Proposed development of the Windfield substation to Villiers substation 88kV power line, Free State

PALAEONTOLOGY

For:

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1. Executive Summary

The study area is underlain by sedimentary rocks consisting mostly of bluish grey to dark grey mudstone and shale (metamorphosed mudstone) and subordinate siltstone of the fossil-poor Volksrust Formation of the Ecca Group of the Karoo Supergroup in the study area.

The Vryheid Formation that is considered to be of a Very High Palaeontological Sensitivity is exposed along the river bank that crosses the study site. No fossils were found during the site visit.

The underlying geology of the area is largely obscured by maize fields, grassland and soil.

Even though macrofossils are generally scarce in the Volksrust Formation it is considered to have a High Palaeontological Importance by SAHRA. The fossils of the Ecca are important in the debate whether the Ecca Sea was marine or a huge freshwater inland lake. This information is also important in understanding the palaeoenvironments that were responsible for coal formation.

Although Vryheid Formation is exposed in a very small area, the developer should take care when excavations or other development takes place in the area adjacent to the river. Due to the variety and volume of fossils found in the Vryheid Formation it is considered to have a Very High Palaeontological Sensitivity.

When fossils are discovered, the Chance Find Procedure (pp. 24-25) should be followed by the ECO.

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 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 in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Palaeontological Impact Assessment 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 and a visit to the study sites for field assessment.

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-
- destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- 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
- 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-
- 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;
- 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;
- 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
- 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:

