

**PHASE 1 PALAEOLOGICAL DESKTOP  
ASSESSMENT FOR THE PROPOSED  
CONSTRUCTION OF AN ESKOM 11 KV  
POWERLINE FROM THE VREDE MUNIC  
SUBSTATION TO THEMBALIHLE EXTENSION 4  
TOWNSHIP, PHUMELELA LOCAL  
MUNICIPALITY, THABO MAFUTSANYANE  
DISTRICT MUNICIPALITY, FREE STATE  
PROVINCE**

**For:**

**HIA CONSULTANTS**

**GIBB Engineering and Architecture  
for  
Eskom Holdings (Pty) Ltd**

**DATE: 17 March 2016**

**By**

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## EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Gibb Engineering and Architecture to undertake a Phase 1 Palaeontological field survey, assessing the potential Palaeontological Impact of the proposed construction of an 11 kV Eskom powerline from the Vrede Munic Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province.

The purpose of this Palaeontological Impact Assessment is to identify exposed and potential Palaeontological Heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

This report forms part of the Environmental Impact Assessment for the proposed proposed construction of an 11 kV powerline at the Vrede Munic Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed upgrade of the an 11 kV powerline at the Vrede Munic Substation to Thembalihle Extension 4 township Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province.

The development site for the proposed proposed construction of an 11 kV powerline from the Vrede Munic Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province is underlain by Permian aged sedimentary rocks of the Normandien Formation, Adelaide Subgroup and Dolerite of the Karoo Supergroup as well as deep alluvial sediments.

No fossils were observed during the field investigation. The potential for finding significant fossils in deeply exposed sediments of the Normandien Formation did not realise during the construction. Exposure of bedrock in the western part of the proposed area as well as aland no further mitigation for Palaeontological Heritage was necessary.

It is recommended that:

1. The EAP and ECO must be informed of the fact that a Very High Palaeontological Sensitivity was allocated to the central part of the development but no fossils were recorded during the construction phase.
2. No further mitigation for Palaeontological Heritage is recommended.

## TABLE OF CONTENT

1.	INTRODUCTION .....	1
1.1.	Legal Requirements .....	1
2.	AIMS AND METHODOLOGY .....	1
2.1.	Scope and Limitations of the Phase 1 Investigation .....	3
3.	LOCALITY AND PROPOSED DEVELOPMENT .....	4
4.	GEOLOGY OF THE AREA .....	4
4.1.	Karoo Supergroup .....	4
4.1.1.	Normandien Formation (Pne) of the Adelaide Subgroup .....	4
4.1.2.	Dolerite .....	5
4.1.3.	Alluvium .....	5
5.	PALAEONTOLOGY OF THE AREA .....	5
5.1.	Karoo Supergroup (Adelaide Subgroup) .....	5
5.1.1.	Normandien Formation (Pne) .....	5
5.1.2.	Dolerite .....	6
5.1.3.	Alluvium .....	6
6.	PRELIMINARY ASSESSMENT RESULTS .....	6
7.	FIELD INVESTIGATION .....	6
8.	PALAEONTOLOGICAL IMPACT AND MITIGATION .....	11
9.	CONCLUSION .....	12
10.	REFERENCES .....	13
11.	QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR .....	14
12.	DECLARATION OF INDEPENDENCE .....	14

## LIST OF FIGURES

Figure 3.1	The locality of the study area to the west of Vrede .....	4
Figure 4.1	The entire study site falls on the underlying sedimentary rocks of the Normandien Formation (Pne), Dolerite and alluvium. Study site forms part of Eskom Power line in the region. ....	5
Figure 7.1	GPS sites where photographic evidence of observations were recorded (see Table 7.1) ....	7
Figure 8.1	Initial indications of very high potential for fossils in the central part of the development (red dot) did not realise due to deep soils and no presence of expected boulder beds in the soil profiles .....	12

## LIST OF TABLES

Table 2-1	Colour Coding for Palaeontological Sensitivity Classes.....	2
Table 7-1	Photographic record of observations .....	7

## **1. INTRODUCTION**

Gideon Groenewald was appointed by Gibb Engineering and Architecture to undertake a Phase 1 Palaeontological field survey, assessing the potential Palaeontological Impact of the proposed construction of an Eskom 11 kV powerline from the Vrede Munc Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province.

The purpose of this Palaeontological Impact Assessment is to identify exposed and potential Palaeontological Heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

### **1.1. Legal Requirements**

This report forms part of the Environmental Impact Assessment for the proposed proposed construction of an Eskom 11 kV powerline at the Vrede Munc Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed upgrade of the 11 kV powerline from the Vrede Munc Substation to Thembalihle Extension 4 township Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

## **2. AIMS AND METHODOLOGY**

A Phase 1 investigation is often the last opportunity to record the fossil heritage within the development footprint. These records are very important to understand the past and form an important part of South Africa's National Estate.

