

**PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE  
PROPOSED TWEELAAGTE PROSPECTING APPLICATION  
ON FARM 175, MOSES KOTANE LOCAL MUNICIPALITY,  
BOJANALA DISTRICT MUNICIPALITY, NORTH WEST  
PROVINCE**

**For:**

**HIA CONSULTANTS**

**Eco Partners**

**DATE: 7 August 2016**

**By**

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## EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Eco partners to undertake a desktop survey, assessing the potential palaeontological impact of the proposed prospecting for minerals referred to as the Tweelaagte Study on Farm 175, Moses Kotane Local Municipality, Bojanala District Municipality, North West Province.

This report forms part of the Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development. The presence of known as well as potential groundwater resources forms part of the Palaeontological Impact Assessment reports as groundwater is regarded as a historic geological feature, contained in Section 3 of the Heritage Resources Act, and is key to the National Heritage Estate of any development site.

The Application for exploration referred to as the Tweelaagte study area on Farm 175, Moses Kotane Local Municipality, Bojanala District Municipality, North West Province is underlain Vaalian aged Quartzite of the Magaliesberg Formation of the Pretoria Group, Transvaal Supergroup, Vaalian aged igneous rocks of the Tweelaagte Bonzite and other associated units as well as the Ruigtehoek Pyroxenite and Quaternary sand.

The high fossiliferous potential of the Magaliesberg Formation of the Pretoria Group, Transvaal Supergroup, warrants an allocation of a High palaeontological sensitivity to the two areas underlain by quartzite. The Moderate Palaeontological sensitivity of the Quaternary sandy cover is retained and the EAP must take this into account in the planning of excavation for prospecting. Any recording of fossil material will be of high significance as these units have been neglected in the past studies of these areas.

The prominent and inferred fault zones that cut the study area are Very Highly significant potential secondary groundwater aquifers and must be recorded and properly investigated during future geohydrological studies. These zones are important seepage lines and can cause serious groundwater pollution along linear zones across the study area.

### Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Magaliesberg Formation of the Pretoria Group contains highly significant fossil remains, albeit that most will only be exposed during infrastructure development. Several types of trace and micro-fossils have been recorded from this Group in the Transvaal Basin of South Africa. The Moderate Palaeontological sensitivity is retained for the Quaternary sediments and excavation during exploration must include a note on the possible presence of significant new fossils in this unit.
2. A Very High Palaeontological sensitivity is allocated to the fault zones in the study area. The EAP must note that, specifically where pollution by waste water is envisaged (following the geotechnical investigation), or where present groundwater abstractions (boreholes) are recorded during the geotechnical investigations, a qualified geohydrologist must be appointed to assess and record the potential pollution of groundwater for the development.
3. These recommendations must form part of the EMP of the project.

## TABLE OF CONTENT

1. INTRODUCTION .....	1
1.1. Background .....	1
1.2. Aims and Methodology .....	1
1.3. Scope and Limitations of the Desktop Study .....	3
2. DESCRIPTION OF THE PROPOSED DEVELOPMENT .....	4
3. GEOLOGY.....	4
3.1. Transvaal Supergroup .....	5
3.1.1. Pretoria Group .....	5
3.2. Bushveld Complex.....	5
3.2.2. Rustenburg Layered Suite .....	5
3.3. Quaternary Sand, Colluvium and Alluvium (Q) .....	5
3.4. Fault Zones and potential Groundwater Aquifers .....	5
4. PALAEOLOGY OF THE AREA .....	5
4.1. Transvaal Supergroup .....	5
4.1.1. Pretoria Group .....	5
4.2. Bushveld Complex (VI, Vcr) .....	5
4.3. Quaternary Sandy Colluvium and Alluvium (Q) .....	6
5. HISTORIC AND POTENTIAL GROUNDWATER RESOURCES .....	6
6. PALAEOLOGICAL SENSITIVITY .....	6
7. CONCLUSION AND RECOMMENDATIONS.....	7
8. REFERENCES.....	7
9. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR .....	8
10. DECLARATION OF INDEPENDENCE .....	8

## LIST OF FIGURES

Figure 2.1 Locality of study area for the Tweelaagte Prospecting Rights Application .....	4
Figure 3.1 Geology of the Tweelaagte Prospecting Right Application area that is underlain by the Vaalian aged Magaliesburg Quartzite (Vm) of the Pretoria Group; Tweelaagte Bronzite (VI) and Ruighoek Pyroxenite (Vcr) of the Rustenburg Layered Suite of the Bushveld Complex and Quaternary aged sandy colluvium (Q) .....	4
Figure 6.1 Palaeontological sensitivity of the Study Area. Colour coding is explained in Table 1.1.....	6

