeuwbosch 3 Solar PV Plant. The proposed development is located within the Maquassi Hills Local Municipality in the Dr Kenneth Kaunda District Municipality.

At this stage, it is anticipated that the proposed solar PV plant will include PV fields (arrays) comprising multiple PV modules. In addition, the proposed solar PV plant will have a maximum total generation capacity of up to approximately 15 MW. The associated infrastructure would include, but not be limited to, internal access roads, one (1) switching substation, one (1) permanent guard house and one (1) temporary building zone. As mentioned, the electricity generated by the proposed solar PV plant (part of this application) will be fed into the national electricity grid via the Leeudoringstad Solar Plant Substation.

In summary, the following key components are to be constructed as part of the proposed development:

Solar PV arrays:

- The proposed solar PV plant will include PV fields (arrays) comprising multiple PV modules.
- PV panel mountings. PV panels will be single axis tracking mounting, and the modules will be either crystalline silicon or thin film technology.
- Each PV module will be approximately 2274mm (≈2.3m) long and 1134mm (≈1.1m) wide and mounted on supporting structures above ground. At this stage it is anticipated that the structures will be mono-facial modules. The final design details will become available during the detailed design phase of the proposed development, prior to the start of construction.

- The foundations will most likely be either concrete or rammed piles. The final foundation design will be determined at the detailed design phase of the proposed development.

Switching Substation:

- The proposed development will include the construction of one (1) new on-site switching substation with a capacity of more than 33kV but less than 275kV. The switching substation will occupy an area of up to approximately 0.2ha.
- The switching substation will contain transformer(s) for voltage step-up from medium voltage to high voltage. DC power from the modules will be converted into AC power in the inverters and the voltage will be stepped up to medium voltage in the inverter transformers.
- Medium voltage cabling (anticipated to be approx. 0.8m x 0.6m wide at this stage) will link the various PV arrays to the switching substation, as well as the Leeudoringstad Solar Plant Substation. These cables will be laid underground, wherever technically feasible.

Access Roads:

- Access to the facility will be via an existing gravel road which connects to the tarred R502 road.
- Existing internal gravel access roads will be used to access the PV arrays as well as the switching substation.
- New internal gravel roads of up to approximately 4m wide may however be constructed, where necessary.

One (1) permanent guard house, occupying a site of approximately 0.0876ha (i.e. 876m2);

Fencing will surround the entire proposed solar PV plant. At this stage it is anticipated that the fencing will be approximately 2.1m high and will be made of galvanised steel with electrification on top. In addition, fencing is anticipated to cover an area of up to approximately 18ha.

Temporary infrastructure:

- to obtain water from available local sources. Existing boreholes will be utilised. Water will potentially be stored in temporary water storage tanks. The necessary approvals from the Department of Water and Sanitation (DWS) will be applied for separately (should this be required
- One (1) temporary building zone which will occupy a site of up to approximately 0.2944ha (i.e. 2 944m2).

It should be noted that the proposed solar PV plant development does not fall within any of the Renewable Energy Development Zones (REDZs) which were formally gazetted on 16 February

2018 (Government Notice 114) for the purpose of development of solar and wind energy generation facilities.

No layout alternatives are being considered and assessed as part of the current BA process.

The "No-go" alternative is the option of not implementing the proposed development. This alternative would result in no environmental impacts from the proposed development on the site or surrounding local area. It provides the baseline against which other alternatives are compared and was considered throughout the BA process. Implementing the "no-go" option would entail no development. The development site itself consist mostly of natural grassland. The "no-go" would therefore imply that the land would remain as per the status quo, undeveloped the natural grassland will be maintained.

The "no-go" option is a feasible option, however, this would prevent the proposed solar PV plant from contributing to the environmental, social and economic benefits associated with the development of the renewables sector within the local and district municipalities, as well as the North West province. It will also prevent the electricity generated by the proposed solar PV plant being fed into the national transmission and distribution network and being sold to consumers within the Maquassi Hills Local Municipality."