Following the "SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment are:

- to identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assessing the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to the field investigation a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps (2728 Frankfort) in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc) were identified within the study area and the known fossil heritage within each rock unit was inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author’s field experience.

Priority palaeontological areas were identified within the development footprint to focus the field investigator’s time and resources. The aim of the fieldwork was to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The likely impact of the proposed development on local fossil heritage was determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the minimal extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 2.1 below.

**Table 2-1 Colour Coding for Palaeontological Sensitivity Classes**

<b>PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS</b>	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008, 2009) (Groenewald et al.,2014).	
<b>RED</b>	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction ) as well as application for collection and destruction permit compulsory.
<b>ORANGE</b>	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
<b>GREEN</b>	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.

<b>BLUE</b>	<p>Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Collection of a representative sample of potential fossiliferous material is recommended.</p>
<b>GREY</b>	<p>Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during emplacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits.</p>

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

### **2.1. Scope and Limitations of the Phase 1 Investigation**

The scope of a phase 1 Investigation includes:

- an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units;
- a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports;
- data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and
- where feasible, location and examination of any fossil collections from the study area (e.g. museums).
- an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The

investigation focussed on the bedrock exposure where excavations would most probably require palaeontological monitoring.

The results of the field investigation are then used to predict the potential of buried fossil heritage within the development footprint. In some investigations this involves the examination of similar accessible bedrock exposures, such as road cuttings and quarries, along roads that run parallel to or across the development footprint.

### 3. LOCALITY AND PROPOSED DEVELOPMENT

The Project area is located to the west of Vrede and comprises the linear zone from the Vrede Munic Substation to the Thembalihle Extension 4 township Phumelela Local Municipality (Figure 3.1)



Figure 3.1 The locality of the study area to the west of Vrede

### 4. GEOLOGY OF THE AREA

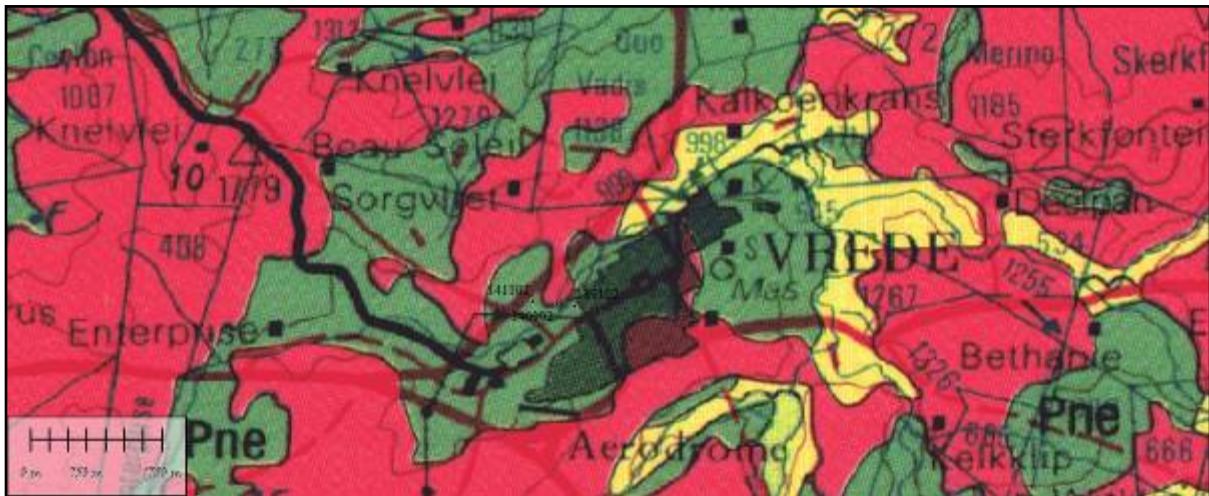
The section of the proposed construction of an Eskom 11 kV powerline from the Vrede Munic Substation to Thembalihle Extension 4 township, Phumelela Local Municipality is underlain by Permian aged sedimentary rocks of the Normandien Formation, Adelaide Subgroup, Jurassic aged Dolerite sills of the Karoo Supergroup and Quaternary alluvial material in the river valleys.