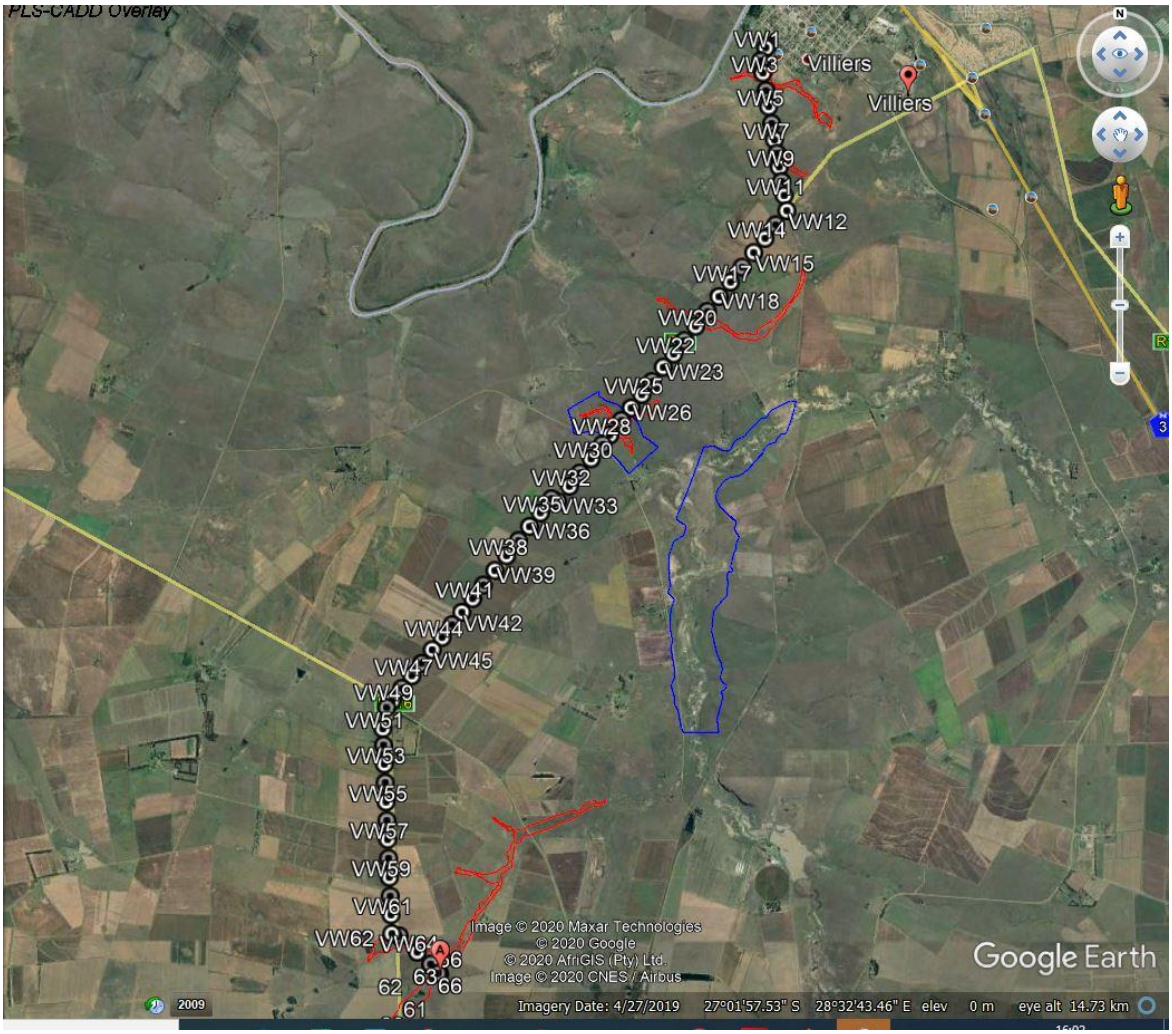
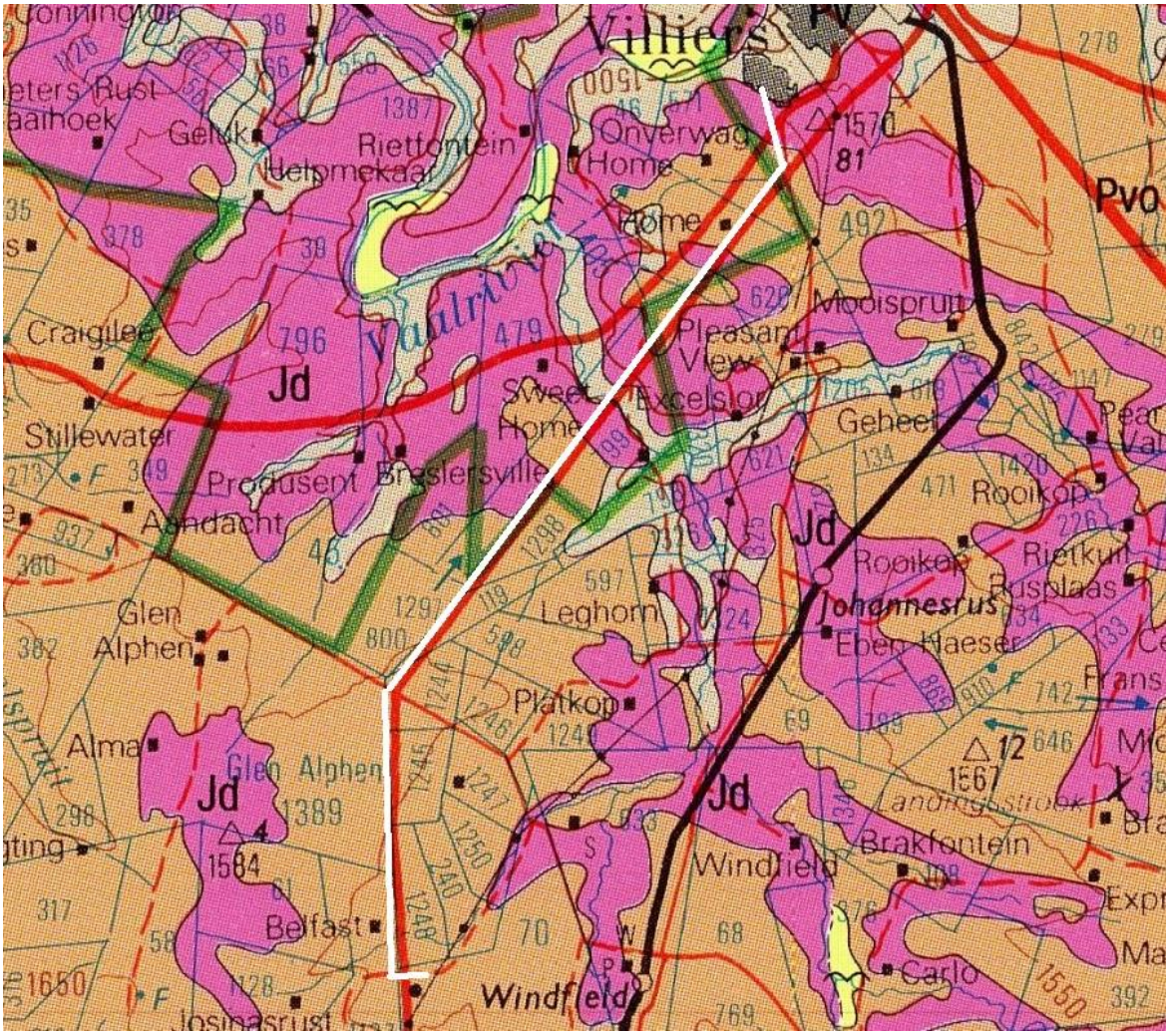