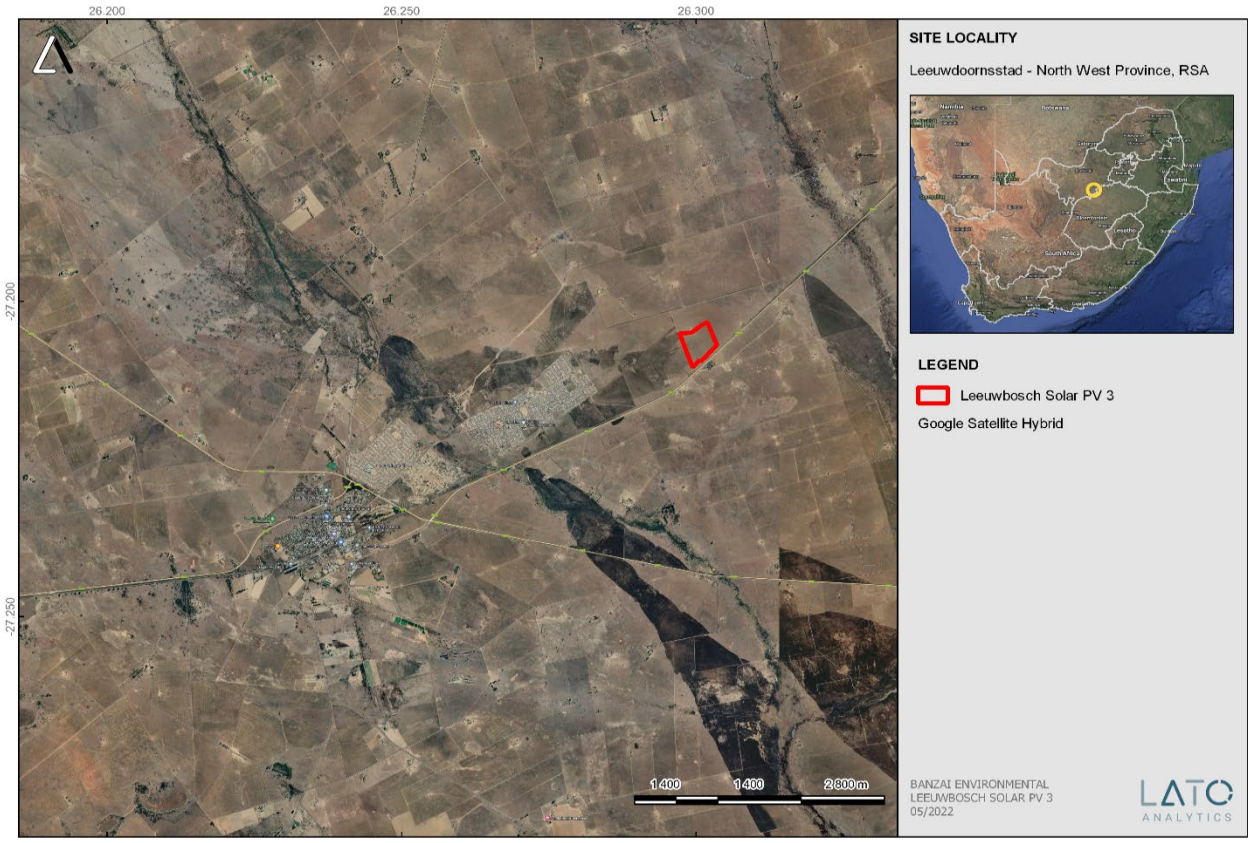

***Figure 1**: Google Hybrid image (2022) of the proposed Leeuwbosch PV Plant and associated infrastructure on Portion 37 of the Farm Leeuwbosch No. 44 near Leeudoringstad within the Maquassi Hills Local Municipality, Dr Kenneth Kaunda District Municipality in the North West Province.*

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present 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-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

The geology of this project was verified by Professor WA van der Westhuizen. He obtained his Ph.D. in geochemistry from the University of the Free State, South Africa, in 1984. He acted as departmental chairperson (Geology Department) from 1998 to 2013. He retired as full professor in 2015. Research in southern Africa includes the Ventersdorp Supergroup, volcanology, mineralogy, geology of eastern Namaqualand, vanadium deposits in the Otavi Mountainland. Consulting work was conducted in South

Africa, Namibia, Zimbabwe, and Malawi. Prof van der Westhuizen was an author and co-author for more than 70 peer reviewed articles and more than 70 conference presentations at national and international level. Apart from being a registered professional scientist, up to his retirement he was a member of the following societies: Fellow of the Geological Society of SA, Archaeological Society of SA, International Association of Volcanology and Chemistry of the Earth's Interior, Spectroscopic Society of SA, International Liaison Group on Gold Mineralisation.

