Proposed wind and solar energy facility at Springfontein, Free State

DESKTOP REPORT
PALAEONTOLOGY

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For:

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Table of Contents:

List of Figures:

1. Introduction

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in *i.a.* the origin of life, dinosaurs and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and to study evolutionary relationships, sedimentary processes and palaeoenvironments. The Beaufort Group of the Karoo Supergroup contains amongst others approximately 70% of all known synapsid (also known as mammal-like reptile) fossils in the world which have played a crucial role in our understanding of the origin of mammals and the Permo-Triassic terrestrial palaeoenvironment.

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 which may be impacted by the proposed development.

2. 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.

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

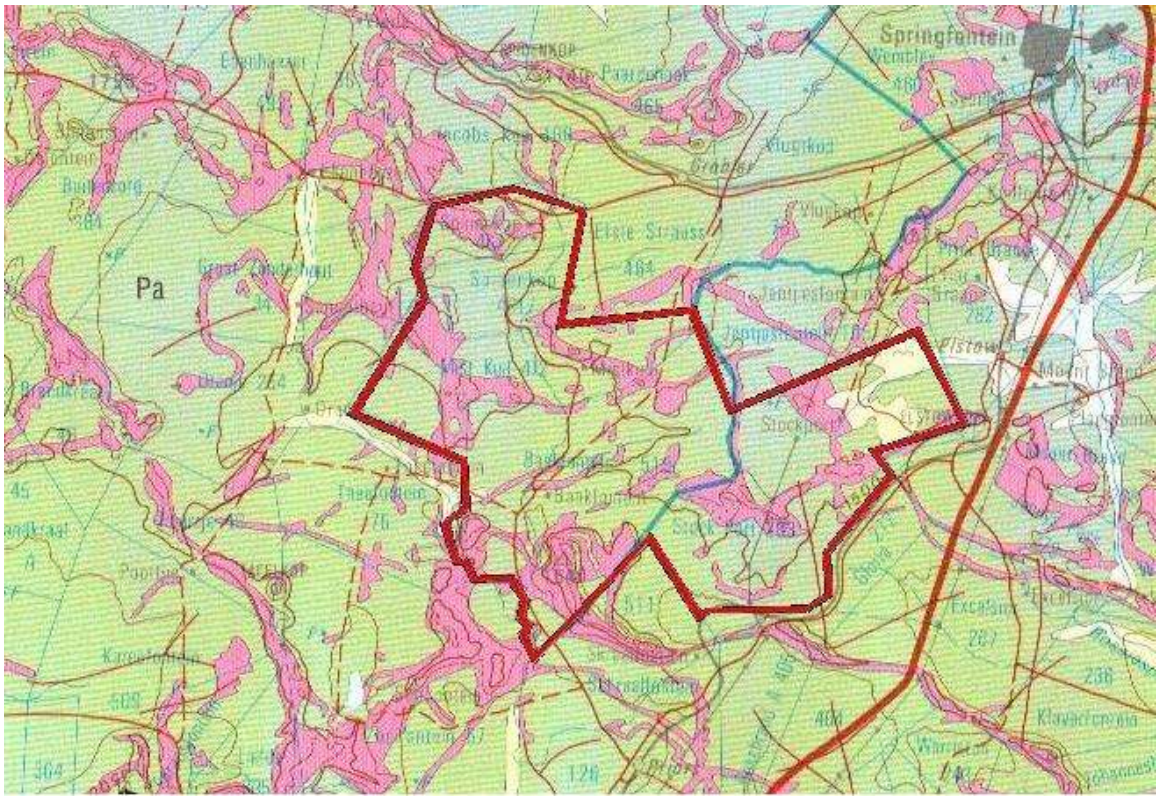
Figure 1: Google Earth photo indicating study area in the red polygon

The study area (indicated by the red polygon) lies in the southern part of the Free State to the west of the N1 between Springfontein to the north and the Orange River to the south (See Fig. 1).

Geomorphologically the study area is characterised by low hills and koppies often topped by doleritic sills.

The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied for a scoping report.

4. Geological setting



The study area is indicated by the red polygon

GEOLOGICAL LEGEND

Jurassic dolerite intrusions

Pa

Adelaide Subgroup, Beaufort Group, Karoo Supergroup

Figure 2: Geological Map of the study area and surroundings (adapted from the 3024 Colesberg 1: 250 000 Geology Map, Geological Survey, 1997)

The study area is dominated by sedimentary rocks (mostly mudstone, siltstone and sandstone) of the Adelaide Subgroup of the Beaufort Group of the Karoo Supergroup. Dolerite sills and dykes are also common in the area and are often associated with the hilltops and crests in the region. The mudstones are bluish-grey when freshly exposed and turns into a buff khaki-colour when weathered. The rocks consist of repeating fluvial cycles of upwards-fining sediments ranging from sandstone at the bottom, to siltstone, to mudstone at the top (Geological Survey, 1993).

5. Palaeontology of the study area

The region is relatively fossil rich. Fossils have been found on the farms in the study area. The fossils of the region include fossilised wood and vertebrate skeletal material.

The study area falls within the Adelaide Subgroup of the Beaufort Group. Biostratigraphically the study area falls primarily in the *Cistecaphalus* Assemblage Zone although a part of the *Dicynodon* Assemblage Zone may occur in the northern part of the study area (Rubidge, 1995).

