Proposed development of the Lephalale Railway Yard, Limpopo Province

PALAEONTOLOGICAL DESKTOP STUDY

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For:

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1. Executive Summary

The Kheisian-aged Mogalakwena Formation of the Waterberg Group outcrops in the southern half of the study site while the northern half of the study site is largely covered by Quaternary-aged sands and sandy soils. Both are considered to be of Moderate Palaeontological Sensitivity.

Permian to Triassic-aged rocks of the Karoo Supergroup outcrop along the northern limit of the study site. The Grootgeluk Formation are considered to have a Very High Palaeontological Sensitivity, while the rocks of the Eendrachtspan Formation are considered to have a Moderate Palaeontological Sensitivity. None of the sites earmarked for development falls within the area with Very High Palaeontological Sensitivity.

The ECO should take responsibility of monitoring the excavations and development onsite. If a significant find is made the procedure stipulated under Procedure for Chance Palaeontological Finds (p.15-16) should be followed which includes the safeguarding of the exposed fossils and the contacting of a palaeontologist for further advice.

2. Introduction

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area that may be impacted by the proposed development.

The purpose of this document is to detail the probability of finding fossils in the study area and whether, if indeed there are fossils, what the impact of the mining activities will be on the fossils and fossil sites.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in inter alia the origin of dinosaurs, mammals and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and played a crucial role in the discovery of Gondwanaland and the formulation of the theory of plate tectonics. Fossils are also used to study evolutionary relationships, sedimentary processes and palaeoenvironments.

South Africa has the longest record of palaeontological endeavour in Africa. South Africa was even one of the first countries in the world in which museums displayed fossils and palaeontologists studied earth history. South African palaeontological institutions and their vast fossil collections are world-renowned and befittingly the South African Heritage Act is one of the most sophisticated and best considered in the world.

Fossils and palaeontological sites are protected by law in South Africa. Construction and mining in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Desktop Study that was prepared in line with Regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involved an overview of the literature on the palaeontology and associated geology of the area.

3. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(4)** No person may, without a permit issued by the responsible heritage resources authority-
- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- (c) trade in, sell for private gain, export or attempt to export from the republic any category of archaeological or palaeontological material or object, or any meteorite; or
- (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(5)** When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedures in terms of section 38 has been followed, it may-
- (a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
- (b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
- (c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
- (d) recover the costs of such investigation form the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

South Africa’s unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports. The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them. The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

Scoping stage in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial photos

, etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of high palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large-scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