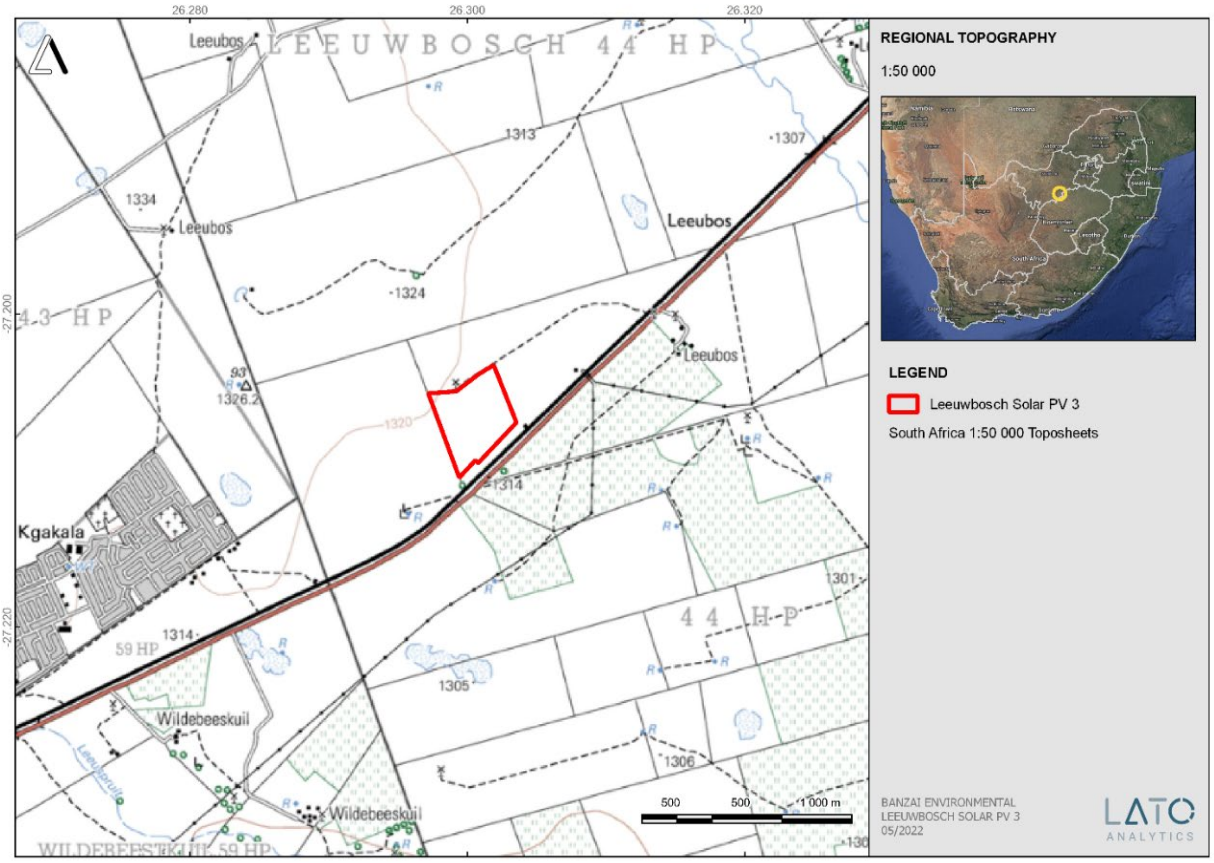

Figure 2: *Topographical location of the Leeuwbosch PV Plant and associated infrastructure on Portion 37 of the Farm Leeuwbosch No. 44 near Leeudoringstad within the Maquassi Hills Local Municipality, Dr Kenneth Kaunda District Municipality in the North West Province.*

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**".

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 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 aim of a Palaeontological Impact Assessment (PIA) is to decrease the effect of the development on potential fossils at the development site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the purpose of the PIA is: 1) to identify the palaeontological importance of the rock formations in the footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) to clarify the impact on fossil heritage; and 4) to suggest how the developer might protect and lessen possible damage to fossil heritage.

The palaeontological status of each rock section is calculated as well as the possible impact of the development on fossil heritage by a) the palaeontological importance of the rocks, b) the type of development and c) the quantity of bedrock removed.

When the development footprint has a moderate to high palaeontological sensitivity a field-based assessment is necessary. The desktop and the field survey of the exposed rock determine the impact significance of the planned development and recommendations for further studies or mitigation are made. Destructive impacts on palaeontological heritage usually only occur during the construction phase while the excavations will change the current topography and destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation usually precede construction or may occur during construction when potentially fossiliferous bedrock is exposed. Mitigation comprises the collection and recording of fossils. Preceding excavation of any fossils 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

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 sensitive areas to be avoided (providing shapefiles/kml's) 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 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).

