PALAEONTOLOGICAL IMPACT SCREENING REPORT

PROPOSED MARQUARD SOLID WASTE FACILITY

Marquard, Free State Province of South Africa
Marquard Townlands in the Setsoto Local Municipality within the Thabo Mofutsanyane District Municipality

Developer: Setsoto local Municipality

Consultant:

LHL Consulting Engineers

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EXECUTIVE SUMMARY

The development of a Solid Waste Disposal Facility near Marquard in the Eastern Free State is an initiative of Setsoto Local Municipality. The purpose of this Palaeontological Impact Screening 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.

The Setsoto Local Municipality plans to develop a solid waste disposal facility on the Marquard townlands west of Moemaneng in the Eastern Free State Province. The development's footprint is approximately 3ha.

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000, 2826 Winburg) map in conjunction with Google Earth. A review of the literature on the geological formations underlying the development site and the fossils that have been associated with these geological strata was undertaken.

The Marquard Waste Disposal Site development is underlain by the Middle Permian to Middle Triassic Tarkastad Subgroup that consists of the upper Burgersdorp Formation, predominantly red mudstone and interbedded yellow-grey to light greenish-grey sandstone, and the lower Katberg Formation, extensive beds of yellowish-grey to light greenish-grey sandstones and bluish-grey and reddish-grey mudstones. Soils are derived from the underlying rock and are generally deep and high in fertility.

The Tarkastad Subgroup has a high palaeontological sensitivity rating. The probability to enter the Tarkastad Subgroup is however unsure as no outcrops of bedrock are visible and deep soils are expected.

In the event that bedrock is reached during excavations, it is recommended that the resident ECO be trained by a professional palaeontologist in the recognition of fossil material. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof.

That all earth-moving activities within the bedrock with a potential impact on Elliot Formation be monitored by a palaeontologist. That a monitoring report be submitted to SAHRA after the completion of the earth works phase.

SIGNIFICANCE RATING							
Rock Unit	Temporal Scale	Spatial Scale	Degree of Confidence	Impact Severity		Overall Significance	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Tarkastad Subgroup	permanent	international	Unsure (no outcrops of bedrock)	beneficial	very severe	beneficial	High negative

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1. INTRODUCTION

The development of a Solid Waste Disposal Facility near Marquard in the Eastern Free State is an initiative of the Setsoto Local Municipality. 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 Scoping and Environmental Impact Assessment for the Marquard Solid Waste Disposal Site 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 Senekal Solid Waste Disposal site.

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 METHODS

After discussions with LHL Engineers a request for a Palaeontological Impact Screening was received. Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the Palaeontological Impact Screening were:

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

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000, 2826 Winburg) maps in conjunction with Google Earth. The only limitation on this methodology is the scale of mapping, which restricts comparison of the geology to the 1:250 000 scale. This restriction only applies in areas where major changes in the geological character of the area occur over very short distances or on the geological transformation zones.

A review of the literature on the geological formations underlying the development site and the fossils that have been associated with these geological strata was undertaken.

3. PROPOSED DEVELOPMENT DESCRIPTION

The Setsoto Local Municipality plans to develop a solid waste disposal facility on vacant municipal townlands to the west of Moemaneng in the Eastern Free State Province (See Locality Map Figure 2-1). The disposal site's footprint area is approximately 3ha. The development will consist of 2 new waste cells which will be 30m wide, 140m long and 2m deep. Additional infrastructure includes a 5m wide access road, 2m high fence surrounding the proposed site.

