

Proposed development at Petsana, Reitz,  
Free State

**PALAEONTOLOGICAL IMPACT  
ASESSMENT**

For:

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# 1. Executive Summary

The study area is underlain by sedimentary rocks consisting mostly of mudstone and subordinate sandstone, while dolerite is situated in the middle of the study site.

The fact that a dolerite intrusion occurs in the middle of the study site precludes the possibility that fossils will occur in this section and in the areas immediately adjacent to it due to contact thermal metamorphism that occurred in the surrounding mudrock and sandstone.

The geology at the study site is obscured by soil and vegetation and no fossils were found during the site visit. The western and northern sections of the study area, further away from the dolerite intrusion are most vulnerable from a palaeontological perspective and construction should be done with care.

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 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 development of the site 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 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 a 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 from 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 in the Petsana Township of Reitz in the Free State (Fig. 1). 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 lines)

	Lithology	Stratigraphy			Age
Jd	Dolerite				Jurassic
Trt	Fine to medium-grained sandstone, maroon, green and blue mudstone	Tarkastad Subgroup	Beaufort Group	Karoo Supergroup	Triassic
Pne	Olive-green and grey mudstone, subordinate sandstone	Normandien Formation of the Adelaide Subgroup			Permian

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

Part of the northernmost section and the western part of the study site are underlain by the Normandien Formation of the Adelaide Subgroup of the Beaufort Group of the Karoo Supergroup. The Normandien Formation comprise predominantly of olive-green and grey mudstone and subordinate very coarse-grained sandstones that exhibit coarsening upward cycles (see Fig. 2).

The eastern part of the study site is mainly underlain by mudstone, shale and sandstone of the Tarkastad Subgroup of the Beaufort Group of the Karoo Supergroup. The mudstones of the Tarkastad Subgroup are often maroon coloured, compared to the greenish grey mudstones of the underlying Adelaide Subgroup. These sediments were deposited during the early Triassic by meandering rivers (Johnson et al., 2009).

A dolerite intrusion is present in the middle of the study site (see Fig.2).

## 6. Site visit



Figure 3: facing southeast from 27°47'42.83"S 28°27'30.07"E



Figure 4: facing east from 27°48'12.42"S 28°27'51.56"E



Figure 5: facing south from 27°48'12.42"S 28°27'51.56"



Figure 6: facing southwest from 27°48'12.57"S 28°27'53.51"E



Figure 7: facing southwest from 27°48'16.95"S 28°27'47.11"E



Figure 8: facing west from 27°48'20.36"S 28°27'43.24"E



Figure 9: layers of mudstone at: 27°48'25.46"S 28°27'36.04"E



Figure 10: quarry at 27°48'26.99"S 28°27'26.99"E



Figure 11: facing west-southwest from 27°48'33.15"S 28°27'16.70"E



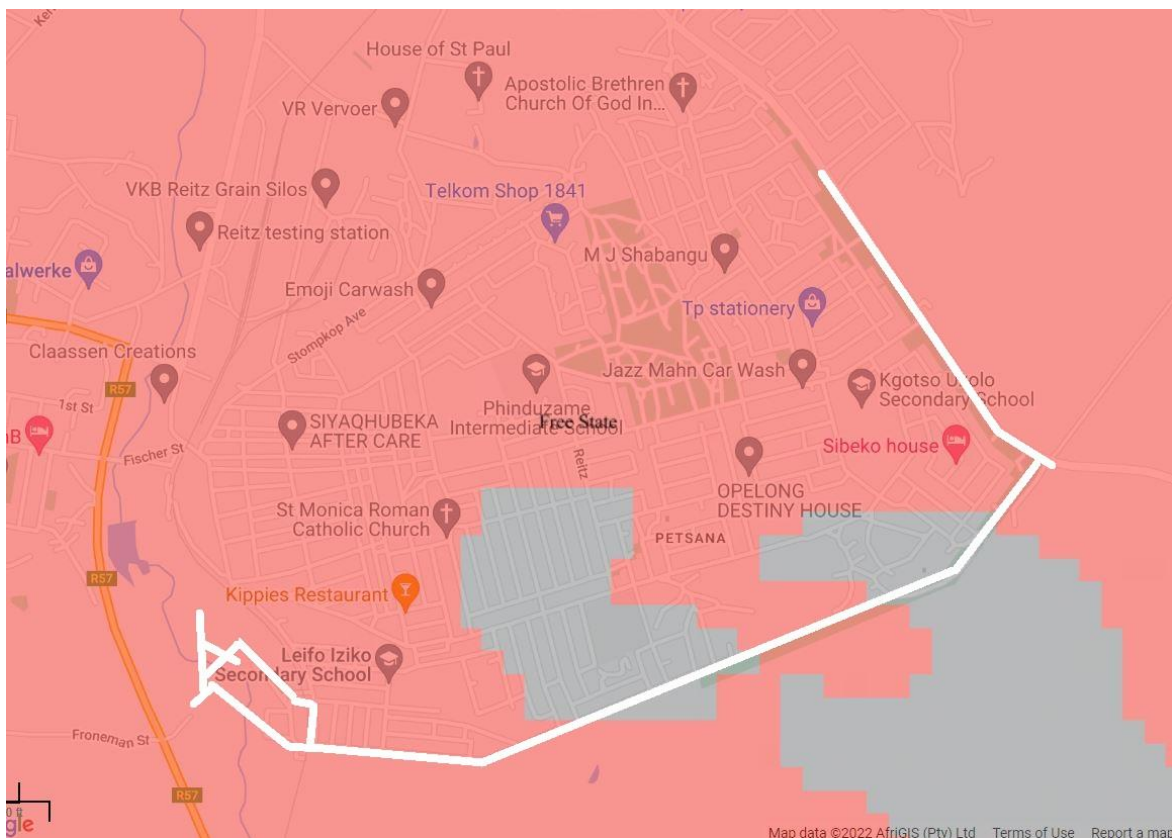
Figure 12: facing west-southwest from 27°48'39.68"S 28°26'48.30"E