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the Leeuwbosch PV3 and associated infrastructure near Leeudoringstad in the North West Province is depicted on the 1:250 000 Kroonstad 2726 (2000) Geological map (Council of Geoscience, Pretoria). This map indicates that the proposed development is underlain by the Allanridge Formation (Ra-dark green) (Ventersdorp Supergroup) (**Figure 3, Table 2).** Recent Shape files compiled by the Council of Geosciences (Pretoria) is depicted in **Figure 4**. According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Allanridge Formation is LOW (**Figure 5**; Almond and Pether 2008, SAHRIS website).

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.

Some of 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 6**). 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 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 non-porphyritic zones alternate with the porphyritic zones and areas with small dark phenocrysts is present in flows with a crystalline texture. In the upper flows red chalcedony amygdales are prominent but they are rarer in the lower flows while amygdales comprise of calcite, chlorite or epidote and quartz, (Keyser, 1992). Groenewald et al (2014) indicated that as yet no fossils have been found in the Allanridge Formation.

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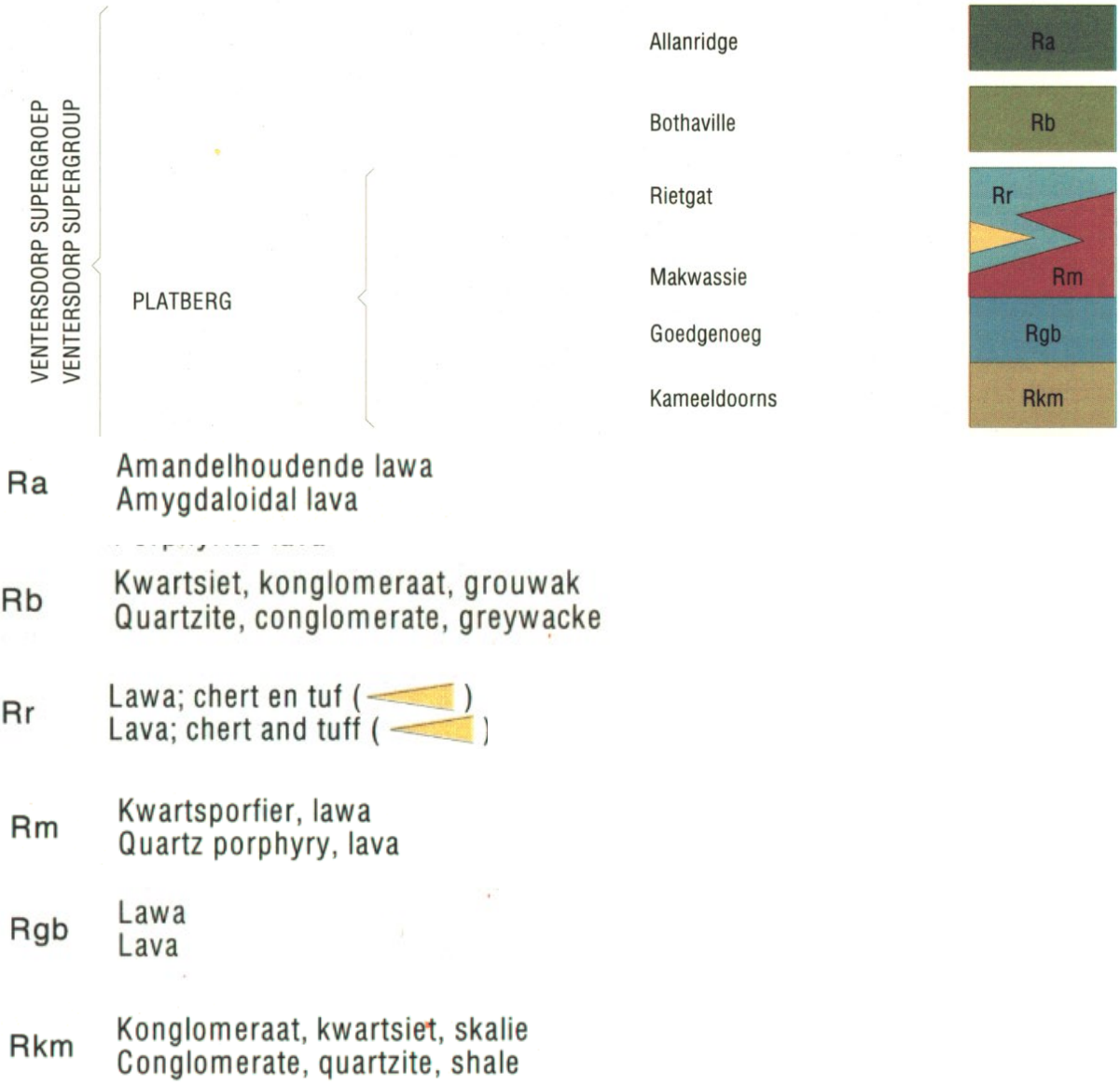
***Figure 3**: 1:250 000 Kroonstad 2726 (2000) Geological map (Council of Geoscience, Pretoria) indicating the Leeuwbosch PV3 development. The proposed development is underlain by the* Allanridge Formation of the Ventersdorp Supergroup.

