PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED ROAD UPGRADE DEVELOPMENT MATATIELE TO STRYDFONTEIN, MATATIELE LOCAL MUNICIPALITY, ALFRED NZO DISTRICT MUNICIPALTY, EASTERN CAPE PROVINCE

For:

CES Environmental CONSULTANTS

DATE: 15 September 2022

By

Gideon Groenewald
078 713 6377

EXECUTIVE SUMMARY

Gideon Groenewald was appointed by CES Environmental and Social Advisory Services to revise the existing Desktop Survey, assessing the potential Palaeontological Impact of the proposed Road Upgrade Development Matatiele to Strydfontein, Matatiele Local Municipality, Alfred Nzo District Municipality, Eastern Cape Province.

This report forms part of the Basic 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 potential Palaeontological Impact of the proposed Road Upgrade Development Matatiele To Strydfontein, Matatiele Local Municipality, Alfred Nzo District Municipalty, Eastern Cape Province is Moderate to Very High, with small section allocated a Very Low Palaeontological sensitivity, based on the fact that most of the route is underlain by Triassic aged rocks of the Tarkastad Subgroup and Jurassic aged dolerite of the Karoo Supergroup as well as Tertiary aged sediments associated with terrestrial deposits associated with wetlands in the study area.

The very high fossiliferous potential of the Tarkastad Subgroup, Beaufort Group of the Karoo Supergroup warrants an allocation of a Very High palaeontological sensitivity to the areas underlain by the rocks of this Subgroup. A Moderate Palaeontological sensitivity is allocated to Tertiary aged sediments in this region. Dolerite areas are allocated Very Low Palaeontological sensitivity. If extensive excavation of topsoil and removal of more than 1.5m of soil cover is planned in this region, all the areas of activity will be allocated a Very High Palaeontological Sensitivity as these rocks can contain very significant remains of plants and animals that will contribute significantly to our understanding of the palaeo-environments in this part of the Karoo Basin.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Beaufort Group sediments contains very highly significant fossil remains, albeit mostly exposed during infrastructure development. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the Tarkastad Subgroup. Similar fossil richness might be observed in Tertiary aged sediments at Matatiele.
2. In areas that are allocated a Very High and Moderate Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA) preferably during initial excavations for the development.
3. These recommendations must form part of the EMP of the project.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

2. INTRODUCTION

2.1. Background

Gideon Groenewald is appointed by CES Environmental and Social Advisory Services to undertake a Desktop Survey, assessing the potential Palaeontological Impact of the proposed Road Upgrade Development Matatiele To Strydfontein, Matatiele Local Municipality, Alfred Nzo District Municipalty, Eastern Cape Province.

This report forms part of the Basic 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.

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;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

2.2. 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.

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.

Table 2.1 Palaeontological Sensitivity Classes and Colour Codes

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
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 etal.,2014).	
RED	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.
ORANGE	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.
GREEN	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.
BLUE	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.

GREY	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 implacement 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.

2.3. 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) and iv) where feasible, location and examination of any fossil collections from the study area (e.g. museums).

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.).

3. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The study area is located along the road between Matatiele and the farm Strydfontein (Figure 3.1).