Figure 1: Google Earth photo indicating the study area

The study area lies between Windfield Rural Substation and Villiers Municipal Substation (Fig. 1). The study area runs through an area used for agriculture.

The relevant literature and geological maps for the study area, in which the development is proposed to take place, have been studied and the site was visited for a Palaeontological Impact Assessment.

5. Geological setting of the study area



(The study site is indicated by the white line)

	Lithology	Stratigraphy		Age
~	Alluvium			Quarter-nary
Jd	Dolerite			Jurassic
Pvo	Blueish-grey to dark grey mudstone and shale	Volksrust Formation	Ecca Group of the Karoo Supergroup	Permian
Pv	Sandstone, dark grey mudstone and shale, coal beds in places	Vryheid Formation		

Figure 2: Geological Map of the study area and surroundings. Adapted from the FRANKFORT 2728 1: 250 000 Geology Map (Geological Survey, 1992)

The study area is mainly underlain by extensive dolerite intrusions and sedimentary rocks consisting mostly of blueish grey to dark grey mudstone and shale (metamorphosed mudstone) and subordinate siltstone of the Volksrust Formation of the Ecca Group of the Karoo Supergroup (Muntingh, 1989).

The Vryheid Formation is exposed in the study area along the banks of the tributary of the Vaal River. The study area is underlain by sedimentary rocks consisting mostly of shale (metamorphosed mudstone), shaly sandstone, sandstone, grit, gravel, conglomerate and coal of the Vryheid Formation of the Ecca Group of the Karoo Supergroup (see Fig. 2).

The Volksrust Formation is an argillaceous geological unit that interfingers with the overlying Beaufort Group and underlying Vryheid Formation. This formation comprises of grey to black silty shale with thin siltstone or sandstone lenses and beds. These sandstones occur mostly towards the upper and lower boundaries of this formation. The Volksrust Formation represents a transgressive open shelf sequence that formed when suspended mud particles were deposited on the sea floor. The upper and lower portions of this formation that contain the sandstones were probably deposited in lagoonal and shallow coastal embayment environments (Johnson *et al*., 2009).

The Vryheid Formation was formed when glacial and fluvio-glacial sediments were deposited in shallow marine to fluvio-deltaic environments approximately 280 Ma ago. In places coal seams are associated with these fluvial valley deposits. The coal seams formed in peat swamps which originated on alluvial plains or more rarely in back swamps (Johnson *et al*., 2009).

6. SITE VISIT

Figure 3: Map showing sites where pictures were taken

The geology of the study site is largely obscured by soil cover, grass land and maize and soy fields (Figs. 4-6, 8-11). The only area in the study site where there the underlying geology (and specifically the Vryheid Formation) is exposed, is along the river banks (Fig. 9). The rocks on the river bank consist of weathered mudstone and sandstone. No fossils were found.