Table 2: Legend of the 1:250 000 Kroonstad 2726 (2000) Geological map (Council of Geoscience, Pretoria)



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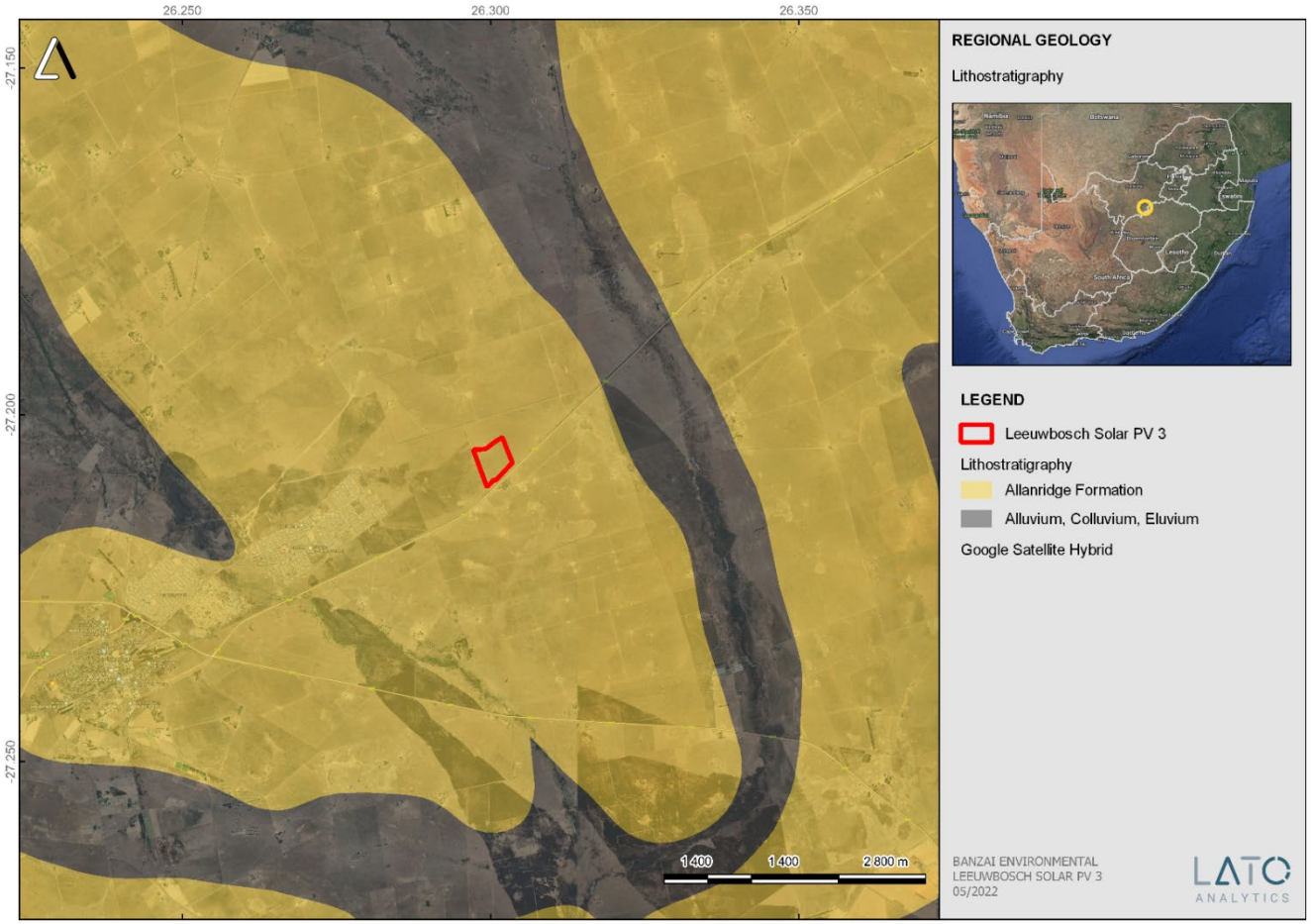