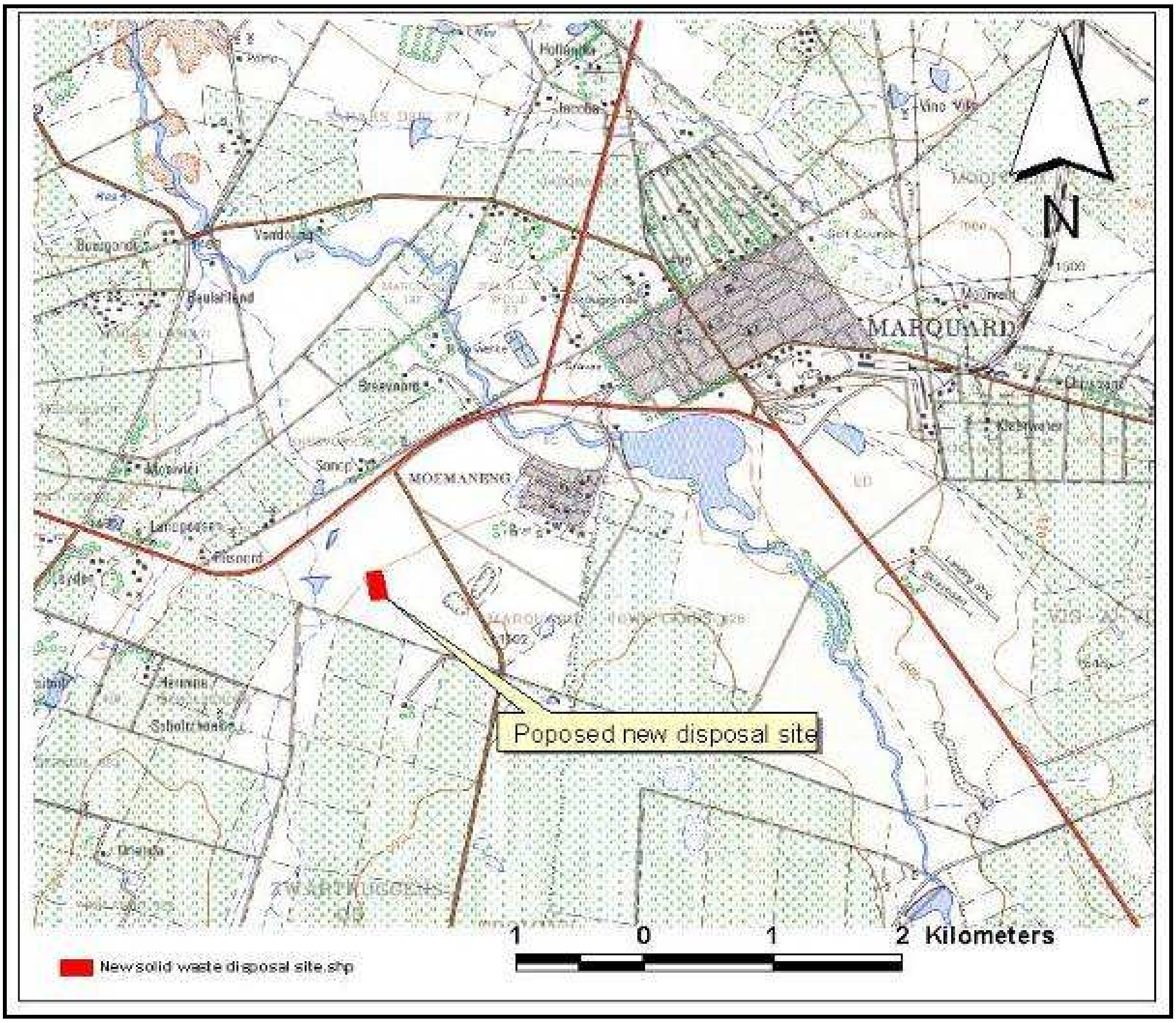

Figure 3-1 Locality map of proposed development

4. GEOLOGY OF THE AREA

The entire development and surrounding area is underlain by the Tarkastad (Trt) Subgroup of the Beaufort Group of the Karoo Supergroup. A dolerite (Jd) sill is located to the south-east of the proposed development. Quaternary (Yellow) sediments occur in the valley floors as illustrated in Figure 4.1.

4.1. The Tarkastad Subgroup

The Tarkastad Subgroup is made up of the lower arenaceous Katberg Formation and the upper argillaceous Burgersdorp Formation. Based on the characteristic presence of upward-fining cycles, lenticular sandstones, massive mudstones and non-marine vertebrate remains, the depositional history of the Tarkastad Subgroup is also interpreted as a fluviatile environment.

4.1.1. The Katberg Formation

The Katberg Formation consists of relatively extensive beds of yellowish-grey to light greenish-grey sandstones and bluish-grey and reddish-grey mudstones (Groenewald, 1996).

