Proposed rebuilding of the Orania Strydenburg 22kV line from pole ORST500-80 to pole ORST500-152-2 in the Strydenburg area, adjacent to the N12 in the Northern Cape

PALAEONTOLOGICAL IMPACT ASSESSMENT

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1. Executive Summary

The study site is situated in an area that is considered to be of Very High to High to Moderate Palaeontological Sensitivity.

Southern Africa is world renowned for its rich and scientifically important fossil heritage. The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed.

An overview of the literature on the palaeontology and associated geology of the area is given. Although no publications exist of palaeontological studies that were done in the study area, several palaeontological studies were done in the Northern Cape in the same geological formations that occur in the study area. The results of these studies enable us to predict that these fossiliferous strata exist within the study area due to the association of certain fossils with certain geological strata.

Although the Whitehill Formation was identified near the study site, no fossils were found during the site visit. The geology of the study area is to a great extent covered by a thick layer of sand and vegetation and only limited outcrops of unweathered rock were observed in the two quarries in the study area.

This report points out the probability of finding fossils on the terrain. Recommendations on the minimizing of the impact on palaeontological sites and the treatment of palaeontological objects impacted upon during construction are given. It is imperative that a palaeontologist has to be consulted if fossils are exposed during the development process.

The ECO should take responsibility for supervising the development and should follow the Chance Find Procedure (p. 24-25) if a significant fossil discovery is made.

2. Introduction

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 site visit.

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.

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 type of assessment:

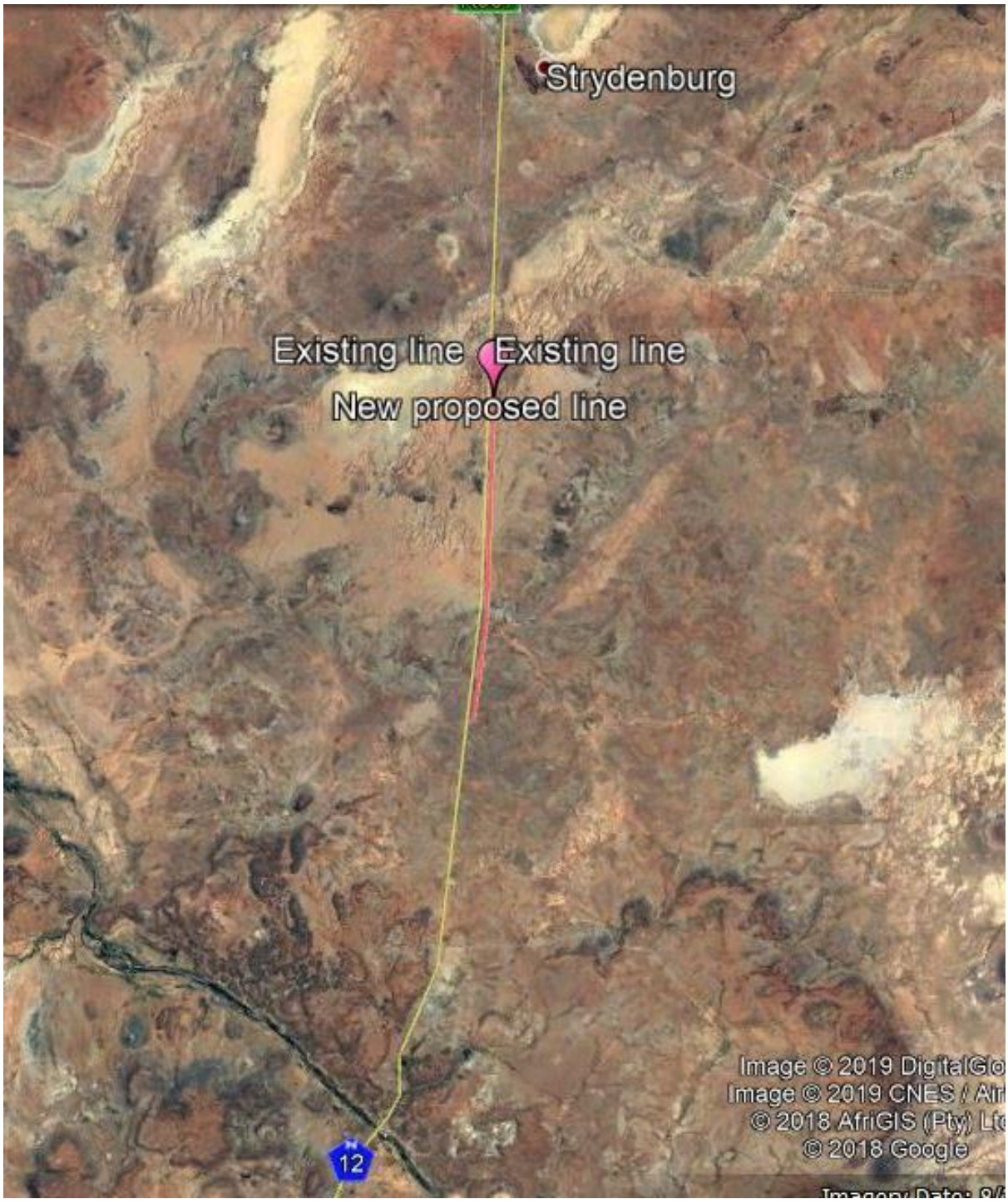
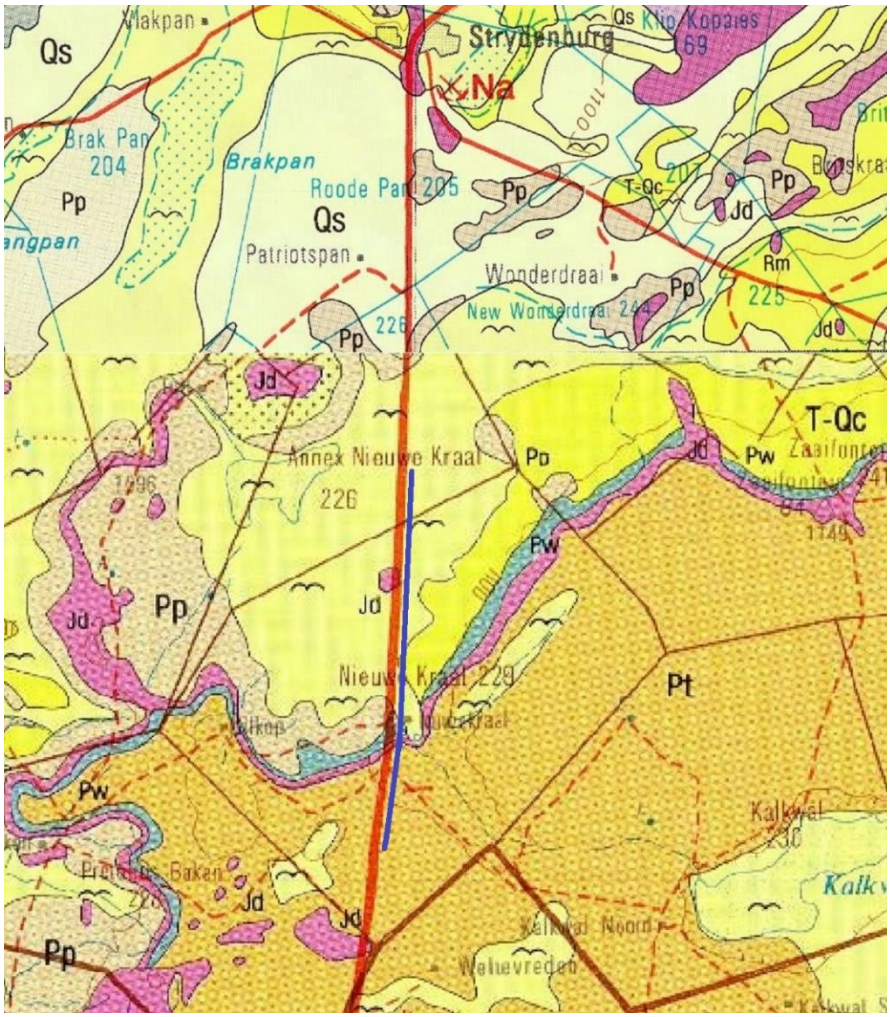