***Figure 4**: Geology indicated by Shape Files indicating the proposed Leeuwbosch PV3 development in red. The PV development is underlain by the Allanridge Formation of the Ventersdorp Supergroup.*

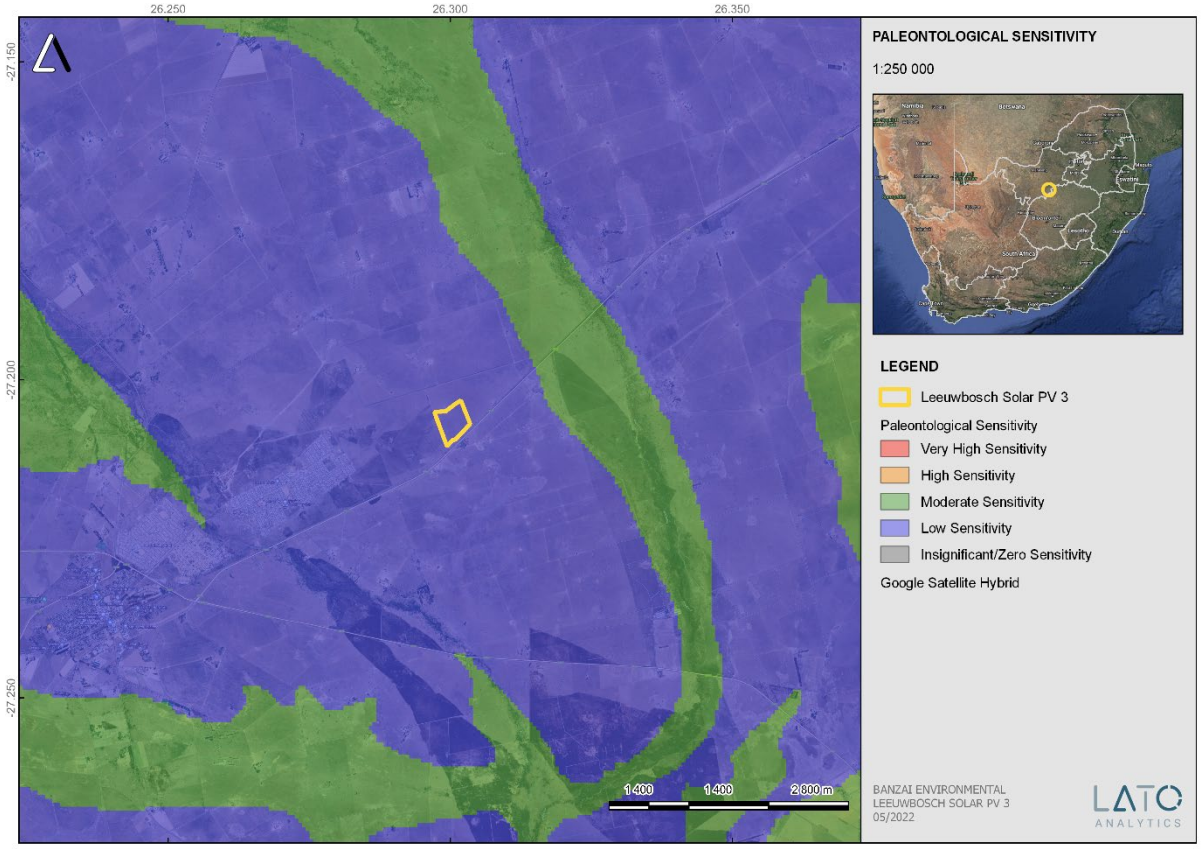

Figure 5: Extract of the 2 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the proposed development in pink.

According to the SAHRIS Palaeosensitivity map (**Figure 5)** the proposed development is underlain by sediments of LOW (blue) Palaeontological Sensitivity.

Table 3:Palaeontological Significance

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.