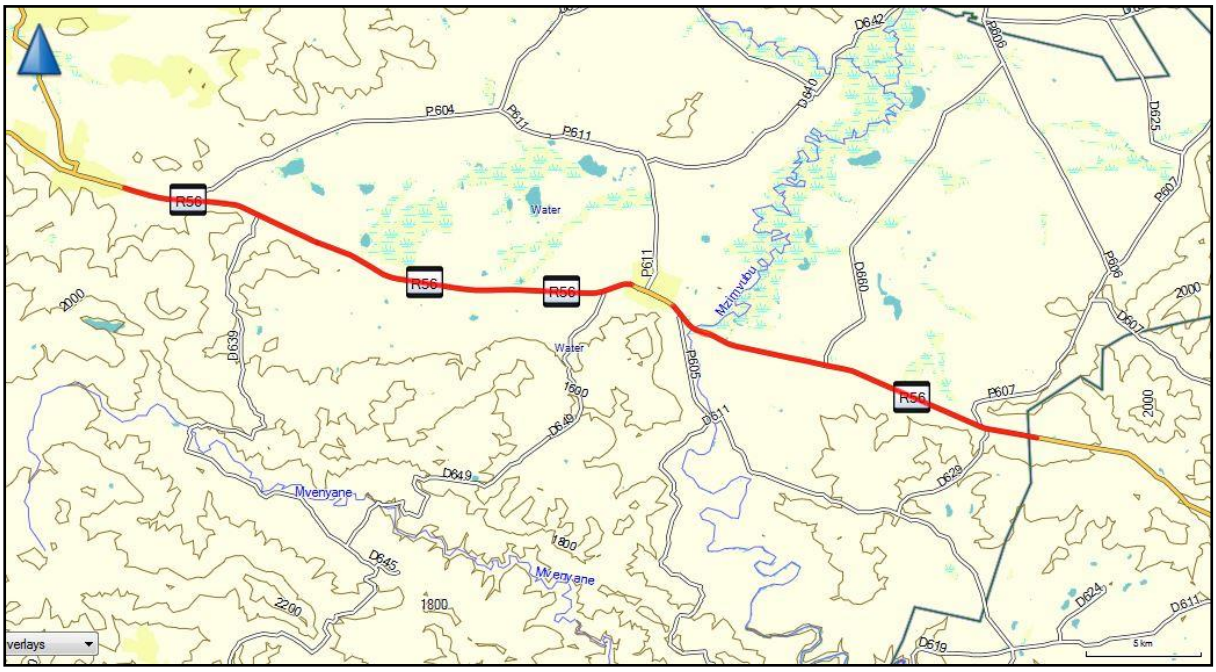

Figure 3.1 Locality of study area

4. GEOLOGY

The study area is underlain by Triassic aged sandstone and red mudstone of the Tarkastad Subgroup (Trt) of the Beaufort Group, Jurassic aged Dolerite of the Karoo Supergroup and Tertiary aged Alluvium (Figure 4.1).

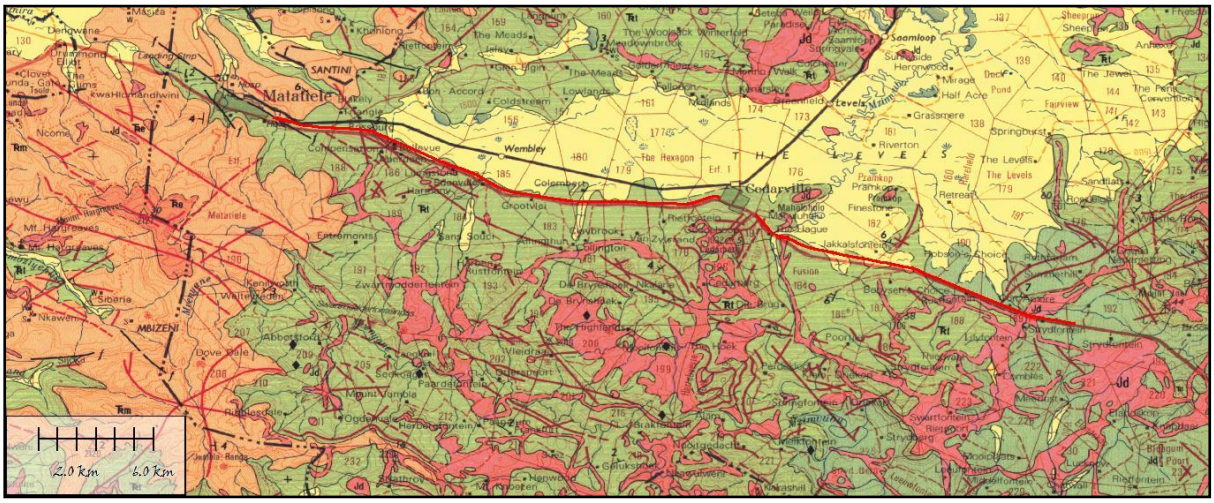

Figure 4.1 Geology of the M56. Mainly underlain by rocks of the Tarkastad Subgroup and Alluvium

4.1. Karoo Supergroup

4.1.1. Beaufort Group, Tarkastad Subgroup (Trt)

The Tarkastad Subgroup consists largely of a lower, fine-grained sandstone known as the Katberg Formation and upper red coloured mudstone of the Burgersdorp Formation (Groenewald, 1996; Johnson et al, 2009).

