

**Palaeontological desktop assessment of a commercial renewable energy facility site located approximately 34 km south of Victoria West in the Western Cape Province Western Cape Province.**

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## Executive Summary

The author of this report was appointed by Savannah Environmental Consultants to conduct a desktop palaeontological heritage assessment with regard to the proposed development of a commercial renewable energy facility at a site located approximately 34 km south of Victoria West in the Western Cape Province. The findings are as follows:

- Bedrock sediments underlying the proposed renewable energy facility are mainly composed of lowermost strata of the Teekloof Formation, which is represented by the fossil-bearing Poortjie and Hoedemaker Members.
- The Teekloof Formation bedrock sediments located within the proposed area of development are regarded as of high overall palaeontological significance, especially with regard to potential impact on terrestrial tetrapods, plants, silicified wood and trace fossils.
- Pre-excavation surveying of selected sites and access roads will be essential where development is planned directly on potential fossil-bearing strata.

- Construction activities planned on igneous bedrock (dolerite) represent no palaeontological impact.
- Quaternary alluvial deposits in the area, especially near water courses and drainage lines, are of medium overall palaeontological significance and have the potential to yield microfossil and fossil mammal remains as well as Early Stone Age artefacts.
- Future development that calls for trench or pit excavations, exposing fresh Teekloof Frm. bedrock or intact superficial deposits in the area, will require a Phase 1 palaeontological impact assessment.

## Glossary

**Fossil:** Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

**Heritage:** That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

**Permian:** A geological time period dated between 299 – 251 Ma (million years ago).

**Palaeontology:** Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

**Quaternary:** Geological period spanning the last 2.6 million years ago.

**Supergroup:** A group of rock strata formed during a single, major and widespread episode of rock accumulation.

## Introduction

The report is a preliminary assessment of potential palaeontological impact with regard to the planned development of a commercial renewable energy facility consisting of both a wind energy facility component and a photovoltaic solar facility component, as well as associated infrastructure on a site located approximately 34 km south of Victoria West (**Fig. 1**). The project is proposed on portions of the farms Nobelsfontein 227, Annex Nobelsfontein 234, Ezelsfontein 235, Rietkloofplaat 239, Modderfontein 228 and PhaisantKraal 1 (1:50 000 topographic maps 3123CA Verster, 3123CB Bulberg, 3123CC Three Sisters and 3123CD Tierhoek). A broader area of approximately 20 222 ha is being considered within which the facility is to be constructed. The assessment was carried out in accordance with National

Heritage Resources Act 25 of 1999 with the aim to assess impact on potential palaeontological heritage resources.

Because the palaeontological footprint is related to continuous sedimentary units that cover large geographical areas, the report primarily focuses on the local lithostratigraphy for the assessment of palaeontological significance. The palaeontological significance of the local and surrounding environment was evaluated through a desktop study and carried out on the basis of existing field data, database information and published literature.

## **Geological Background**

As indicated on the 1: 250 000 scale geological map 3122 Victoria West in Figure 2, (Published by the Council for Geoscience, Pretoria, 1991), the proposed energy facility is entirely underlain by sediments and rocks of the Karoo Supergroup, which are assigned to the Lower Beaufort Group (Adelaide Subgroup). Relevant geological references include Le Roux and Keyser (1988) and Johnson *et al.* (2006). The deposits of the Adelaide Subgroup are subdivided into the Abrahamskraal and Teekloof Formations. These sediments form part of the Lower Beaufort Group of sedimentary rocks that lie about halfway up the Karoo Supergroup sequence and comprise a 2000 m thick fluvio-lacustrine succession of late Permian age. The Teekloof Formation is a 400m thick argillaceous unit, renowned for its rich fossil heritage of terrestrial vertebrates (therapsids). This formation is represented by fluvially derived, Late Permian sequences of sedimentary rocks, comprising fossiliferous siltstones, mudstones, subordinate sandstones and thin pedocretes (calcretes). Sandstone and the mudstone exposures respectively represent river channel and floodplain deposits. These features are considered to be typical of continental deposits derived primarily from fluvial and lacustrine sedimentation.

Bedrock sediments in the study area are mainly represented by lowermost strata of the Teekloof Formation, which is represented by the arenaceous Poortjie Member (*Ptp*, **Fig. 2**). Outcrops of red and purple mudstones, and subordinate sandstones of the overlying Hoedemaker Member (*Pth*) and Oukloof Member (*Pto*) are exposed particularly along dolerite intrusions. These intrusions of Jurassic-age dolerite (*Jd*), in the form of sills and dykes, occur extensively in the region. Superficial deposits are made up of late Cenozoic (Quaternary) sheet wash, river channel alluvium, colluvium and pedocretes.