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

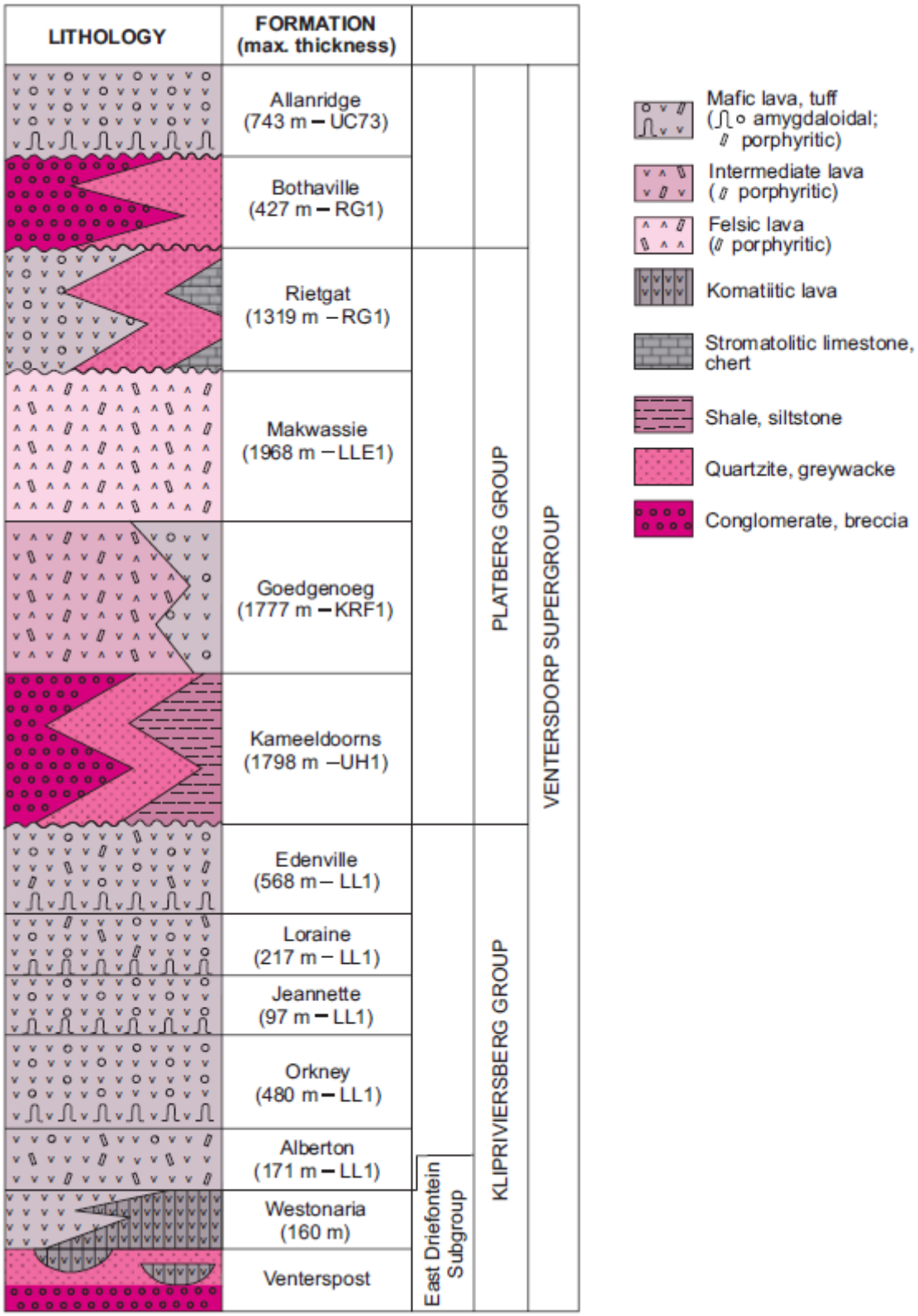

Figure 6: *Ventersdorp stratigraphy (Taken from Van Der Westhuizen and Bruiyn, 2006 after Winter, 1965, 1976; Linton et al., 1990 Meyers, 1990 and Meintjies, 1978).*

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development is located on the R502 about 6 km northeast of the town of Leeudoringstad in the North West Province.

Table 4: Project GPS Coordinates		
	Latitude	Longitude
North western point	27°12'18.41"S	26°17'50.32"E
North eastern point	27°12'11.44"S	26°18'6.95"E
South Eastern point	27°12'25.12"S	26°18'12.57"E
South Western point	27°12'37.89"S	26°17'57.94"E

7 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile a desktop study and includes Palaeontological impact assessment reports in the same area, aerial photos, and Google Earth images, topographical as well as geological maps. Scientific research articles of research conducted in the area is also sourced and included in the Impact Assessment.

7.1 Assumptions and Limitations

When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. 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 used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally **assumed** that exposed fossil heritage is present within the footprint.