4. Details of study area and the type of assessment:

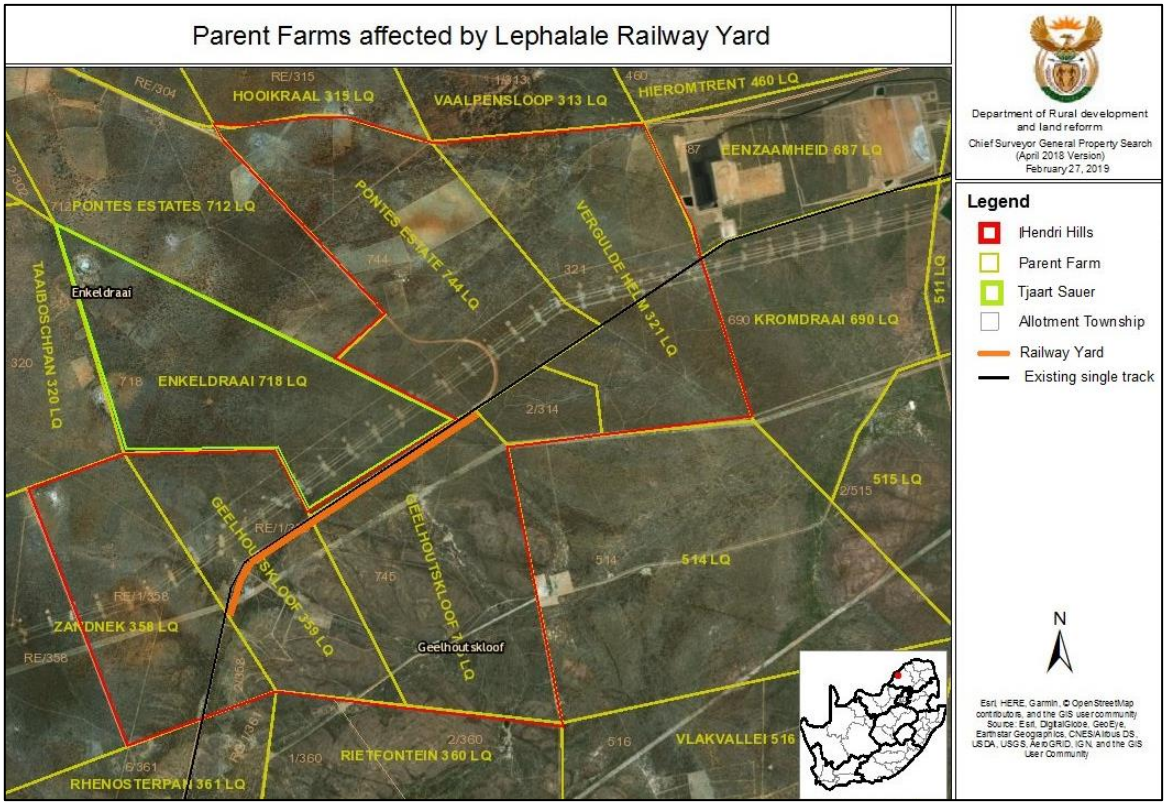

Figure 1: Google Earth photo indicating the study area (red polygon)

The study site covers the Farms Pontes Estate, Vergulde Helm, Zandnek, Geelhoutskloof 745 LQ and Geelhoutskloof 359 LQ (Fig. 1). It is situated approximately 30 km west-southwest of Lephalale (Ellisras). The surface cover consists mostly of sandy red soil.

The areas earmarked for development are depicted in the two maps below (Figs. 2 & 3).

The relevant literature and geological maps for the study site, in which the development is proposed to take place, have been studied for a Desktop Study.