## Palaeontology

The rocks of the Poortjie Member are assigned to the *Pristerognathus* Assemblage Zone (AZ), which overlies the *Tapinocephalus* AZ and underlies the *Tropidostoma* AZ (**Fig. 3**). The *Pristerognathus* AZ is characterised by a therapsid fauna dominated by *Diictodon* in association with *Pristerognathus*. The fossil record of these biozones, which includes a wide variety of terrestrial tetrapods, plants, silicified wood and trace fossils, is summarized in Rubidge (1995) and MacRae (1999). Fragmentary fossil remains of plants, fishes and reptiles have been found in siltstone and mudstone horizons and in mud-pebble conglomerate deposits on the farms Klerksfontein 180, Gembokfontein 186, Wolwefontein 192, Patreisfontein 189, Vingerfontein 162, Van der Mewesdam 118, Melton Wold 158, Amstedam 126, Biesiesfontein 186 and in the Biesiespoort area (**Fig. 4**). Rocks of the overlying Hoedemaker Member are assigned to the *Tropidostoma* AZ, which is characterized by the association of the vertebrate genera *Tropidostoma* and *Endothiodon*. Fossil material from this assemblage zone has been previously recovered from thick mudrock sequences on Melton Wold 158. Oukloof Member outcrop are infrequent in the study area. It is characterized by a significant increase of sandstone at the base of the unit and is assigned to the *Cistephalus* AZ.

The study area is capped by late Cenozoic sheet wash and channel related deposits, which have not as yet yielded fossil remains. However, Quaternary palaeontological sites are occasionally found in Pleistocene alluvial terraces and dongas along rivers and streams dissecting the western Karoo basin. Rock engravings on the farm Klipkraal, near Nelspoort to the southeast, suggest the possibility that a giant long-horned buffalo (*Homoiocerus antiquus*), which became extinct more than 10 000 years ago, previously occurred in the area (**Fig. 5**). Earliest human occupation of the Karoo is indicated by the occurrence of characteristic Early Stone Age (Acheulian) prepared core stone tools commonly found in the vicinity of Victoria West.

## Impact Statement

Any developments that destroy or damage fossils or that conduct excavations exposing fresh bedrock or old superficial deposits are of conservation and research interest. The most appropriate recommendation for mitigation is regular field scoping and monitoring of fresh exposures and bedrock excavations into fossil-bearing strata.

**Table 1.** Geology and potential fossil heritage in the study area.

<b>Geological Unit</b>	<b>Rock types and Age</b>	<b>Fossils Recorded / Biostratigraphy</b>
Superficial deposits	Alluvium, colluvium, pedocretes and soils; Quaternary to Recent	Micromammal bones, large mammal bones, horncores and dentition; freshwater and terrestrial molluscs, coprolites, pollen and phytoliths
Karoo Dolerite ( <i>Ja</i> )	Intrusive igneous bedrock	No fossils
Adelaide Subgroup Teekloof Formation Poortjie Memb. ( <i>Ptp</i> ) Hoedemaker Memb. ( <i>Pth</i> ) Oukloof Memb. ( <i>Pto</i> )	Fluvial and lacustrine mudstones, sandstones, thin calcretes and lenses of pink-weathering “cherts”	<i>Pristerognathus</i> AZ <i>Tropidostoma</i> AZ <i>Cistephalus</i> AZ

The geology and potential fossil heritage of the area is summarized in **Table 1**. The area within which the facility is to be constructed is underlain by igneous bedrock (dolerite, *Jd*) and *in situ* strata of the fossil-bearing Teekloof Formation (*Ptp*, *Pth*, *Pto*). Quaternary alluvial deposits, especially near water courses and drainage lines, have the potential to yield microfossil and fossil mammal remains as well as Early Stone Age archaeological remains. Proposed development located within igneous bedrock (dolerite) represents no palaeontological impact. However the zones that transect low relief strata of the fossiliferous Teekloof Formation are likely to be impacted by substantial excavations into fresh bedrock.

### **Recommendation**

The desktop study indicates that part of the proposed development is likely to impact on fossil-bearing bedrock. It is anticipated that future development that calls for localized trench or pit excavations, exposing fresh bedrock or old superficial deposits in the area, will require

a Phase 1 palaeontological impact assessment. Effective mitigation of palaeontological heritage for this project is only feasible once the positions of individual structures and access roads have been finalised. At this stage, pre-excavation surveying of selected sites and access roads is necessary where development will take place directly on potential fossil-bearing strata. This may involve

- any fossiliferous exposures already existing within the broader footprint of the proposed development,
- fresh cuttings along new access roads,
- substantial bedrock excavations such as borrow pits,
- as well as foundation excavations for the wind turbines, photovoltaic panels and other structures.

