# DESKTOP PALAEONTOLOGICAL ASSESSMENT FOR THE PROPOSED AGRICULTURAL DEVELOPMENT ON THE FARM YORK, UMSHWATHI LOCAL MUNICIPALITY, UMGUNGUNDLOVU DISTRICT MUNICIPALITY, KWAZULU-NATAL PROVINCE.

**FOR**

**JEC Environmental Services**

**DATE: 14 September 2015**

**By**

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## EXECUTIVE SUMMARY

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential palaeontological impact of the proposed Agricultural Development on the farm York, uMshwathi Local Municipality, uMgungundlovu District Municipality, KwaZulu-Natal Province.

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999 as well as the KwaZulu-Natal Heritage Act No 4 of 2008. In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

The study area is underlain by sedimentary rocks of the Carboniferous to Permian-aged Dwyka Group and Permian-aged Pietermaritzburg Formation and Jurassic aged Dolerite of the Karoo Supergroup. Invertebrate, plant and trace fossils are known from the Dwyka Group and trace fossils have been reported from the Pietermaritzburg Formation. As a result, the study area has been allocated a Moderate sensitivity, except for the Dolerite regions where no fossils will be present in the rock sequence.

**Recommendations:**

1. The EAP and ECO of the project must be informed of the fact that significant plant, invertebrate and trace fossils have been described from the Dwyka Group and that there are also trace fossils present in the shale of the upper Pietermaritzburg Formation.
2. A very small part of the development site is underlain by Dwyka Group sediments and most of the area is underlain by shale of the Pietermaritzburg Formation. All sections of the development where trenching for infrastructure will be deeper than 1,5m, the trenches must be inspected and if fossils are recorded, a professional Palaeontologist must be appointed to record and collect the fossils according to SAHRA and AMAFA specifications as part of a Phase 1 Palaeontological Impact Assessment.
3. No further mitigation for Palaeontological Heritage is recommended for this site.

## TABLE OF CONTENT



## TABLE OF FIGURES



## LIST OF TABLES

## INTRODUCTION

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential palaeontological impact of the proposed Agricultural Development on the farm York, uMshwathi Local Municipality, uMgungundlovu District Municipality, KwaZulu-Natal Province (Figure 1).


**Figure 1 Locality of study area (grey line polygon)**

The York Landowners Association wishes to utilise 99 ha of indigenous grassland on York Farm for the commercial cultivation of sugarcane, maize and other crops. The cultivation is proposed to make better use of the property in terms of its agricultural potential, as well as to improve the economic viability of all shareholders of the York Landowners Association. A portion of the profits generated from this commercial production will enable the Applicant to implement improved management of the undisturbed portions of York Farm, e.g. erosion control, improvement of fencing for livestock etc. York Farm is approximately 767 ha in size and is currently used for grazing by cattle, and mowing for the production of hay. The site is currently dominated by *Aristida junciformis*, which has limited grazing potential, particularly during the winter months.

## SOUTH AFRICAN NATIONAL HERITAGE RESOURCE ACT NO 25/1999 AND KWAZULU-NATAL HERITAGE ACT NO 4/2008

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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;
- 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.

## 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 and Google Earth imagery. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

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 bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

**Table 1 Palaeontological sensitivity analysis outcome classification**

| 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 et al., 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. |

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field-based assessment by a professional palaeontologist is usually warranted.

The key assumption for this desktop 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.

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).

## GEOLOGY

The study area is underlain by Carboniferous to Permian-aged rocks of the Dwyka Group, Permian-aged rocks of the Pietermaritzburg Formation of the Ecca Group and Dolerite of the Karoo Supergroup (Figure 2).