#### 4.1. Karoo Supergroup

##### 4.1.1. Normandien Formation (Pne) of the Adelaide Subgroup

The Permian aged Normandien Formation is a thick sequence of sedimentary rocks dominated by coarse-grained sandstones of the Frankfort Member, with interbedded grey to black coloured shale (Groenewald, 1990). These sandstones and mudstones were deposited in ancient deltaic environments associated with rivers alongside which

lay vast swamplands. Burial of plant and animal remains lead to a wealth of fossils preserved in these sediments (Johnson et al, 2009).



**Figure 4.1** The entire study site falls on the underlying sedimentary rocks of the Normandien Formation (Pne), Dolerite and alluvium. Study site forms part of Eskom's Power line in the region.

#### **4.1.2. Dolerite**

Dolerite is an igneous rock that was intruded into the sedimentary sequence of the Karoo Supergroup during the break-up of Gondwanaland.

#### **4.1.3. Alluvium**

Quaternary aged alluvium forms a local fill of sandy soil and gravel that were deposited in the valley floor regions in the study area.

### **5. PALAEOONTOLOGY OF THE AREA**

#### **5.1. Karoo Supergroup (Adelaide Subgroup)**

##### **5.1.1. Normandien Formation (Pne)**

This sequence of sediments is rated as some of the most productive deposits of Permian aged plant fossils of *Glossopteris* assemblages in South Africa. At their peak development during the Permian these plants inhabited a variety of ecological niches, including riverine forests and was dominated by cycadeoids, ginkos and conifers. Rich assemblages of insects are also recorded from these sequences. A rich assemblage of vertebrates, including some of the most important Mammal-like Reptiles in the World, including the *Dicynodon* Assemblage Zone and *Lystrosaurus* Assemblage Zone is recorded from these units (Rubidge et al, 1995; Mac Rae, 1995; Anderson *et al.*, 1998; McCarthy and Rubidge, 2005). Several important trace fossil assemblages, including vertebrate tracks and casts of vertebrate burrows have been described from the Formation (Groenewald, 1996; Johnson *et al.*, 2009).



### **5.1.2. Dolerite**

Dolerite is an igneous rock and will not contain fossils.

### **5.1.3. Alluvium**

The alluvium on site contains big boulders of sandstone and dolerite and might contain significant remains of plants and animals as was discovered at Cornelia, just north of Vrede.

## **6. PRELIMINARY ASSESSMENT RESULTS**

The palaeontological sensitivity was predicted after identifying potentially fossiliferous rock units; ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself. The palaeontological sensitivity was predicted as highly significant, due to the potential abundance of Permian aged fossils, including plant fossils, in the Normandien Formation and in the alluvium.

## **7. FIELD INVESTIGATION**

Dr Gideon Groenewald, experienced fieldworker, visited the site of the proposed construction of the Eskom 11 kV powerline from the Vrede Muncip Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province on Tuesday 15<sup>th</sup> March 2016 and Thursday 17<sup>th</sup> March 2016. The topography of the area is mostly gentle undulating in the river valleys, and rolling hills of grassland away from the deeper valleys. The site of the proposed development transects the local stream west of Vrede, with shallow very gravel-rich alluvial deposits overgrown with thick vegetation of grassland and exotic trees. The soil cover vary from deep vertic Arcadia soils in the valley floors to hutton soils on the gentle slopes underlain by either dolerite or sandstone and deeply weathered mudstone.


Excavations for the new power line will be restricted to the route of the existing poweline and as expected most of the excavation in the Valley Floor areas were into deep soils, with no exposure of Normandien Formation sediments. Excavation at the eastern side as well as the central part of the development was into deep soils and weathered sandstone and dolerite whilst the excavations in the western side of the development exposed of some sandstone of the Frankfort Member of the Normandien Formation, where plant fossils and vertebrate fossils were expected. The route of the new power line was followed and observations regarding the palaeontological heritage was recorded at specific GPS stations where photographic records were kept (Figure 7.1 and Table 7.1).






Photographic records were recorded at different GPS stations (Table 7-1).













Figure 7.1 GPS sites where photographic evidence of observations were recorded (see Table 7.1)

Table 7-1 Photographic record of observations

Photo	GPS station no (Fig. 7-1) and coordinates	Description	Picture
1	(139102) 27° 25' 44.6" 29° 09' 21.5"	Site of Eskom Substation, no outcrops no fossils observed	

2	(139102) 27° 25' 44.6" 29° 09' 21.5"	Power line construction, deep soils, no outcrop, no fossils observed	
3	(139102) 27° 25' 44.6" 29° 09' 21.5"	Deep alluvial fill with potential to contain fossils – no fossils observed during field investigation	
4	(139102) 27° 25' 44.6" 29° 09' 21.5"	Deep alluvial fill on dolerite sill – no fossils observed.	
5	(140102) -27° 25' 43.7" 29° 09' 14.0"	Alluvial fill in valley floor. Exposure of dolerite. No fossils observed, no fossils observed	
6	(141102) -27° 25' 42.5" 29° 09' 03.7"	Coarse-grained sandstone of the Frankfort Member - normally rich in plant remains – no fossils were observed during this investigation	