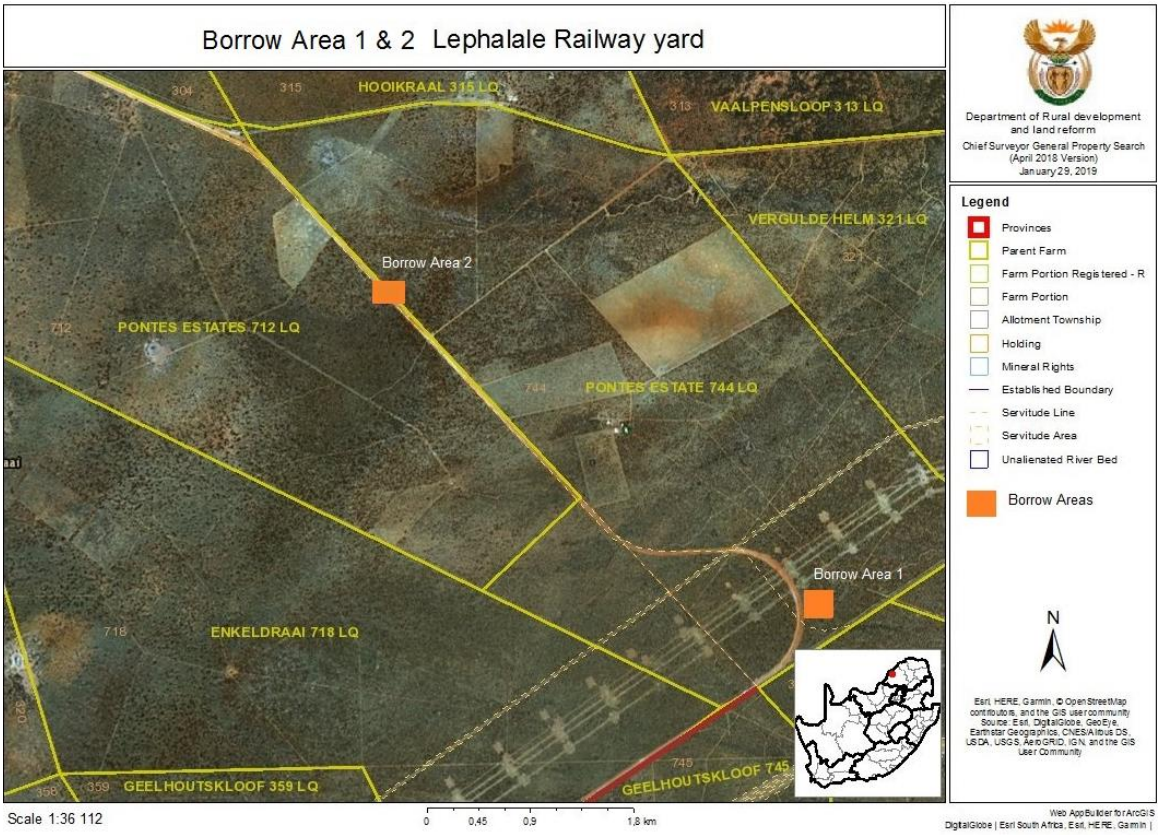

Figure 2: Borrow Areas 1 & 2 in the Lephalale Railway Yard

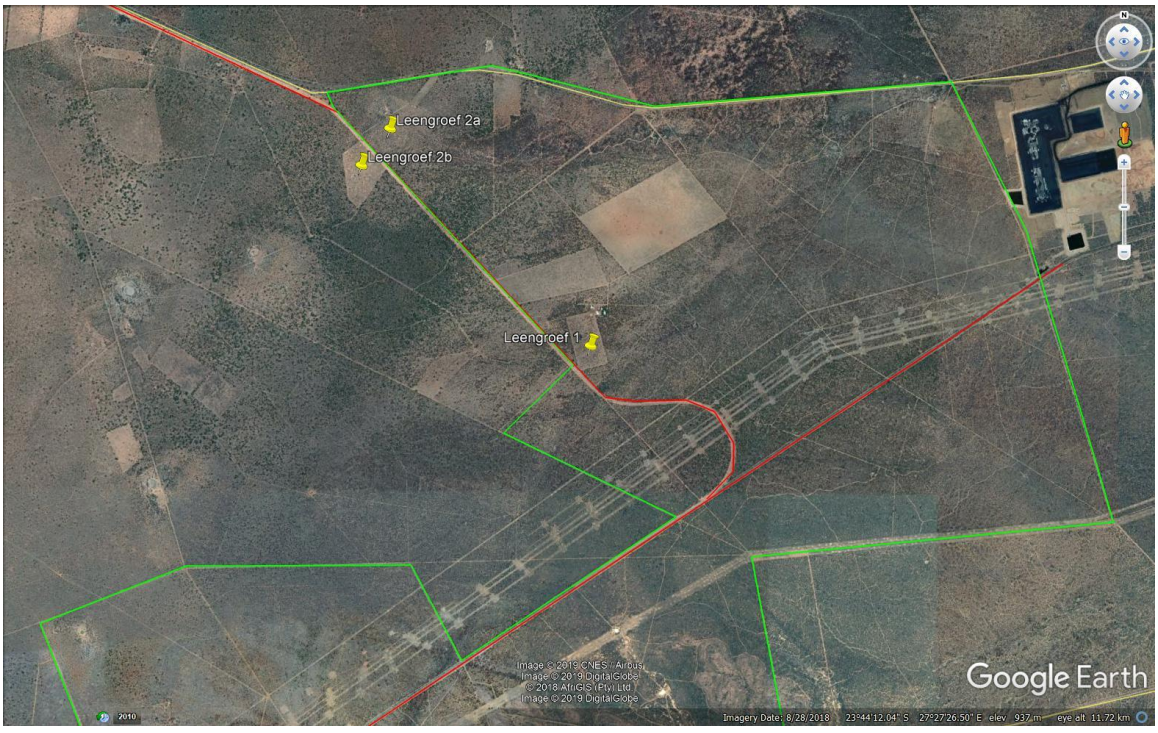

Figure 3: Alternative sites for borrow pits in the Lephalale Railway Yard