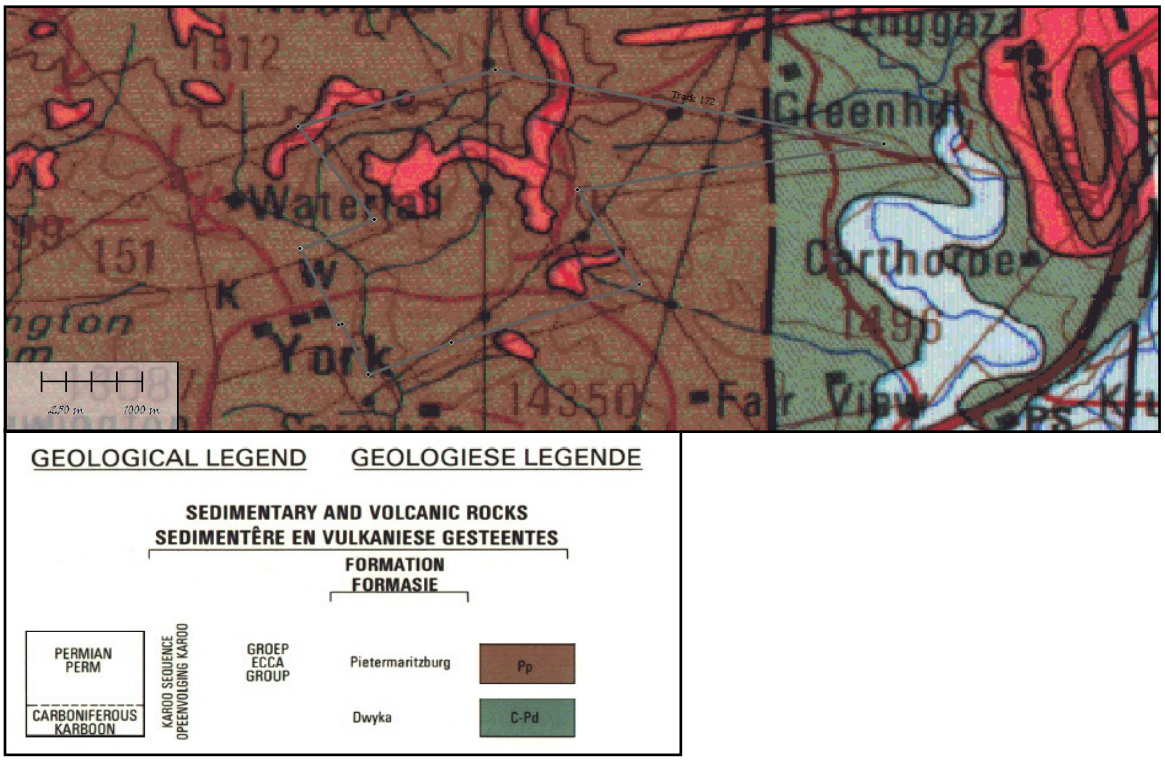


**Figure 2 Geology of Study Area**

### Dwyka Group (C-Pd)

The Carboniferous to Permian aged Dwyka Group consists mainly of poorly sorted tillites. These rocks overly the Natal Group and comprise a thick unit of tillite that was deposited in a glacial environment by retreating ice sheets about 300 million years ago.

At this time South Africa was part of the supercontinent Gondwana, which was situated near the South Pole and covered with ice. Rocks imbedded in the slowly moving ice sheets scoured and polished the underlying older rocks giving rise to glacial pavements. Striation directions indicate that ice flow was from north to south - valuable information when it comes to reconstructing Gondwana.

### Pietermaritzburg Formation (Pp)

As Gondwana moved north towards the equator, thick clay and silt beds were laid down in a large sea that occupied the Karoo Basin, leading to the deposition of the Ecca Group. These sediments, deposited in deep water, now form the shales of the Pietermaritzburg Formation. The shales are easily weathered and often present slope stability problems.

### Dolerite(Jd)

Jurassic aged dolerite sills underlies a portion of the farm.

## PALAEONTOLOGY

### Dwyka Group (C-Pd)

Trace fossils have been recorded from the fine-grained shales of the Dwyka Formation in KwaZulu-Natal (Linstrom, 1987; MacRae, 1999). All of the following could potentially be found in KwaZulu-Natal. Trackways, produced mostly by fish and arthropods (invertebrates), have been recovered in shales from the uppermost Dwyka Formation. Other trace fossils include coprolites (fossilized faeces) of chondrichthyians (sharks, skates and rays).

Body fossils include aranaceous foraminifera and radiolarians (single-celled organisms), bryozoans, sponge spicules (internal support elements of sponges), primitive starfish, orthoceroid nautiloids (marine invertebrates similar to the living *Nautilus*), goniatite cephalopods (*Eoasinites* sp.), gastropods (marine snails such as *Peruvispira viperdorfensis*), bivalves (*Nuculopsis* sp., *Phestia* sp., *Aphanaia haibensis*, *Eurydesma mytiloides*), brachiopods (*Attenuatella* sp.) and palaeoniscoid fish such as *Namaichthys schroederi* and *Watsonichthys lotzi*.

Fossil plants have also been found, including lycopods (*Leptophloem australe*), moss, leaves and stems (possibly belonging to a proto-glossopterid flora). Fossil spores and pollens (such as moss, fern and horsetail spores and primitive gymnosperm pollens) as well as fossilized wood probably belonging to primitive gymnosperms have also been recorded from Dwyka deposits (MacRae, 1999; McCarthy and Rubidge, 2005).

### Pietermaritzburg Formation (Pp)

While fossils are generally absent from the Pietermaritzburg Formation, trace fossils have been recorded from the upper layers by Linstrom (1987).

### Dolerite (Jd)

Dolerite is an igneous rock and will not contain fossils.