Substation 1 Option 1 - Immediate turn-in line to the Hutchinson/Biesiespoort-1 132kV line and Substation 2 Option 1 - Immediate turn-in line to the Droerivier/Hydra-2 400kV line, are the preferred alternatives for the construction of the powerlines.

**Impact table summarising the significance of impacts (with and without mitigation)**

**Nature:** Construction of wind energy turbines and a photovoltaic solar plant, as well as associated infrastructures is likely to impact on fossil-bearing bedrock which is mainly composed of lowermost strata of the Teekloof Formation. These sediments are regarded as of high overall palaeontological significance, especially with regard to potential impact on terrestrial tetrapods, plants, silicified wood and trace fossils. Quaternary alluvial deposits in the area, especially near water courses and drainage lines, are of medium overall palaeontological significance and have the potential to yield microfossil and fossil mammal remains as well as Early Stone Age artefacts. The palaeontological heritage identified in the area may be affected by development that calls for fresh cuttings along new access roads, substantial bedrock excavations such as borrow pits, as well as foundation excavations for wind turbines, photovoltaic panels, pylons and associated building structures .

	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Local High (5)	Local Low (1)
<b>Duration</b>	Permanent (5)	Short-duration (1)
<b>Magnitude</b>	Moderate (6)	Moderate (6)
<b>Probability</b>	Probable (3)	Probable (3)
<b>Significance</b>	<b>48 (Medium)</b>	<b>24 (Low)</b>
<b>Status (positive or negative)</b>	Negative	Negative

<b>Reversibility</b>	Low	Low
<b>Irreplaceable loss of resources?</b>	Yes	Yes
<b>Can impacts be mitigated?</b>	Yes	
<b>Mitigation:</b> Mitigation Measures		
Pre-excavation survey of localities demarcated for the construction of the substations, photovoltaic plant, wind turbine and pylon positions in order to identify potential fossil material already visible at ground surface and which might be damaged during early stages of the development; and to make specific recommendations for second phase mitigation once excavation has taken place.		
<b>Cumulative impacts:</b> Cumulative Impacts		
<b>Residual Impacts:</b> Residual Impacts		



## Draft Palaeontological Management Plan

**OBJECTIVE:** A medium-term management plan, based on constructive collaboration between the developer and the palaeontologist, will need to be set in place to ensure that there will be no accidental or intentional damage caused to potential palaeontological heritage during the construction of the proposed renewable energy facility.

<b>Project component/s</b>	Construction (excavation) activities related to the erection of wind energy turbines photovoltaic solar panels, transmission lines and all associated infrastructures.	
<b>Potential Impact</b>	Development that calls for fresh cuttings along new access roads, substantial bedrock excavations such as borrow pits, as well as foundation excavations for wind turbines, photovoltaic panels, pylons and associated building structures may potentially impact on Late Permian ( terrestrial tetrapods, plants, silicified wood, trackways) fossils as well as Quaternary macro- and microfossils.	
<b>Activity/risk source</b>	Industrial activities related to the preparation of the site for the construction of the facility.	
<b>Mitigation: Target/Objective</b>	<p>A palaeontological survey of existing surface exposures of palaeontologically significant units, as well as of fresh excavations into these units.</p> <p>Pre-excavation surveying of selected sites and access roads where development is planned directly on potential fossil-bearing strata.</p> <p>Access to the site at appropriate stages during development and monitoring of excavations that exposes fresh bedrock or intact superficial deposits in the area.</p>	
<b>Mitigation: Action/control</b>	<b>Responsibility</b>	<b>Timeframe</b>
A pre-excavation survey and possibly 2 <sup>nd</sup> phase assessments as required for new development in terms of the National	Developer, palaeontologist	Pre-construction

Environmental Management Act and is also called for in terms of the National Heritage Resources Act 25 of 1999.		
<b>Performance Indicator</b>	Site visit, assessment report and recommendations to SAHRA	

## References

- Johnson, M.R. et al. 2006. Sedimentary Rocks of the Karoo Supergroup. **In:** M.R. Johnson, C. J. Anhaeusser and R.J. Thomas (Eds). The Geology of South Africa. Geological Society of South Africa.
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- Mcrae, C. 1999. Life etched in stone. Fossils of South Africa, 305 pp. The Geological Society of South Africa, Johannesburg.
- Rubidge, B. S. 1995. Biostratigraphy of the Beaufort Group. Biostrat. Ser. S.Afr. Comm. Strat. 1, 1 – 45.

## Declaration

L. Rossouw does independent specialist consulting and is in no way connected with the proponents of the development, other than delivery of consulting services.