Figure 1: Google Earth photo indicating study site (red line)

The relevant literature and geological maps have been studied and the study site was visited for a Palaeontological Impact Assessment. The area in which the development is planned is relatively flat with sparse vegetation (see Figs. 1, 4-12).

5. Geological setting



(The study area is indicated by the dark blue line)

Figure 2: Geological map of the study site and surroundings (adapted from the 3022 Britstown (lower part) and the 2922 Prieska (upper part) 1:250 000 geology maps (Council for Geoscience; 1991, 1995)

GEOLOGICAL MAP LEGEND

	Lithology	Stratigraphy		Age
	Alluvium			Pleistocene to Recent
Qs	Sands and sandy soil	Gordonia Formation of the Kalahari Group		Quaternary to Recent
T-Qc	Calcrete			Neogene (Late Tertiary)
Jd	Dolerite			Jurassic
Pt	Greenish-weathering shale, subordinate siltstone and sandstone	Tierberg Formation of the Ecca Group	Karoo Supergroup	Permian
Pw	White-weathering black shale	Whitehill Formation of the Ecca Group		
Pp	Brown-red weathering olive-green to dark grey shale and mudstone and siltstone	Prince Albert Frm. of the Ecca Group		

The oldest formation of in the study area is the Prince Albert Formation that is confined to the southwestern half of the Karoo Basin. The study site is situated in the northern facies of this formation that is characterised by the predominance of greyish to olive-green micaceous shale and grey silty shale, as well as a pronounced transition to the underlying glacial deposits. Dark-grey to black carbonaceous shale and fine-to medium-grained feldspathic arenite and wacke are also present. Brownish calcareous concretions and irregular carbonate bodies are present in both the sandstones and mudrocks (Johnson *et al*., 2009).

The Whitehill Formation overlies the Prince Albert Formation. It is characterised by carbonaceous, pyrite-bearing mudrocks that weather white on the surface while the subsurface rocks are black (Figs. 7 & 14). Thin tuffaceous beds occur sporadically, while ferruginous carbonate concretions are dispersed throughout the formation (Johnson *et al*., 2009).

The Tierberg Formation which forms the youngest sedimentary rock formation of the Karoo Supergroup in the study area is a predominantly argillaceous succession that rest with a sharp contact on the Whitehill Formation. The Tierberg Formation comprises mostly of well-laminated, dark shale. Tuffaceous beds occur in the lower part of the succession, while calcareous concretions are common towards the top of the formation (Johnson *et al*., 2009).

The study area is situated on Late Tertiary calcretes and Quaternary alluvium that were set down on the Permian- aged sedimentary rocks of the Ecca Group of the Karoo Supergroup. Other sedimentary and geological features in the direct vicinity include the unconsolidated aeolian sands of the Gordonia Formation (Partridge *et al*., 2009). Pockets of ancient alluvial gravels and younger alluvial sediments occur in the vicinity.