4.1.2. The Burgersdorp Formation

The Burgersdorp Formation consists of a secession of predominantly red mudstone and interbedded yellow-grey to light greenish-grey sandstone. The depositional environment is interpreted to be predominantly fluvial with extensive lacustrine deposits associated with this sequence (Groenewald, 1996; Johnson et al 2006).

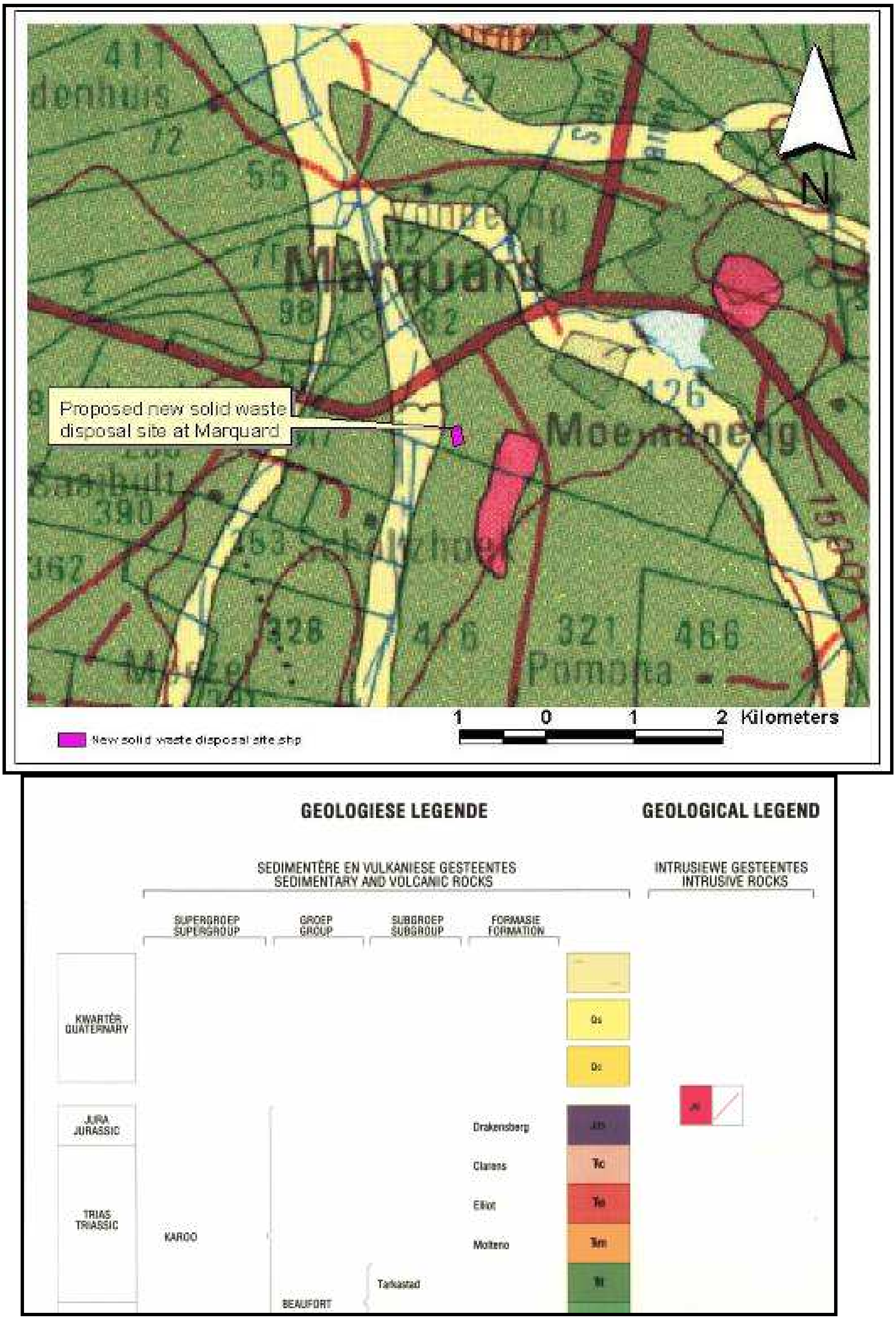

Figure 4-1 The Geology (Geo Map 2826-Winburg) of the Marquard Waste Site Development