5. Geological setting of the study area

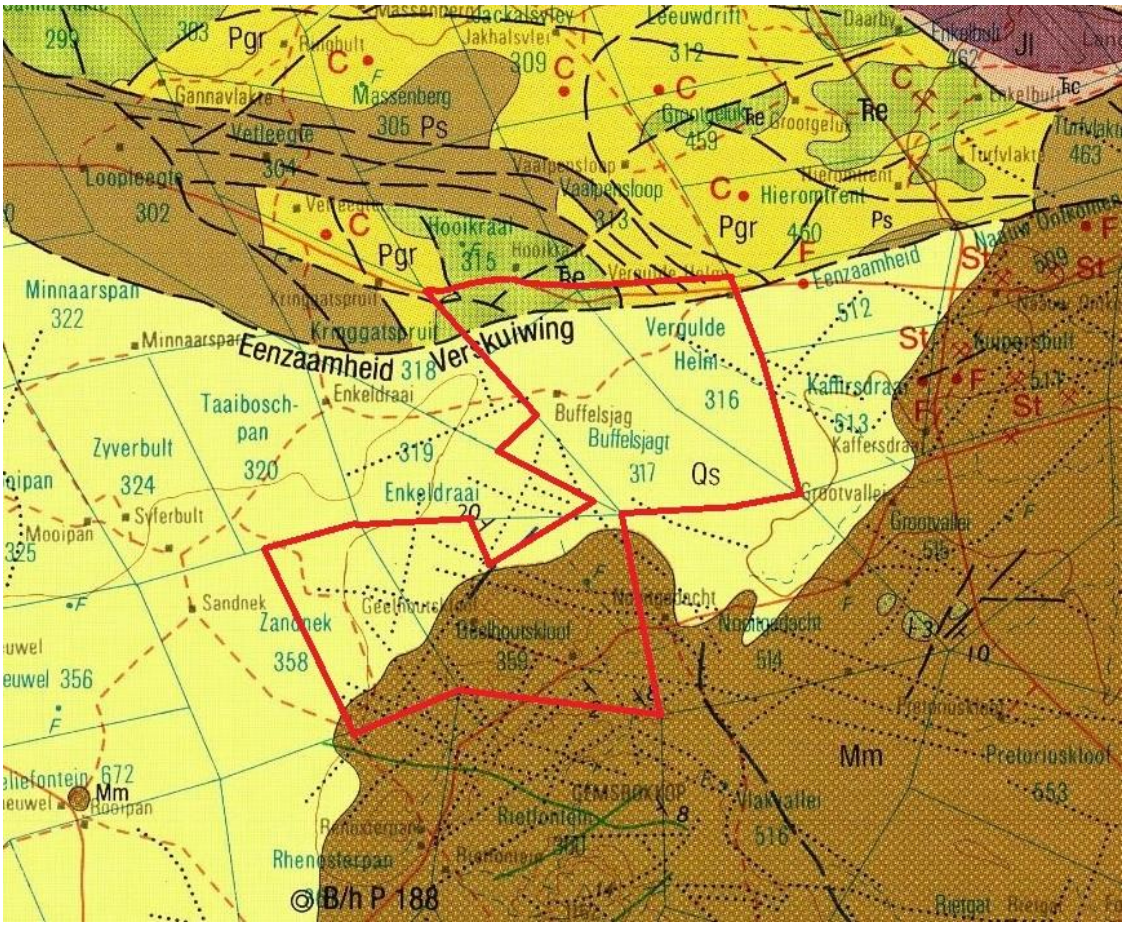

Figure 4: Geology of the study area (red polygon) and surroundings. Adapted from the 2326 ELLISRAS 1:250 000 Geology Map (Council for Geoscience, 1993)