Figure 4: Site A facing south from 27°03'02.8"S 28°35'54.8"E

Figure 5: Site B facing south from 27°03'32.4"S 28°35'28.3"E

Figure 6: Site C facing south from 27°03'32.4"S 28°35'28.3"E

Figure 7: Site D facing east from 27°04'56.66"S 28°34'16.21"E

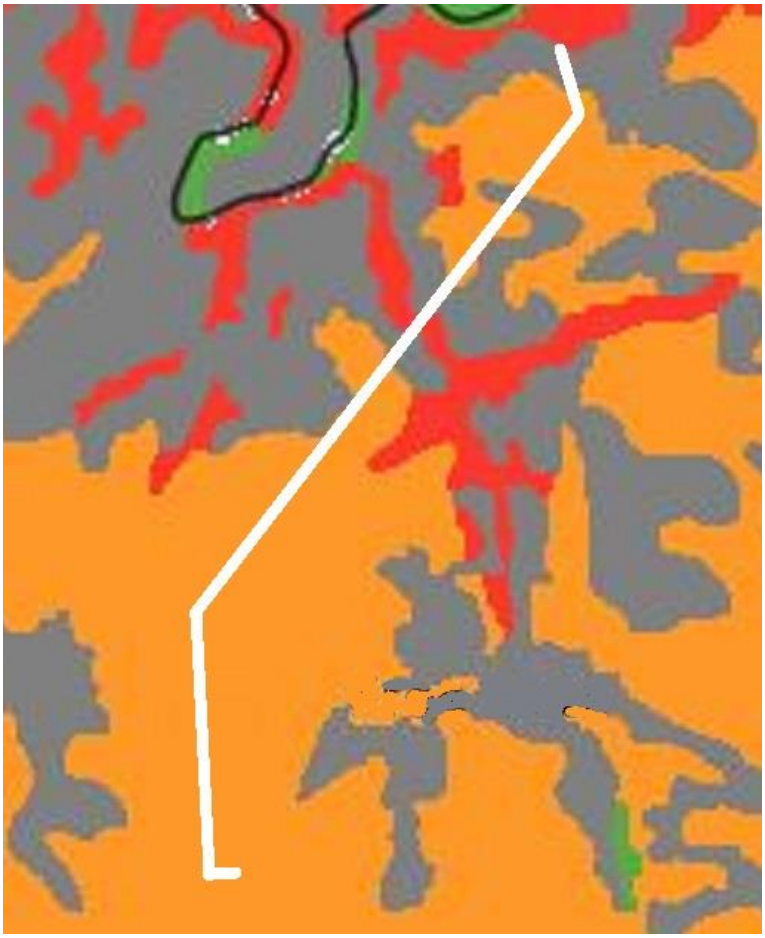
Figure 8: Site E facing south from 27°05'35.5"S 28°33'39.2"E

Figure 9: Site F facing south from 27°06'24.9"S 28°32'55.8"E

Figure 10: Site G facing south from 27°07'38.2"S 28°32'18.3"E

Figure 11: Windfield Power Station in distance looking West-southwest from 27°09'05.55"S 28°32'22.7"E

7. PALAEONTOLOGICAL ASSESSMENT



(The study site is indicated with the white line)

Figure 12: Palaeontological sensitivity map of the study area and surroundings (SAHRA, 2020)

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
ORANGE	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely.
GREEN	MODERATE	Desktop study is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

The study site falls mainly within the Volksrust Formation of the Karoo Supergroup that is classified by SAHRA as being of High Palaeontological Importance (see Fig. 12). Unlike the underlying Vryheid Formation, the Volksrust Formation is devoid of plant fossils which would be consistent with the theory that the Volksrust Formation comprises of deep-sea deposits that were deposited distally from the

source area, while the highly fossiliferous Vryheid Formation represents a proximal deposit of material (Johnson *et al*., 2009).

The Vryheid Formation of the Ecca Group of the Karoo Supergroup contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* in places (Kovács-Endrödy, 1991) in places. Millions of tons of fossiliferous material yielding mostly Glossopteris leaf imprints have been exposed at well-studied sites in the northern rim of the main Karoo Basin such as Hammanskraal (Kovács-Endrödy, 1976), Witbank (Bamford, 2004) and Vereeniging (Rayner, 1986) and the ferromanganese mine at Ryedale (Pack et al., 2000). The study site is also situated in the northern part of the Karoo Basin (see Fig. 13) but no fossils were found during the site visit.