5. PALAEONTOLOGY OF THE AREA

5.1. The Tarkastad Subgroup

5.1.1. The Katberg Formation

The Triassic Katberg Formation overlies the Adelaide Subgroup and contains important international biostratigraphic information. The Katberg Formation represent a time period that includes the Middle Permian to Middle Triassic and contain fossil remains of animals that transcends from reptiles to mammals. The Katberg Formation correlates with the middle and upper part of the *Lystrosaurus* Assemblage Zone, containing fossils of both vertebrates and invertebrates of the Triassic era.

The Katberg Formation also contains some unique well-preserved vertebrate burrows (Groenewald, 1991) that are associated with the *Lystrosaurus* and *Procolophon* fauna that dominates this stratigraphic unit.

5.1.2. The Burgersdorp Formation

The Burgersdorp Formation is associated with the *Cynognathus* Assemblage Zone which is known as a productive fossil bearing zone in the Karoo Supergroup (Rubidge et al 1995: Groenewald 1996; Johnson et al, 2006).

6. PALAEONTOLOGICAL SIGNIFICANCE AND RATING

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews.

The palaeontological significance and rating is summarised in Table 6.1 and 6.2. For the methodology and definitions of impact rating and significance see Appendix A (CES 2011).

Table 6-1 Palaeontological Significance of Geological Units on Site

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Tarkasted Subgroup	Fluvial and lacustrine mudstones and sandstones of the Katberg and Burgersdorp Formations Middle Permian to Middle Triassic	*Vertebrate fossils*	*Lystrosaurus* Assemblage Zone *Cynognathus* Assemblage zone	High sensitivity

Table 6-2 Significance Rating Table as Per CES Template

Rock Unit	Temporal Scale (duration of impact)	Spatial Scale (area in which impact will have an effect)	Degree of confidence (confidence with which one has predicted the significance of an impact)	Impact severity (severity of negative impacts, or how beneficial positive impacts would be)		Overall Significance (The combination of all the other criteria as an overall significance)	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Tarkastad Subgroup	permanent	international	Unsure (no outcrops of bedrock)	beneficial	very severe	beneficial	High negative

There is a possibility that vertebrate fossils could be encountered during excavation of bedrock within the development footprint and these fossils would be of international significance. If effective mitigation measures are in place at the time of exposure, and the fossils are successfully excavated for study, this would represent a beneficial palaeontological impact.

Unfortunately the footprint of the development is located close to a watercourse which may have deep soils in the alluvial flood plain and no outcrops of bedrock are exposed thus, there is no way of assessing the likelihood of encountering vertebrate fossils during excavation.

Therefore, vertebrate fossils within the development site could be characterised as rare but highly significant. The damage and/or loss of these fossils due to inadequate mitigation would be a highly negative palaeontological impact. However, the exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) to a qualified palaeontologist for excavation will be a beneficial palaeontological impact.

7. PALAEONTOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews.

The Tarkastad Subgroup consists mostly of relatively extensive beds of yellowish-grey to light greenish-grey sandstones and bluish-grey and reddish-grey mudstones (Katberg Formation) and a secession of predominantly red mudstone and interbedded yellow-grey to light greenish-grey sandstone (Burgersdorp Formation) that do have potential to yield fossils. The excavation of the different cells will have the potential to uncover the mudstones of the Tarkastad Subgroup. If underlying bedrock is uncovered then monitoring and mitigation in terms of the palaeontological heritage are required.

The following colour coding method was developed to classify a development area's palaeontological impact as illustrated in Figure 8.1:

- Red colouration indicates a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops on the site/route and the chances of finding fossils during the construction phase are very high.
- Orange colouration indicates a possibility of finding fossils of a specific assemblage zone either in outcrops or in bedrock on the site/route.
- Green colouration indicates that there is no possibility of finding fossils in that section of the site/route development.