The *Cistecephalus* Assemblage Zone is characterised by herbivorous synapsid fossils such as *Diictodon* which is the most common vertebrate fossil of this assemblage zone and which comprises approximately 50% of the vertebrate fossils of this zone (see Fig.3), *Oudenodon* which forms approximately 20% of the fossil yield from this zone, *Cistecephalus* which forms 10% of the fossil yield and from which the name of this biozone was derived (see Fig.4) and *Aulacephalodon*, and carnivorous synapsids such as gorgonopsians and therocephalians. Fish fossils (*Atherstonia*) and amphibian fossils (*Rhinesuchus*) have been found in this zone as well. Plant fossils from this zone include *Glossopteris* leaves (see Fig. 5) and fossilised wood (Rubidge, 1995).

Figure 3: Fossil skeleton of *Diictodon*

Figure 4: Fossil skeleton of *Cistecepahlus*


Figure 5: *Glossopteris* leaf imprint

The *Dicynodon* Assemblage Zone is characterised by the presence of herbivorous synapsid fossils such as *Dicynodon* from which the name of this assemblage zone was derived (see Fig. 6) and *Oudenodon*. Carnivorous synapsid fossils include gorgonopsians (see Fig.7), therocephalians and cynodonts.

Figure 6: Fossil skull of *Dicynodon*

Figure 7: Fossil skull of a gorgonopsian

Fish fossils such as *Atherstonia* and *Namaichthys* and amphibian fossils such as *Rhinesuchus* and fossil reptiles (other than synapsids) such as *Milleretta*, *Owenetta* (see Fig.8) and *Pareiasaurus* are known from this zone. Plant fossils include *Glossopteris* leaves and fossilised wood (Rubidge, 1995).

Figure 8: Fossilised skeletons of *Owenetta*

Although it is difficult to predict where fossils would occur in the mudrock and sandstone of the study area, there is a high probability that fossils would be uncovered when clearing and excavations for foundations, pipelines and roads take place during construction.

References:

Geological Survey (1993). Colesberg Toeligting Blad 3024 (1:250 000).

Geological Survey (1997). 3024 Colesberg 1: 250 000 Geology Map.

Rubidge, B.S. (Ed.) (1995). Biostratigraphy of the Beaufort Group (Karoo Supergroup), Biostratigraphic Series no.1, South African Committee for Stratigraphy, Council for Geoscience.

6. Conclusion and recommendations:

The area is characterised by fossiliferous mudstones and sandstones. Several dolerite sills and dykes occur in the region and are often found capping hills and forming ridges. Dolerite, being of igneous origin, is devoid of fossils. In addition fossils are usually absent in the sedimentary rocks immediately adjacent to the dolerite intrusions. There is no palaeontological concern in the instances where the proposed construction is situated on dolerite, which would probably be the case with wind turbines which will be constructed on the hill tops.

Care should be given however to constructions such as access routes, construction facilities, substations, pylons and buildings which would not be limited to dolerite. It is recommended that a palaeontological surface survey of the site is conducted in all the non-doleritic areas prior to construction where construction is planned.

In addition the ECO should photograph and record the position of fossiliferous material when exposed during construction. If the fossiliferous material is going to be damaged during construction, the ECO could make an attempt to salvage it and store it safely in order for a professional appointed palaeontologist to collect it at his or her earliest convenience. If however the fossil is part of a skeleton or too big or delicate to remove, palaeontological assistance should be called for immediately. Little harm will come to a fossil if it could be collected simply by picking it up (as long as it is numbered and the locality is recorded by means of GPS), but actual excavations should be left to a professional palaeontologist. A professional palaeontologist should be appointed to salvage and collect fossiliferous material from the site which may exposed during construction.

The excavations and collection of fossils should be performed by a qualified palaeontologist and with a permit from the South African Heritage Resources Agency. The fossils should be donated to the Bloemfontein Museum.

Palaeontological specialist:
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BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP),
Higher Education Diploma (RAU), PhD Palaeontology (WITS)

Experience:
Palaeontological assessments:

- Urban development in Cradle of Humankind World Heritage Site (Gauteng): Letamo, Honingklip, Windgat, Sundowners, Ekutheni
- Urban development at Goose Bay, Vereeniging, Gauteng
- Upgrade of R21 between N12 and Hans Strydom Drive, Gauteng
- Vele Colliery, Limpopo Province
- De Wildt 50 MW Solar Power Station, Gauteng
- 10 MW PV Plant Potchefstroom, North West Province
- Omega 342 50MW Solar Power Station, Viljoenskroon, Free State
- Solar power plant, Bethal, Mpumalanga
- Diamond mine on Endora, Limpopo Province
- Development at Tubatse Ext.15, Limpopo Province
- Manganese mine south of Hotazel, Northern Cape
- Wind energy facility at Cookhouse, Eastern Cape

Palaeontological research:

- Gauteng: Wonder Cave
- KwaZulu/Natal: Newcastle, Mooi River, Rosetta, Impendle, Himeville Underberg, Polela & Howick Districts, Sani Pass
- Eastern Cape: Cradock District, Algoa Basin
- Western Cape: Clanwilliam District
- Free State: Memel & Warden Districts
- Limpopo Province: Nyalaland (KNP), Vhembe Reserve, Pont Drift
- Zimbabwe: Sentinel Ranch, Nottingham