GEOLOGY LEGEND

	Lithology	Stratigraphy		Age
Qs	Sandy soil			Quaternary
Jl	Basalt	Letaba Formation	Karoo Supergroup	Jurassic
Tc	Fine-grained cream-coloured sandstone	Clarens Formation		Triassic
Re	Variegated shale	Eendractspan Formation of the Ellisras Group		
Pgr	Mudstone, carbonaceous shale, coal	Grootegeluk Formation		Permian
Ps	Sandstone, siltstone, mudstone, coal	Swartrant Formation		
Mm	Coarse-grained, purplish brown sandstone	Mogalakwena Formation of the Waterberg Group		Kheisian

The Mogalakwena Formation of the Waterberg Group is the oldest geological unit of the study site and dominates the southern half of the study site (Fig. 4). It comprises granule-rich lithic arenites and granule rudites with pebble washes and interbedded pebble to cobble rudites. Clast- and matrix-supported rudites are subordinate in volume to the arenites. The arenites are in general poorly sorted with a high percentage of lutaceous matrix. It is hypothesized that these sediments were deposited by large braided rivers during the Kheisian (~ 1.7 - 2 Ga) (Barker *et al*., 2009).

The Permian rocks in the northern part of the study site and to the west and north of the study site are represented by the Swartrant and the Grootgeluk Formations of the Karoo Supergroup (Fig. 4). The Swartrant Formation comprises of alternating layers of sandstone, siltstone and mudstone with coal seams. The Grootgeluk Formation is the most important economical geological resource in the Lephalale region because of the numerous thick coal seams that are found in this layer. The Grootgeluk Formation consists of alternating layers of coal, carbonaceous shale and mudstone. These sediments accumulated in poorly drained swamps on a flood plain (Johnson *et al*., 2009).

The Eendrachtspan Formation of the Karoo Supergroup comprises of variegated mudstones with purplish-red colours dominant towards the top. A narrow strip of this formation occurs in the northern part of the study area (Fig. 4). Whitish reduction spots occur throughout this layer. It is hypothesized that this layer was deposited during a dramatic change in climatic conditions at the beginning of the Triassic, with the disappearance of the Permian forests that formed the coal beds. The sediments were set down in a low-energy, well-drained flood plain. The reddish colour of the mudstones suggest oxidising conditions during deposition under subaerial conditions (Johnson *et al*., 2009).

Aeolian sand and the sandy soils in the area is part of the most extensive body of terrestrial sediments of Cenozoic age in southern Africa (Partridge *et al*., 2009) and covers most of the northern half of the study site, obscuring the underlying geological formations (Fig. 4).

7. Palaeontological potential of the study site

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
GREEN	MODERATE	Desktop study is required.

Figure 5: Palaeosensitivity map of the study site (white polygon) and surroundings (SAHRA, 2019)

The proposed development will take place in an area that is to have Very High to Moderate Palaeontological Sensitivity (see Fig. 5).

No fossils have been reported from the Mogalakwena Formation of the Waterberg Group yet, but some of the oldest evidence for bacterial mats were discovered in the Makgabeng Formation of the Waterberg Group on the Makgabeng Plateau in the Waterberg. Delicate structures such as bacterial mats would probably not be preserved in the course sandstone of the Mogalakwena Formation even though it is younger than the Makgabeng Formation.

The Ecca Group of the Karoo Supergroup is represented at the study site by the Swartrant and Grootegeluk Formations. The Swartrant Formation consists of deltaic, glacial, lacustrine, fluvial and swamp sediments that are rich in *Glossopteris* flora leaf imprints and coal. The Grootgeluk Formation on the other hand consists of thick coal seams and carboniferous shale in which leaf imprints

dominated by *Glossopteris* are found (Fig. 6). Both these formations are considered to have a Very High Palaeontological Sensitivity (Groenewald & Groenewald, 2014). A narrow strip of the Grootgeluk Formation occurs on the northern border of the study area.