4.1.2. Dolerite (Jd)

Dolerite is a mafic intrusive igneous rock and occurs as dykes or sills in the study area. The Jurassic aged dolerite in the study area is associated with the "koppies" or high-lying areas in the region as well as with rocky outcrops along river courses.

4.2. Tertiary to Recent Alluvium

The study area is known for the presence of Tertiary aged sediments that represent fluvial deposits along the present river courses and these sediments are terrestrial sediments, including diatomite (diatom deposits), spring deposits, pedocretes, calcareous tufa and other calcrete deposits, peats, soils and gravel that are very important in terms of our understanding of the Early and Late Pliocene period in this region in Southern Africa.

5. PALAEONTOLOGY OF THE AREA

5.1. Karoo Supergroup

5.1.1. Beaufort Group, Tarkastad Subgroup (Trt)

Katberg Formation

The Beaufort Group is very well known as a treasure house of Palaeontological Heritage in Southern Africa (Smith, 1990; Rubidge (ed) 1995; Groenewald, 1996; Hancox et al, 1997; MacRae, 1999; McCarthy and Rubidge, 2005; Rubidge, 2005; Botha et al, 2006; Van der Walt *et al*, 2010; Smith *et al* 2012, Gastaldo *et al*, 2015). The Tarkastad Subgroup is relatively thin in the study area (Groenewald, 1996) and the Lower Katberg Formation is still very under-studied in the Project Area although previous studies indicate that it is normally underlain by a very fossil rich red musdstone unit, known as the Palingkloof Member that is very well known as the *Lysrosaurus* Assemblage Zone (Rubidge et al 1995). The Katberg Formation is normally sandtone-rich or arenaceous, but in the study area several thin, highly fossiliferous red mudstones are known to occur in the hillside next to the R56 (Groenewald, 1996).

Towards the far west and south new information (Van der Walt *et al*, 2010, Day *et al,* 2013; Viglietti *et al*, 2015, Rutherford *et al*, 2015, Groenewald DP (2021) confirms very significant vertebrate and plant fossil remains. Plant fossils are mostly associated with *Glossopteris* Assemblages and are well-known from the Lower Beaufort Group (Groenewald, 1996, 2012, Bamford, 1999). Trace fossils, including very significant casts of vertebrate burrows have been described from the Adelaide Subgroup that underlies the Katberg Formation and outcrops at the end of the proposed upgrade of the R56 (Groenewald, 1996, Modesto et al, 2010; Groenewald, 2021; Bordy et al, 2020; Botha et al, 2020; Smith et al, 2020).

Burgersdorp Formation

The Burgersdorp Formation overlies the Katberg Formation and it is unlikely that this mudstone will be exposed during the upgrading of the road. It is however very highly likely that mudstone from this formation will form a very important part of the road material quarried for this upgrading from quarries associated with dolerite along the route R56 (Personal observation of the Author, 2013). This formation is very well-known for the presence of fossils of the *Cynognathus* Assemblage Zone and the

recording of fossils from this part of the Karoo Basin will be highly significant. Plant fossils include mainly horsetail ferns whilst important trace fossils also include burrows of vertebrates such as Trirachodon (Groenewald, et al, 2001).

"The richness of fossil tetrapods from the Beaufort Group of South Africa has enabled biostratigraphic subdivision of this Permo-Triassic succession, with global applicability. Despite being the thickest of the seven biozones recognised, attempts at further subdivision of the Middle Permian Tapinocephalus Assemblage Zone (Abrahamskraal Formation) have not been successful, largely because the exact stratigraphic ranges of fossil taxa are unknown. This gap in knowledge has limited stratigraphic correlation of the Abrahamskraal Formation and hindered understanding of Middle Permian Karoo basin development. Currently, the lowermost Beaufort Group is split between an eastern and a western stratigraphic scheme and, because of poor outcrop and the relative paucity of fossils in the east, stratigraphic correlation between the two areas has been uncertain. Recent fossil discoveries of the parareptile *Eunotosaurus africanus* in the Eastern Cape and Free State provinces have extended its known geographic range in the east. An additional specimen from the lower Middleton Formation in the Eastern Cape has, for the first time, enabled the biostratigraphic correlation of this unit with the Poortjie Member of the Teekloof Formation in the west. These finds confirm the diachroneity of the boundary between the marine Ecca Group and the terrestrial Beaufort Group." (Day *et al*, 2013) which can be very difficult to follow in the study area due to intrusion of dolerite sills. The use of Palaeontology to confirm relative dating of sedimentary rocks in this part of the basin is therefore highly significant.