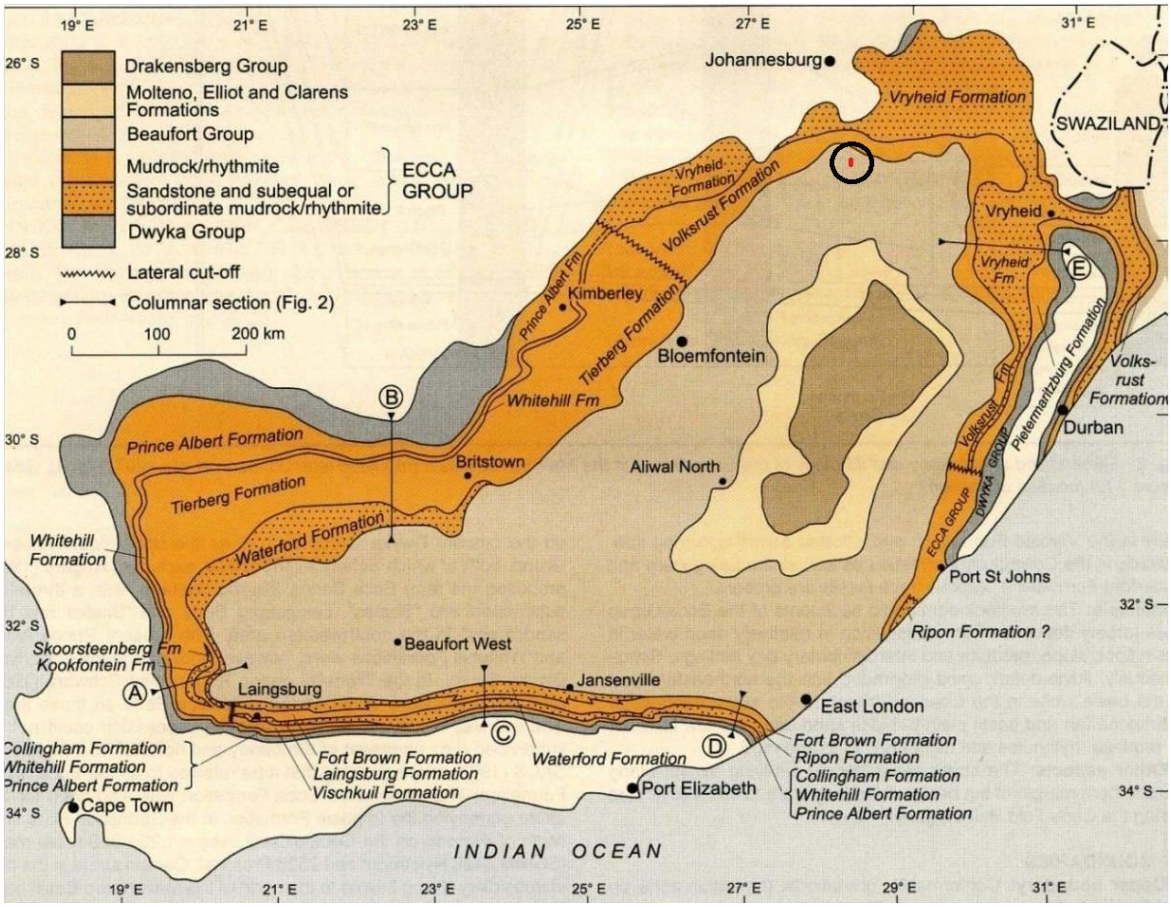


Figure 13: Map showing the location of the study site in the Main Karoo Basin (red marker in black circle) (adapted from Johnson *et al*., 2009)

The near horizontal layering of the geological strata and erosion of the adjacent and underlying rock strata resulted in a gently undulating landscape covered to a great extent by sandy soil. Exposures of the underlying geology are therefore exceptionally scarce in the northern part of the Main Karoo Basin and are mostly limited to gullies, riverbanks (see Fig. 14), road cuttings and coal mines.

Figure 14: Sandstone and mudstone of the Vryheid Formation exposed in the riverbank at Site D

The study site is for the best part covered in soil and vegetation for the and the underlying geology is therefore obscured. There are only limited exposures of the Vryheid Formation that is considered to be of Very High Palaeontological Sensitivity.

The rock rubble that was excavated for the erection of Pole 27 north of the river (see Figs. 16 & 17) and Pole 28 south of the river (see Figs. 17 & 18) was inspected during the field assessment. The rubble pile consist of dolerite and weathered sandstone and no fossils were found. Similarly, the weathered sandstone and mudstone exposed along the river bank (see Fig. 14) did not yield any fossils.

Figure 15: Pole 27 just north of the river (Site D)

Figure 16: Rubble consisting of doleriete and weathered sandstone at Pole 27

Figure 17: Pole 28 just south of the river (site D)

Figure 18: Rubble consisting of doleriete and weathered sandstone at Pole 28

Fossils have been found on the farms and the mines elsewhere in the district. These fossils are mostly leaf and stem imprints of *Glossopteris*, lycopods, ferns, horsetails, cordaitaleans, conifers and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales have also been found in the shales and sandstones of the Vryheid Formation in the Free State (Groenewald & Groenewald, 2014). *Glossopteris* leaves are abundant in Ecca Group sediments at certain localities in Gauteng, Free State, Mpumalanga and KwaZulu-Natal and could be considered to be amongst the most common fossils in South Africa.