## LIST OF TABLES

Table 1.1 Palaeontological Sensitivity Classes and Colour Codes.....	2
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## 1. INTRODUCTION

### 1.1. Background

Gideon Groenewald was appointed by Eco partners to undertake a desktop survey, assessing the potential palaeontological impact of the proposed prospecting for minerals referred to as the Tweelaagte Study on Farm 175, Moses Kotane Local Municipality, Bojanala District Municipality, North West Province.

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

### 1.2. Aims and Methodology

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 identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess 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.
- to identify present and future groundwater resources and to prevent future degradation of groundwater resources that might result from the proposed development.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature and previous palaeontological impact studies in the same region.

The likely impact of the proposed development on local fossil heritage is 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 extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1.1 below.

The impact assessment of the development on groundwater resources forms part of the Palaeontological Impact Assessment and the presence of known and potential groundwater

resources will, by virtue of the Very High Sensitivity of clean drinking water, always have a Very High Palaeontological Impact Rating for National Heritage.

**Table 1.1 Palaeontological Sensitivity Classes and Colour Codes**

<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. The Very High Sensitivity of all known and potential future Groundwater Resources must form part of the Palaeontological Sensitivity Maps of all developments that might impact on the supply of clean drinking water from groundwater resources.
<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) will be required.
<b>BLUE</b>	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. At least a Desktop Survey by a suitably qualified Palaeontologist is required. Collection of a representative sample of potential fossiliferous material is recommended.

<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 at least a Desktop PIA report is provided and the report should also refer to archaeological reports with possible reference to palaeontological finds in Cenozoic aged surface deposits.</p>
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### 1.3. Scope and Limitations of the Desktop Study

The study will include: (i) an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units; (ii) a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports; (iii) data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged); (iv) where feasible, location and examination of any fossil collections from the study area (e.g. museums) and (v) a review of all existing and potential groundwater resources associated with the study area.

The key assumption for this scoping study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There is also an inadequate database for fossil heritage for much of the RSA, due to the small number of professional palaeontologists carrying out fieldwork in RSA. Most development study areas have never been surveyed by a palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and without supporting field assessments may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc.).

## 2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The study area is located just North of Witrandjie and west of Pilansberg National Park in the North West Province (Figure 2.1)

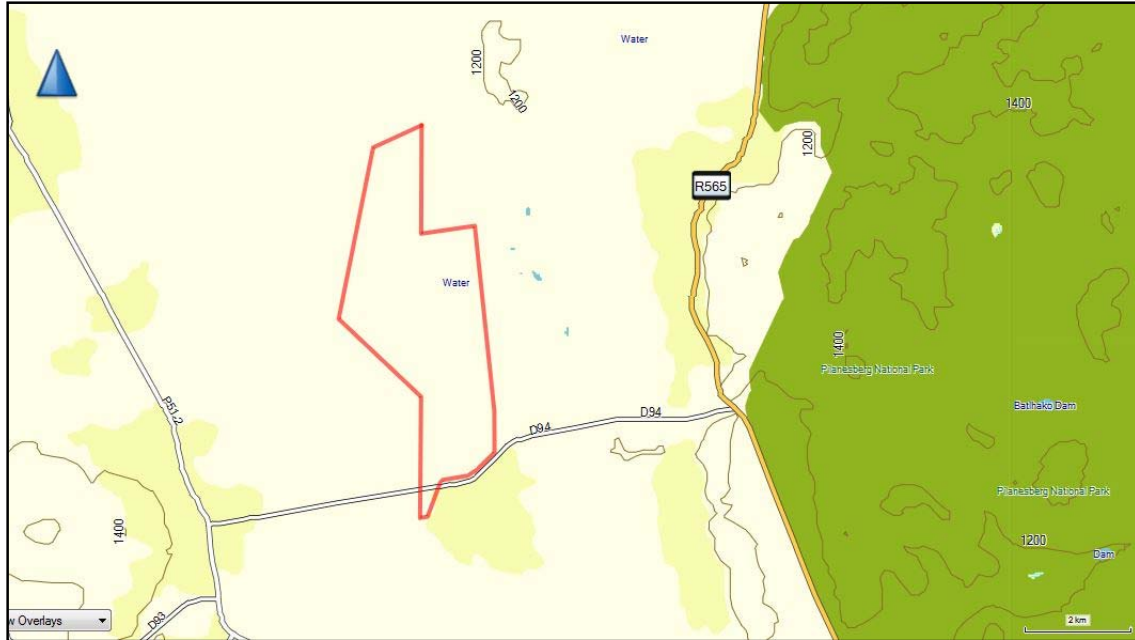


Figure 2.1 Locality of study area for the Tweelaagte Prospecting Rights Application