Figure 13: facing west from 27°48'38.36"S 28°26'31.46"E

No fossils were discovered during the field assessment. The rocks underlying the study site is mostly covered in soil and grass and few rock exposures were found.

## 7. PALAEONTOLOGICAL ASSESSMENT



(The study site is indicated with the white lines)

**Figure 14: Palaeontological sensitivity map of the study area and surroundings (SAHRA, 2022)**

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

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, river banks, road cuttings and coal mines.

According to the SAHRA Free State Palaeotechnical Report (Groenewald & Groenewald, 2014) the Normandien Formation of the Adelaide Subgroup of the Beaufort Group that occurs in the western and northern parts of the study area, has a Very High Palaeontological Sensitivity. The Normandien Formation is known for rare temnospondyl amphibian (see Fig. 15) and synapsid remains,

insect fossils, plant remains in minor coal seams, petrified wood, organic microfossils (acritarchs), low-diversity marine to non-marine trace fossil assemblages (Groenewald & Groenewald, 2014).



Figure 15: Temnospondyl skull

The study area falls within the *Lystrosaurus* Assemblage Zone (see Fig.8) which is considered to be of a Very High Palaeontological Sensitivity (Groenewald, 2012). The fossils of this assemblage zone in this region include vertebrate skeletal material and fossilised wood.

The *Lystrosaurus* Assemblage Zone is well known for its *Lystrosaurus* fossils (see Fig. 16). *Lystrosaurus* is also the most common fossil of this assemblage zone and hundreds of these have been collected and are stored in fossil repositories around the country. Fossils of other synapsids such as *Moschorhinus* (see Fig. 17) and *Thrinaxodon* (see Fig. 18), the small anapsid *Procolophon* (see Fig. 19), archosaurs such as *Proterosuchus* (see Fig. 20) and the small amphibian *Lydekkerina* are also known from this assemblage zone (Kitching, 1977; Rubidge, 1995; Durand, 2005). Fossil burrows are common in this assemblage zone and are often found in association with *Thrinaxodon*, *Procolophon* and *Lystrosaurus* remains (Groenewald, 1991; Rubidge, 1995).