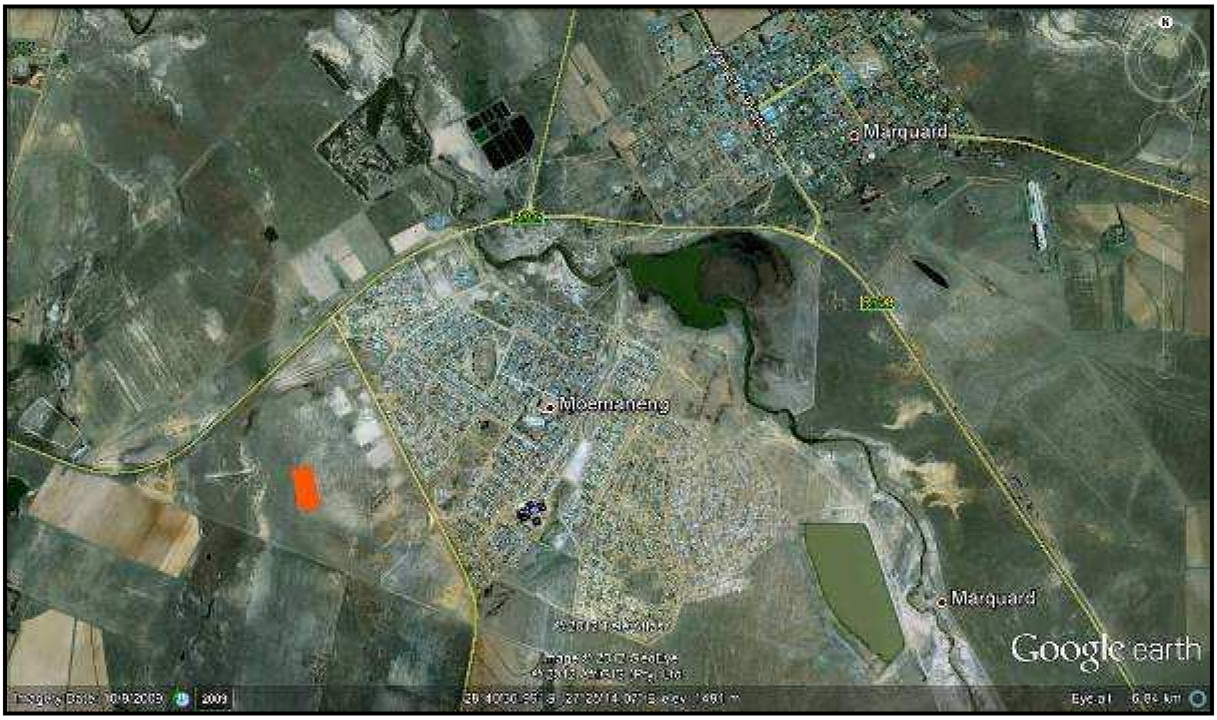

Figure 7-1 **Palaeontological Impact of the Proposed Marquard Waste Disposal Facility**

The proposed development involves the excavation of waste disposal cells and infrastructure such as roads and buildings. The construction phase will require excavation of soils, possibly bedrock, and has the potential to impact directly on fossil heritage if the mudstone of the Tarkastad Subgroup is exposed. From Figure 7.1 the following mitigation measures are recommended:

Table 7-1 **Site Specific Mitigation Measures**

Colour Coding (Figures. 8.1 & 8.2)	**Mitigation Recommended**
Orange Sites	The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation. All earth-moving activities within bedrock are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.

8. CONCLUSION

The development site for the Marquard Solid Waste Disposal Facility is underlain by the Middle Permian to Middle Triassic Tarkastad Subgroup of the Beaufort Group of the Karoo Supergroup. There is a moderate potential for fossil material in the underlying mudstones. Deep soils are expected to cover the development site and there is a limited possibility that the bedrock will be reached during excavations.

In the event that bedrock is uncovered during excavations it is recommended that:

- The resident ECO must also be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation.

- All earth-moving activities within the underlying bedrock with potential impact are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activities.

9. REFERENCES

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10. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the Nelson Mandela Metropolitan University (1996) and the National Diploma in Nature Conservation from the University of South Africa (1990). 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 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 25 years).