The Tarkastad Subgroup is relatively thin (100m) in the study area and fossil assemblages include but is not restricted to petrified wood, tetrapod faunas of the *Lystrosaurus* Assemblage Zone (dicynodonts, cynodonts, therocephalians, procolophonids, archosaurs etc.), including rich lacustrine biotas of amphibians, fish; trace fossils including vertebrate burrows, coprolites. The lower part of the Subgroup is known to overlie examples of diverse terrestrial and freshwater tetrapods of *Dicynodon* (now *Daptocephalus*) Assemblage Zones (amphibians, true reptiles, synapsids – especially therapsids), palaeoniscoid fish, freshwater bivalves, trace fossils (including tetrapod trackways), sparse to rich assemblages of vascular plants (Glossopteris Flora, including spectacular petrified logs) and insects. The sequence contains some of the richest Permo-Triassic tetrapod fauna from Pangaea/Gondwana, including trace fossils and casts of vertebrate burrows as well as plant fossils of the *Glossopteris* Assemblage (MacRae, 1999).

5.2. Dolerite

Due to the igneous nature of dolerite, no fossils will be found in the rock units.

5.3. Tertiary to Recent Alluvium

Although no fossils have to date been recorded from the extensive alluvial and Tertiary to Recent aged valley fill in the study area exposure of these sediments can produce significant fossil remains. Examples include bones and teeth of mammals (e.g. proboscideans, rhinos, bovids, horses, micromammals, early Homo (Florisbad Man (Homo heidelbergensis)); Cornelian and Florisian Mammal Age faunas), reptiles, fish, freshwater molluscs, petrified wood, trace fossils (e.g. termitaria), rhizoliths, diatom floras. Fauna is generally sparse but locally very rich. Scattered records with many areas being poorly studied (e.g. from ancient drainage systems). Key examples include sites at Cornelia, Uitzoek, Erfkroon, Florisbad, Vlakkraal and several sites where Orange River Gravels are preserved, including a site close to the study area known as the Virginia Railway Cutting site, now referred to as the Matjhabeng Site (De Ruiter *et al*, 2010). Careful observation can reveal similarly important fossils in the Matatiele region.

6. PALAEONTOLOGICAL 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 5.1). The different sensitivity classes used are explained in Table 1 above.