## 3. GEOLOGY

The study area is underlain by rocks of the Pretoria Group, Bushveld Complex and Quaternary aged sand (Figure 3.1).

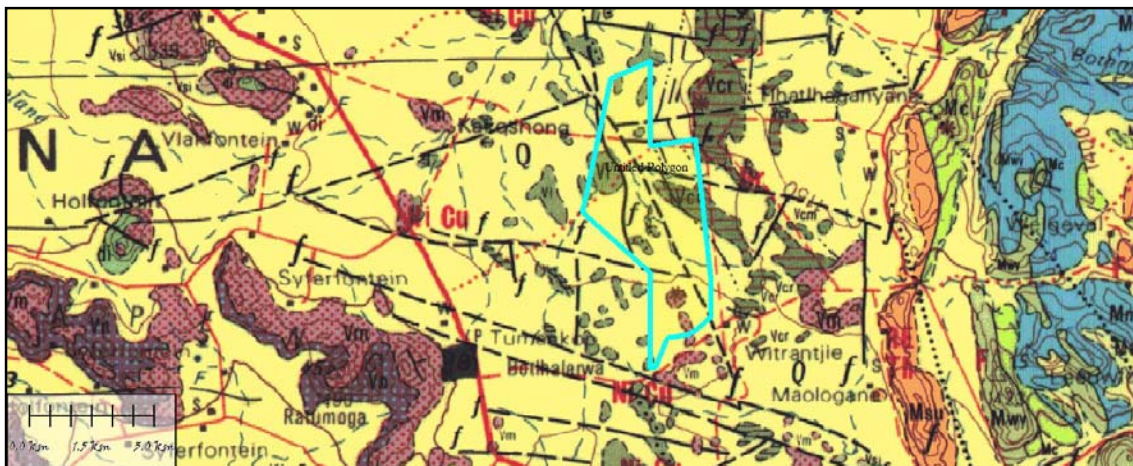


Figure 3.1 Geology of the Tweelaagte Prospecting Right Application area that is underlain by the Vaalian aged Magaliesburg Quartzite (Vm) of the Pretoria Group; Tweelaagte Bronzite (VI) and Ruighoek Pyroxenite (Vcr) of the Rustenburg Layered Suite of the Bushveld Complex and Quaternary aged sandy colluvium (Q)

### **3.1. Transvaal Supergroup**

#### **3.1.1. Pretoria Group**

##### *Magaliesberg Formation (Vm)*

The Vaalian aged Magaliesberg Formation consists largely of a sequence of coarse-grained sandstone and quartzite (Johnson et al, 2009).

### **3.2. Bushveld Complex**

#### **3.2.2. Rustenburg Layered Suite**

##### *Tweelaagte Bronzitite and associated units(VI)*

Vaalian aged igneous rocks comprising pyroxenite, bornzite, hartzburgite and dunite with chromite occurring as islands of outcrop in Quaternary aged cover.

##### *Ruigtehoek Pyroxenite (Vcr)*

Vaalian aged igneous rocks comprising mainly pyroxenite with chromitite.

### **3.3. Quaternary Sand, Colluvium and Alluvium (Q)**

Quaternary aged sand cover large parts of the study area and in valley floors can be of significant depth of up to 2m thick. To date, these sediments have not been studied in any great detail.

### **3.4. Fault Zones and potential Groundwater Aquifers**

No significant historic spring sites have been mapped on the geological map for the study area. Potential Primary aquifers are associated with deep soils and deep weathering of the igneous rocks but no significant primary aquifer has been mapped in this study area. Secondary aquifers are associated with prominent fault zones and these linear structures are very well defined in the study area as indicated on the geological map, designated an **f** as indication to the nature of the line denoting the fault zone.