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

11. APPENDIX A - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

Although specialists will be given relatively free rein on how they conduct their research and obtain information, they will be required to provide their reports to the EAP in a specific layout and structure, so that a uniform specialist report volume can be produced.

To ensure a direct comparison between various specialist studies, a standard rating scale has been defined and will be used to assess and quantify the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed. Four factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.

3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word ‘mitigation’ means not just ‘compensation’, but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurs - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Negative impacts that are ranked as being of “**VERY HIGH**” and “**HIGH**” significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of “**MODERATE**” significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as “**LOW**” significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

Table 9-1: Criterion used to rate the significance of an impact

Significance Rating Table	
Temporal Scale (The duration of the impact)	
Short term	Less than 5 years (Many construction phase impacts are of a short duration)
Medium term	Between 5 and 20 years
Long term	Between 20 and 40 years (From a human perspective almost permanent).
Permanent	Over 40 years or resulting in a permanent and lasting change that will always be there
Spatial Scale (The area in which any impact will have an affect)	
Individual	Impacts affect an individual.
Localised	Impacts affect a small area, often only a portion of the project area.
Project Level	Impacts affect the entire project area.
Surrounding Areas	Impacts that affect the area surrounding the development
Municipal	Impacts affect either the Local Municipality, or any towns within them.
Regional	Impacts affect the wider district municipality or the province as a whole.
National	Impacts affect the entire country.
International/Global	Impacts affect other countries or have a global influence.
Will definitely occur	Impacts will definitely occur.
Degree of Confidence or Certainty (The confidence to predicted the significance of an impact)	
Definite	More than 90% sure of a particular fact. Should have substantial supportive data.
Probable	Over 70% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or of the likelihood of an impact occurring.

Table 9-2: The severity rating scale

Impact severity (The severity of negative impacts, or how beneficial positive impacts would be on a particular affected system or party)	
Very severe	**Very beneficial**
An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example the permanent loss of land.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit. For example the vast improvement of sewage effluent quality.
Severe	**Beneficial**
Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these. For example, the clearing of forest vegetation.	A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example an increase in the local economy.
Moderately severe	**Moderately beneficial**
Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated. For example constructing the sewage treatment facility where there was vegetation with a low conservation value.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way. For example a 'slight' improvement in sewage effluent quality.
Slight	**Slightly beneficial**
Medium or short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example a temporary fluctuation in the water table due to water abstraction.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect	**Don't know/Can't know**
The system(s) or party(ies) is not affected by the proposed development.	In certain cases it may not be possible to determine the severity of an impact

Table 3: Overall significance appraisal

Overall Significance (The combination of all the above criteria as an overall significance)	
VERY HIGH NEGATIVE	**VERY BENEFICIAL**
These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in **severe** or **very severe** effects, or **beneficial** or **very beneficial** effects. **Example:** The loss of a species would be viewed by informed society as being of VERY HIGH significance. **Example:** The establishment of a large amount of infrastructure in a rural area, which previously had very few services, would be regarded by the affected parties as resulting in benefits with VERY HIGH significance.	
HIGH NEGATIVE	**BENEFICIAL**
These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as HIGH will need to be considered by society as constituting an important and usually long term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light. **Example:** The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated. **Example:** The change to soil conditions will impact the natural system, and the impact on affected parties (such as people growing crops in the soil) would be HIGH.	
MODERATE NEGATIVE	**SOME BENEFITS**
These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial. **Example:** The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.	
LOW NEGATIVE	**FEW BENEFITS**
These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect. **Example:** The temporary change in the water table of a wetland habitat, as these systems is adapted to fluctuating water levels. **Example:** The increased earning potential of people employed as a result of a development would only result in benefits of LOW significance to people who live some distance away.	
NO SIGNIFICANCE	
There are no primary or secondary effects at all that are important to scientists or the public. **Example:** A change to the geology of a particular formation may be regarded as severe from a geological perspective, but is of NO significance in the overall context.	
DON'T KNOW	
In certain cases it may not be possible to determine the significance of an impact. For example, the significance of the primary or secondary impacts on the social or natural environment given the available information. **Example:** The effect of a particular development on people's psychological perspective of the environment.	