7	(141102) -27° 25' 42.5" 29° 09' 03.7"	Deep soils with lush vegetation. Sandstone outcrops but no fossils were observed. Excavation will probably be into deep soils with no outcrop of bedrock.	
8	(150101) -27° 25' 42.3" 29° 09' 16.9"	Training the team on site to identify potential fossiliferous rocks in the study area	
9	(142101) -27° 25' 41.3" 29° 09' 09.3"	Deep vertic soils in alluvial material with potential fossiliferous zones	
10	(142101) -27° 25' 41.3" 29° 09' 09.3"	Deep soil and alluvium underlies the central part of the development in the valley floor of the stream. No outcrops of fossils were observed. Construction did not involve deep excavation into gravel beds on site.	
11	(143101) -27° 25' 42.5" 29° 09' 08.5"	Deep alluvial deposits and deep soils underlies the development and no outcrops or fossils were observed. No fossils exposed during excavation	

12	(144102) -27° 25' 40.4" 29° 09' 07.8"	No outcrop of NormandienFormation sediments. Deep weathering of dolerite. No fossils observed.	
13	(145102) -27° 25' 38.6" 29° 09' 07.3"	Shallow soils with partly weathered to well-exposed sandstone of the Normandien Formation. Excavation for power line did not expose fossils	
14	(146102) -27° 25' 35.7" 29° 09' 06.6"	Shallow soils on newly exposed bedrock of the Normandien Formation. No fossils were observed during the field inspection	
15	(147102) -27° 25' 32.1" 29° 09' 05.5"	Shallow soils with well-defined outcrops of sandstone of the Normandien Formation. No fossils were observed in the limited outcrops on site during this investigation	
16	(148101) -27° 25' 41.2" 29° 09' 09.1"	Deep Westleigh soils with low water tables on the middle slopes of the study area. No fossils exposed during excavation	

17	(149101) -27° 25' 41.2" 29° 09' 09.1"	No significant fossils exposed during excavation to required depth of construction sites	
18	(150101) -27° 25' 42.3" 29° 09' 16.9"	Deeper soils on Normandien Formation sediments, dolerite and alluvium. No outcrops and no fossils observed	
19	(150101) -27° 25' 42.3" 29° 09' 16.9"	General view of the construction site area at the center of the proposed development site. Deep weathering and deep soils. No outcrop or fossils observed.	

## 8. PALAEOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the field investigation. The field investigation confirms that the study area is underlain by coarse-grained sandstone and khaki-coloured to grey shale beds of the Normandien Formation and Dolerite of the Karoo Supergroup, as well as dark vertic soils of the Alluvium on site.

The excavations for the construction of the power line for this development exposed some sediments of the Normandien Formation. Due to weathering, no fossils were observed during the field investigation. Exposure of bedrock during excavation did not result in the exposure of significant plant or vertebrate fossils.

The desktop surveys and initial site visit (Groenewald, 2016) indicated a high possibility for the exposure of significant fossils in the central part of the development (Figure 8.1), but the field observation confirmed that no significant fossils are present in the soil profiles.



**Figure 8.1 Initial indications of very high potential for fossils in the central part of the development (red dot) did not realise due to deep soils and no presence of expected boulder beds in the soil profiles**

## **9. CONCLUSION**

The development site for the proposed proposed construction of an Eskom 11 kV powerline from the Vrede Munic Substation to Thembalihle Extension 4 township, Phumelela Local Municipality, Thabo Mafutsanyane District Municipality, Free State Province is underlain by Permian aged sedimentary rocks of the Normandienr Formation, Adelaide Subgroup and Dolerite of the Karoo Supergroup as well as deep alluvial sediments.

No fossils were observed during the field investigation. The potential for finding significant fossils in deeply exposed sediments of the Normandien Formation did not realise during the construction . Exposure of bedrock in the western part of the proposed area as well as aland no further mitigation for Palaeontological Heritage was necessary.

It is recommended that:

3. The EAP and ECO must be informed of the fact that a Very High Palaeontological Sensitivity was allocated to the central part of the development but no fossils were recorded during the construction phase.
4. No further mitigation for Palaeontological Heritage is recommended.

## 10. REFERENCES

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## **11. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR**

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

## **12. DECLARATION OF INDEPENDENCE**

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.



**Dr Gideon Groenewald**  
**Geologist**