8 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 SiVEST.
- 1:250 000 *Kroonstad 2726 (2000) Geological map (Council of Geoscience, Pretoria)*
- *Shape files obtained from the Council of Geosciences*

9 IMPACT ASSESSMENT METHODOLOGY

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 following project phases:

• Construction.
• Operation; and
• 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 5: The rating system

NATURE		
The Nature of the Impact is the possible destruction 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 = X.** 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

9.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a high probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

Table 6: Summary of Impact Tables								
	Site	Probability	Duration	Magnitude	Reversibility	Irreplicable Loss	Cumulative Effect	Significance
	1	2	4	1	4	4	2	17

10 FINDINGS AND RECOMMENDATIONS

The proposed development is underlain by the Allanridge Formation (Ventersdorp Supergroup). According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Allanridge Formation is LOW (Almond and Pether 2008, SAHRIS website).

It is therefore considered that the proposed development is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological heritage of the area. Hence, the construction of the development may be authorised in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources

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 Environmental Control Officer (ECO) in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO 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 correct mitigation (recording and collection) can be carry out by a paleontologist.

11 CHANCE FINDS PROTOCOL

A following procedure will only be followed if fossils are uncovered during excavation.

11.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 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.

11.2 Background

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past 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.

11.3 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.

11.4 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.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (site manager). 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 Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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APPENDIX A
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 and Collection Manager	National Museum, Bloemfontein 1998–currently

TECHNICAL REPORTS

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Curriculum Vitae

Willem Andries van der Westhuizen

School:	Grey College Bloemfontein1968.	
University Training:	B.Sc. (Geology, chemistry)	1973
	B.Sc. Honours (Geology)	1974
	M.Sc. (Geology)	1977
	Ph.D. (Geochemistry)	1984

All degrees obtained at the University of the Free State.

Research

Research included the following visits:

1 Mineral Exploration Research Institute (Universities of Montréal and McGill) in Montréal (1986).

2 Study volcanic successions in Channel Islands, France, and Whales in 1986.
3 Visit Australia in 1988 to study gold deposits (Kalgoorlie).
4 Study gold deposits in Brazil in 1991.
5 Excursion to the active volcanoes of Sicily and the Aeolian islands (1994).
6 Mineral Resource Management (value tracking) symposium in Australia in 2002.
7 Excursion to study high-pressure metamorphic rocks in Turkey in 2005.
8 Excursion to northern Spain with students from Wales and South Africa 2008.
9 Attended workshop on gold mineralisation in Namibia (±2007).
10 Visited New Zealand in 2019 to investigate volcanological aspects of active volcanoes.

Research in southern Africa includes the Ventersdorp Supergroup, volcanology, mineralogy, geology of eastern Namaqualand, vanadium deposits in the Otavi Mountainland, Witwatersrand geology and mineralisation.

Consulting work in South Africa, Namibia, Zimbabwe and Malawi.

Author and co-author of more than 70 peer reviewed articles and more than 70 conference presentations at national and international level.

Positions held:

Employed by the University of the Free State since 1974. Started as technical assistant at the Institute for Groundwater Studies and then the Department of Geology. Promoted to X-ray fluorescence analyst in charge of the analytical laboratory and later to lecturer, senior lecturer and associate professor.

Departmental chairperson (geology department) since 1998.

Professor and departmental chairperson from 2003 until 2013.

Supervised and co-supervised 16 M.Sc. students and 4 Ph.D. students. Involved with two more Ph.D. candidates.

Supervised 75 mini-dissertations from MRM (mineral resource management) students.

Retired end of 2015.

Appointed part-time 2016 – 2018.

Teaching

Taught courses in mineral exploration, geochemical exploration, economic geology and analytical techniques (geochemistry).

Introduced a course in Mineral Resource Management at the University of the Free State in 2000 in collaboration with private sector (Comparex, now Business Connection) and Kumba.

Societies

Member of the following societies:

Fellow of the Geological Society of SA.

Archaeological Society of SA.

International Association of Volcanology and Chemistry of the Earth's Interior.

Spectroscopic Society of SA.

International Liaison Group on Gold Mineralisation.

Chairman Maccauw Gun Club (clay target shooting) for four years.

Registered as a professional scientist.

Most of above lapsed since retiring.

Business

Director Woodland Hills Wildlife Estate from 2001 until present (property development on the outskirts of Bloemfontein (includes houses, sectional title units and hospital).

Trustee of the Hillandale Homeowners association since inception (chairperson for four years).

Director and chairperson of the board of Hillandale Hospital (property investment and a private company leases the buildings.

Conducted some geotechnical and environmental work for Woodland Hills Wildlife Estate.