Figure 6: Example of *Glossopteris* leaf imprints

The Eendractspan Formation of the Ellisras Group of the Karoo Supergroup consists of arid floodplain mudrocks that is probably an equivalent to the Beaufort Group or Molteno Formation of the Main Karoo Basin. Although no coal occurs in this geological unit, there is a possibility that it might yet yield plant fossils and is therefore considered to be of Moderate Palaeontological Importance (Groenewald & Groenewald, 2014).

The fossil record of the Quarternary sediments that cover the older rock strata in the arid northerly and central regions of South Africa is sparse, occurs sporadically and is low in diversity. The fossils that have been discovered elsewhere in the Tertiary to Recent calcretes and the overlying aeolian sands and sandy soils of the Gordonia Formation include root casts, burrows, termitaria, ostrich egg shells, mollusc shells and isolated bones (Almond & Pether 2008). The Quarterly sands and sandy soils that cover the northern half of the study site (Fig. 5) is therefore considered to be of Moderate Palaeontological Importance (Groenewald & Groenewald, 2014).

References:

Barker, O.B.; Brandl, G.; Callaghan, C.C.; Eriksson, P.G. & Van der Neut, M. (2009). The Soutpansberg and Waterberg Groups and the Blouberg Formation. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The Geology of South Africa*. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria. Pp: 461-499.

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Groenewald, G.H. & Groenewald, D. (2014) Palaeontological Heritage of Limpopo, SAHRA Palaeotechnical Report.

Johnson, M.R.; Van Vuuren, C.J.; Visser, J.N.J.; Cole, D.I.; Wickens, H. de V.; Christie, A.D.M.; Roberts, D.L. & Brandl, G. (2009). Sedimentary rocks of the Karoo Supergroup. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The Geology of South Africa*. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria. Pp: 461-499.

8. Conclusion and recommendations:

The area indicated as having a Very High Sensitivity rating, i.e. the narrow strip in the northern part of the study site where the rocks of the Grootgeluk Formation occurs, will not be impacted by the suggested development (Figs. 2 & 3). The areas where development will occur falls within areas that are identified as having a Moderate Sensitivity rating.

Although fossils are scarce in the Quaternary sand and sandy soils, the possibility of finding any in the study area should not be dismissed. In fact, the paucity of fossils in this particular area increases the importance of preserving any fossil that will aid in understanding the sedimentology and chronostratigraphy of the Quaternary sediments in this area.

In the rare event of a significant fossil find during excavations or other development on the study site, the ECO should follow the following Chance Find Procedure:

PROCEDURE FOR CHANCE PALAEONTOLOGICAL FINDS

Extracted and adapted from the National Heritage Resources Act, 1999 Regulations Reg No. 6820, GN: 548.

The following procedure must be considered in the event that previously unknown fossils or fossil sites are exposed or found during the life of the project:

1. Surface excavations should continuously be monitored by the ECO and any fossil material be unearthed the excavation must be halted.

2. If fossiliferous material has been disturbed during the excavation process it should be put aside to prevent it from being destroyed.

3. The ECO then has to take a GPS reading of the site and take digital pictures of the fossil material and the site from which it came.

4. The ECO then should contact a palaeontologist and supply the palaeontologist with the information (locality and pictures) so that the palaeontologist can assess the importance of the find and make recommendations.

5. If the palaeontologist is convinced that this is a major find an inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.

From the photographs and/or the site visit the palaeontologist will make one of the following recommendations:

a. The material is of no value so development can proceed, or:

b. Fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:

c. The fossils are scientifically important and the palaeontologist must obtain a SAHRA permit to excavate the fossils and take them to a recognised fossil repository, after which the development may proceed.

7. If any fossils are found then a schedule of monitoring will be set up between the developer and palaeontologist in case of further discoveries.

9. Declaration of Independence:

I. Jacobus Francois Durand declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Palaeontological specialist:
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