Fossilised leaf imprints are not found ubiquitously throughout the Ecca Group, but in pockets such as in the eMalahleni and Vereeniging areas where the physical and chemical conditions during deposition resulted in the preservation of not only the structure of the leaves but also in some cases the organic material itself. The structure of the fossilised leaves is better preserved in the shales than in the sandstone units. The leaf structures are mostly lost in the coal layers.

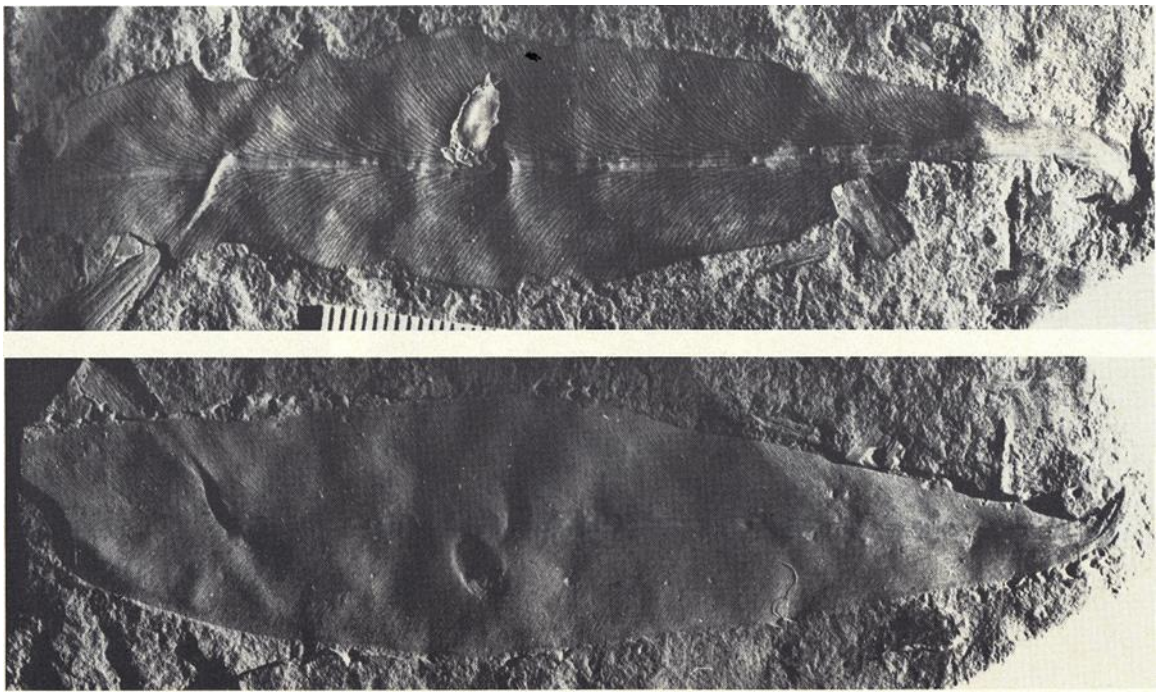


Figure 19: *Glossopteris* leaf imprint (from Kovács-Endrödy, 1976)

There is a high volume but low species diversity of fossil material in the Vryheid Formation. Large and well described collections of fossil material from this region are housed at the Council for Geoscience, the Bernard Price Institute for Palaeontology at the University of the Witwatersrand and the Botanical Research Institute.

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8. Conclusion and recommendations:

The chances of finding fossils in the fossil-poor Volksrust Formation that underlies the largest part of the study area are very small. The dolerite will be devoid fossils. The only rock unit in the study site that could yield fossils is the Vryheid Formation that is exposed along the river bed between VW 27 and VW 28.

If fossils are discovered in this area during development, the ECO must follow the Chance Palaeontological Find Procedure as stipulated below and the ECO should contact a palaeontologist for further advice.

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:

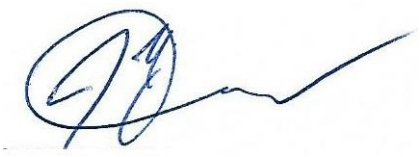
b. Fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:

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.



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