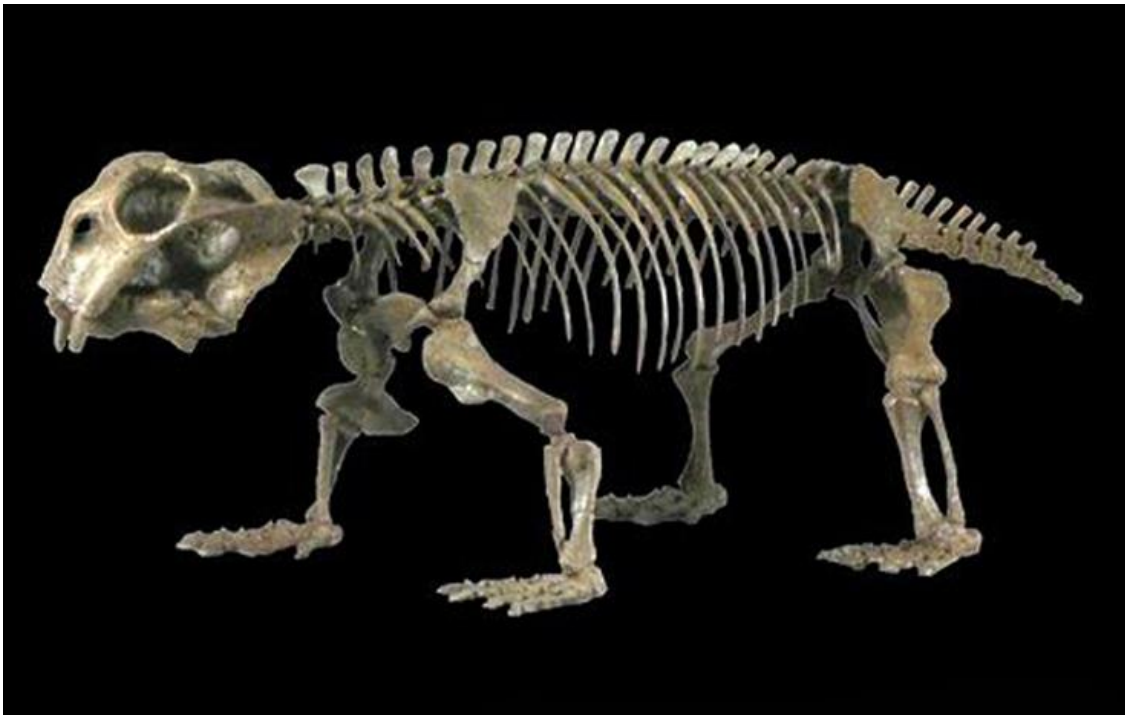


Figure 16: *Lystrosaurus* skeleton



Figure 17: *Moschorhinus* skull



Figure 18: *Thrinaxodon* skeleton



Figure 19: *Procolophon* skull

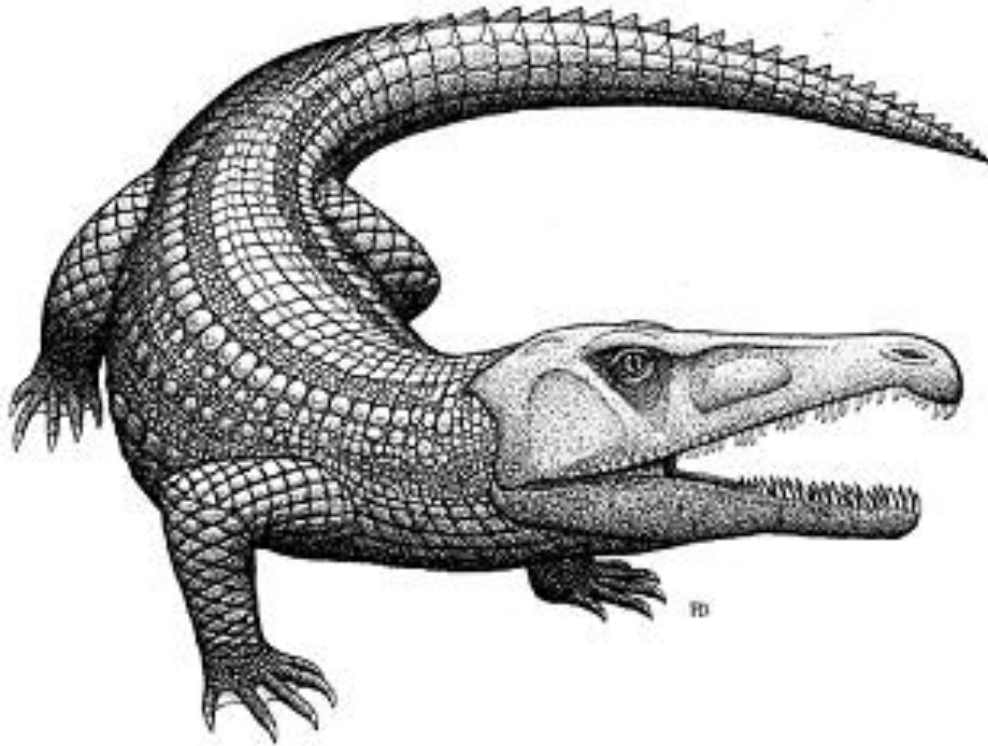


Figure 20: *Proterosuchus* reconstruction (JF. Durand)

## References:

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Kitching, J.W. (1977). The distribution of the Karoo vertebrate fauna. Memoir 1, Bernard Price Institute Palaeontological Research, University Witwatersrand.

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SAHRA (2022). *Palaeosensitivity Map* <http://www.sahra.org.za/sahris/map/palaeo>

## 8. Conclusion and recommendations:

The sedimentary rocks of the Beaufort Group of the Karoo Supergroup are fossiliferous and are considered to have a Very High Palaeontological Sensitivity. Unlike layers containing plant fossils, the fossils of Karoo vertebrates are unevenly distributed and scarce and therefore it is impossible to predict where they will occur within this formation. These fossils are scientifically very important however and should be collected when possible.

The dolerite sill in the middle of the study site precludes the possibility of finding fossils in that area. Contact thermal metamorphism would have destroyed fossils in the mudstone and sandstone adjacent to the dolerite sill and it is therefore improbable that fossils will be found in the mudstone and sandstone in the quarry at 27°48'26.99"S 28°27'26.99"E

The Chance Find Procedure should be followed by the ECO in the event of fossils being uncovered in the rocks underlying the study site, especially in the western and northern sections of the study site:

### **PROCEDURE FOR CHANCE PALAEOLOGICAL 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 construction of the road:

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.

A handwritten signature in blue ink, consisting of a large, stylized 'J' followed by a series of loops and a long horizontal stroke extending to the right.

Palaeontological specialist:

**Dr JF Durand (Sci. Nat.)**

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