## **4. PALAEOLOGY OF THE AREA**

### **4.1. Transvaal Supergroup**

#### **4.1.1. Pretoria Group**

##### *Magaliesberg Formation (Vm)*

Microbial mat structures (Desiccated mats sometimes resemble trace fossils) on ripple laminated surfaces. These micro-fossils have not been studied in detail and recording of algal mat structures will contribute significantly to our understanding of the palaeo-environments in this part of the Transvaal Basin.

### **4.2. Bushveld Complex (VI, Vcr)**

Due to the igneous nature of these rocks they will not contain any fossils. In the mapping of these hills the possible presence of tertiary aged fossils in local deposits are highly likely. Recording of any new find will be highly significant.



### 4.3. Quaternary Sandy Colluvium and Alluvium (Q)

Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms and other microfossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood and pollens have been recorded from these, sometimes neglected sedimentary deposits in the study area.

## 5. HISTORIC AND POTENTIAL GROUNDWATER RESOURCES

No historic spring site is mapped the study area, although the area is underlain by relatively coarse-grained sand that can, in the valley floor regions, lead to extensive and very important primary aquifer units (Vegter, 1995; 2001; Jonck and Meyer, undated). Very well defined linear structures, ie fault zones, have been recorded and mapped out on the geological map. These fracture zones are very important potential groundwater aquifers and any planning for development of infrastructure must include these zones and their potential groundwater supply, as part of the Geohydrological Investigation for future excavation onto the subsurface igneous rocks. Contamination of groundwater will occur along these linear structures.

## 6. PALAEOLOGICAL SENSITIVITY

The likely impact of the proposed development on local fossil heritage is 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 extent of fresh bedrock excavation envisaged (Figure 6.1). The different sensitivity classes used are explained in Table 1.1 above.



Figure 6.1 Palaeontological sensitivity of the Study Area. Colour coding is explained in Table 1.1

The larger part of the study area is underlain by Quaternary aged sandy colluvium and alluvium that might form local primary aquifers in deeply weathered igneous rock, but no such springs have been

mapped out in this study area. The very prominent fault zones are however very significant linear secondary aquifers and groundwater contamination along these zones are highly likely. The fault zones might also indicate important present groundwater sources and where such boreholes are present the future possible mining of this area must plan for proper hydrogeological impact assessments for the planning of infrastructure.

## 7. CONCLUSION AND RECOMMENDATIONS

The application for exploration referred to as the Tweelaagte study area on Farm 175, Moses Kotane Local Municipality, Bojanala District Municipality, North West Province is underlain by the Vaalian aged Magaliesberg Quartzite, Vaalian aged igneous rocks of the Tweelaagte Bonzitite and other associated units as well as the Ruigtehoek Pyroxenite and then largely by Quartzite of the Magaliesberg Formation of the Pretoria Group, Transvaal Supergroup.

The high fossiliferous potential of the Magaliesberg Formation of the Pretoria Group, Transvaal Supergroup, warrants an allocation of a High palaeontological sensitivity to the two areas underlain by quartzite. The Moderate Palaeontological sensitivity of the Quaternary sandy cover is retained and the EAP must take this into account in the planning of excavation for prospecting. Any recording of fossil material will be of high significance as these units have been neglected in the past studies of these areas.

The prominent and inferred fault zones that cut the study area are Very Highly significant potential secondary groundwater aquifers and must be recorded and properly investigated during future geohydrological studies. These zones are important seepage lines and can cause serious groundwater pollution along linear zones across the study area.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Magaliesberg Formation of the Pretoria Group sediments contains highly significant fossil remains, albeit mostly will only be exposed during infrastructure development. Several types of trace and micro-fossils have been recorded from this Group in the Transvaal Basin of South Africa. The Moderate Palaeontological sensitivity is retained for the Quaternary sediments and excavation during exploration must include a note on the possible presence of significant new fossils in this unit.
2. A Very High Palaeontological sensitivity is allocated to the fault zones in the study area. The EAP must note that, specifically where pollution by waste water is envisaged (following the geotechnical investigation), or where present groundwater abstractions (boreholes) are recorded during the geotechnical investigations, a qualified geohydrologist must be appointed to assess and record the potential pollution of groundwater for the development.
3. These recommendations must form part of the EMP of the project.

## 8. REFERENCES

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## 9. 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 palaeo-ecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including 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 35 years). Dr Groenewald has 35 years of experience as a hydrogeologist and is an accredited member of the Borehole Water Association of South Africa.

## 10. 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 and groundwater assessment services. There are no circumstances that compromise the objectivity of my performing such work.



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