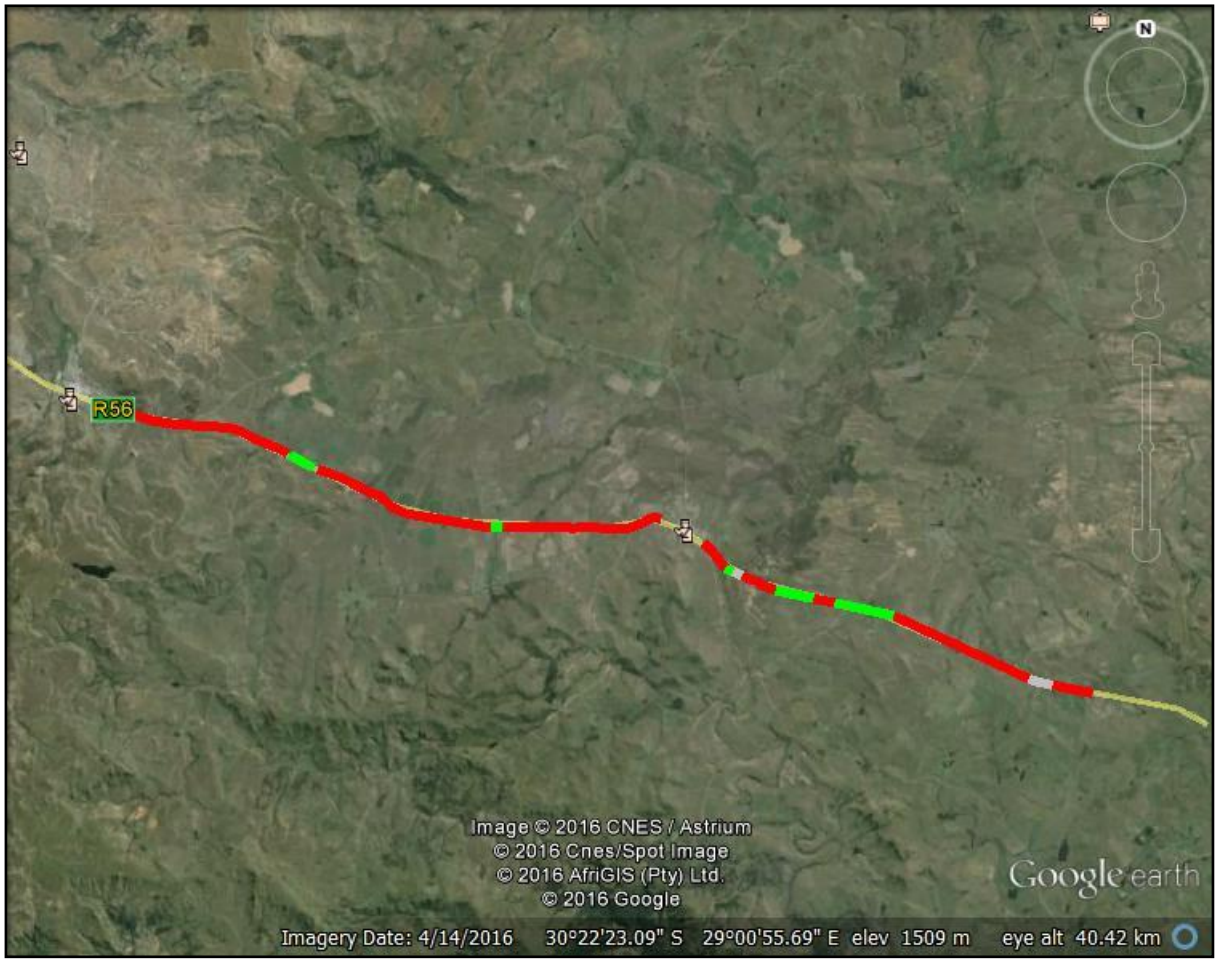

Figure 6.1 Palaeosensitivity of the road upgrading of the R56

The Triassic aged Tarkastad Subgroup of the Beaufort Group, Karoo Supergroup underlies most of the study site and although large areas are covered in sandy or clayey soils, most of the excavations will be into sandstone or mudstone of the underlying Tertiary aged sediments that might contain significant fossils. Areas underlain by Tarkastad Subgroup and those underlain by Tertiary aged sediments are Very Highly sensitive and Moderately sensitive for Palaeontological Heritage and these areas must be monitored and subjected to Phase 1 PIA assessments preferably simultaneous to the timing of initial excavations for construction of the upgrading of the road.

Areas overlain by dolerite and dolerite scree, is allocated a Very Low Palaeontological sensitivity. Due to the igneous nature of dolerite, no fossils will be found.

7. CONCLUSION AND RECOMMENDATIONS

The potential Palaeontological Impact of the proposed Road Upgrade Development Matatiele To Strydfontein, Matatiele Local Municipality, Alfred Nzo District Municipalty, Eastern Cape Province is

Moderate to Very High, with small section allocated a Very Low Palaeontological sensitivity, based on the fact that most of the route is underlain by Triassic aged rocks of the Tarkastad Subgroup and Jurassic aged dolerite of the Karoo Supergroup as well as Tertiary aged sediments associated with terrestrial deposits associated with wetlands in the study area.

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Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Beaufort Group sediments contains very highly significant fossil remains, albeit mostly exposed during infrastructure development. Several types of fossils have been recorded from this Group in the Karoo Basin of South Africa, with special mention of the Tarkastad Subgroup. Similar fossil richness might be observed in Tertiary aged sediments at Matatiele.
2. In areas that are allocated a Very High and Moderate Palaeontological sensitivity and specifically where deep excavation into bedrock is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments (Phase 1 PIA) preferably during initial excavations for the development.
3. These recommendations must form part of the EMP of the project.

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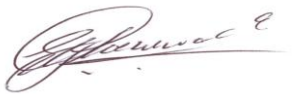
9. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

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 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).

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



Dr Gideon Groenewald
Geologist