## DISCUSSION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews. Significant fossils have been recorded from the Dwyka Formation and the recording of trace fossils and other fossils from this part of the Karoo Basin will contribute significantly to our understanding of the palaeo-environments that existed during the Permian. Note that only a very limited part of the farm is underlain by Dwyka Group sediments and it is unlikely that significant fossils will be exposed during this development.

No significant fossils are expected from the Pietermaritzburg Formation.

## MANAGEMENT PLAN

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 unweathered bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1.

The palaeontological sensitivity of the development is related to the specific geology that underlies the development footprints. For the sake of this desktop survey it is assumed that there are significant outcrops on site, and that trenching of up to 1.5m depth for installation of infrastructure, such as pipelines for irrigation, will in fact expose bedrock of all the geological formations recorded in the desktop survey. Due to the fact that the recording of fossils will have a significant impact on our understanding of the palaeo-environments in this part of

the basin, a Moderate Palaeontological sensitivity is allocated to the study area and the ECO of the project must be sensitive to the possible presence of trace fossils in the Pietermaritzburg Formation. These fossils are associated with bedding planes of shale beds and, although difficult to recognise, can contribute to our understanding of the palaeo-environments of this region during the Permian.

The palaeontological sensitivity of the study area is shown in Figure 3.

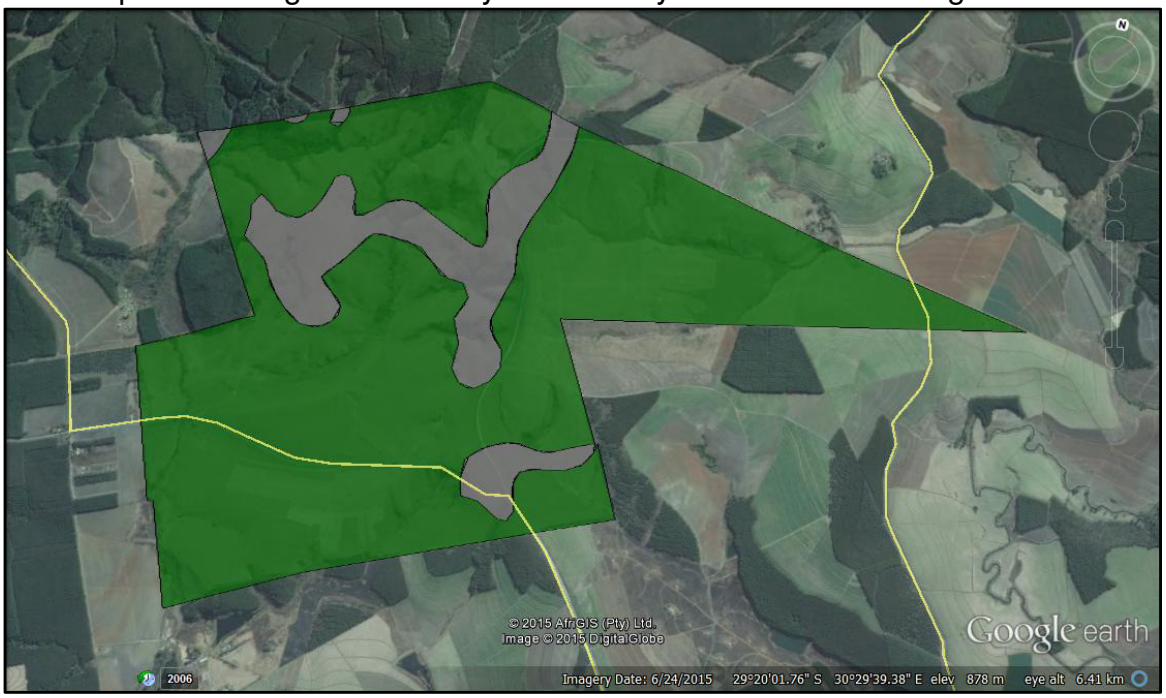


**Figure 3 Palaeosensitivity of the Study Area. Colour coding is explained in Table 1**

## CONCLUSION AND RECOMMENDATIONS

The study area is underlain by sedimentary rocks of the Carboniferous to Permian-aged Dwyka Group and Permian-aged Pietermaritzburg Formation and Jurassic aged Dolerite of the Karoo Supergroup. Invertebrate, plant and trace fossils are known from the Dwyka Group and trace fossils have been reported from the Pietermaritzburg Formation. As a result, the study area has been allocated a Moderate sensitivity, except for the Dolerite regions where no fossils will be present in the rock sequence.

**Recommendations:**

1. The EAP and ECO of the project must be informed of the fact that significant plant, invertebrate and trace fossils have been described

from the Dwyka Group and that there are also trace fossils present in the shale of the upper Pietermaritzburg Formation.

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3. No further mitigation for Palaeontological Heritage is recommended for this site.

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## 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 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.

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