6. Site Visit

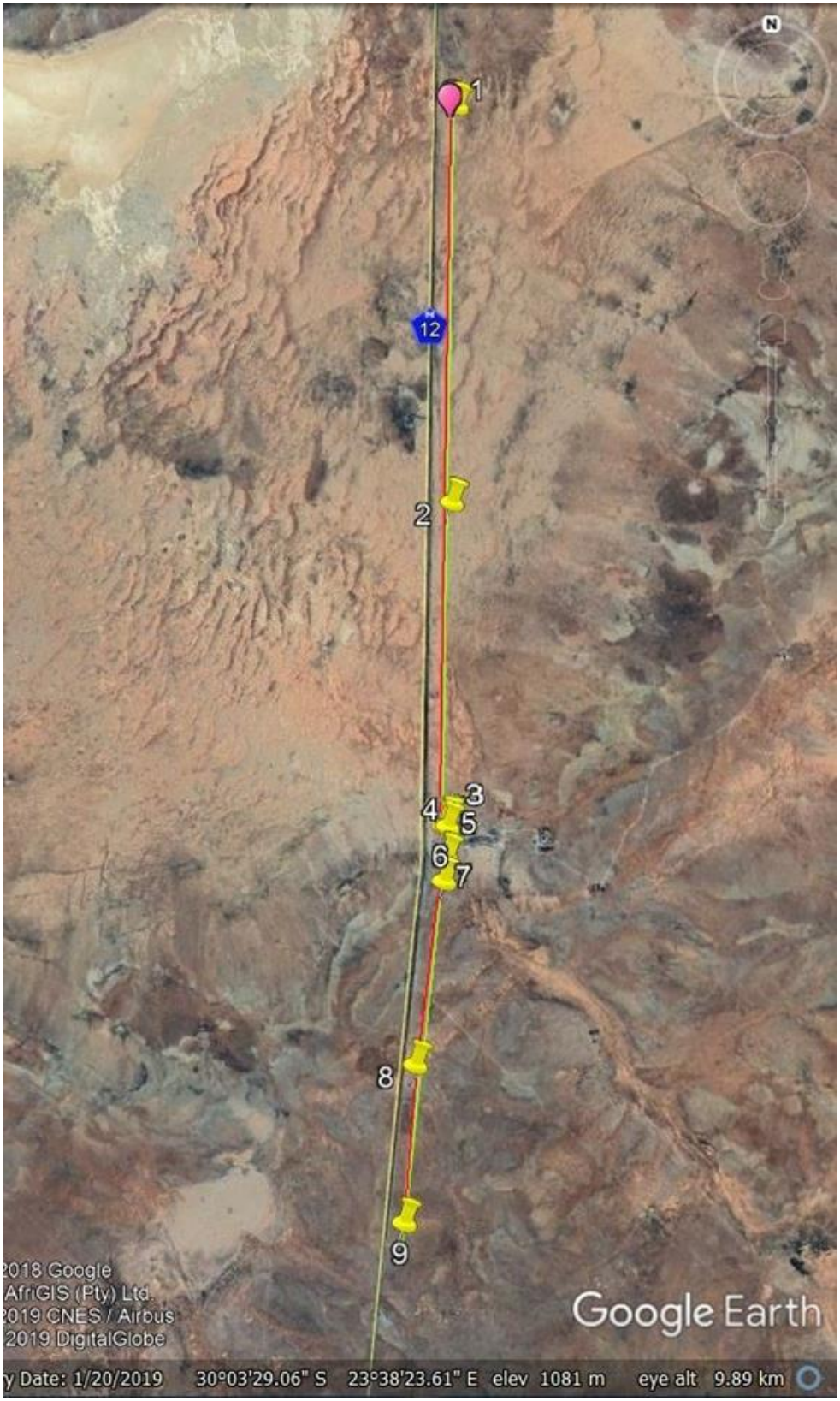


Figure 3: Picture sites

Figure 4: Site 1 facing south

Figure 5: Site 2 soil and vegetation

Figure 6: Site 3 facing north

Figure 7: Site 4 quarry showing Whitehill Formation shale (30°04'11.0"S 23°39'57.75"E)

Figure 8: Site 5 dolerite (30°04'0.1"S 23°39'56.9"E)

Figure 9: Site 6 facing south

Figure 10: Site 7 facing south

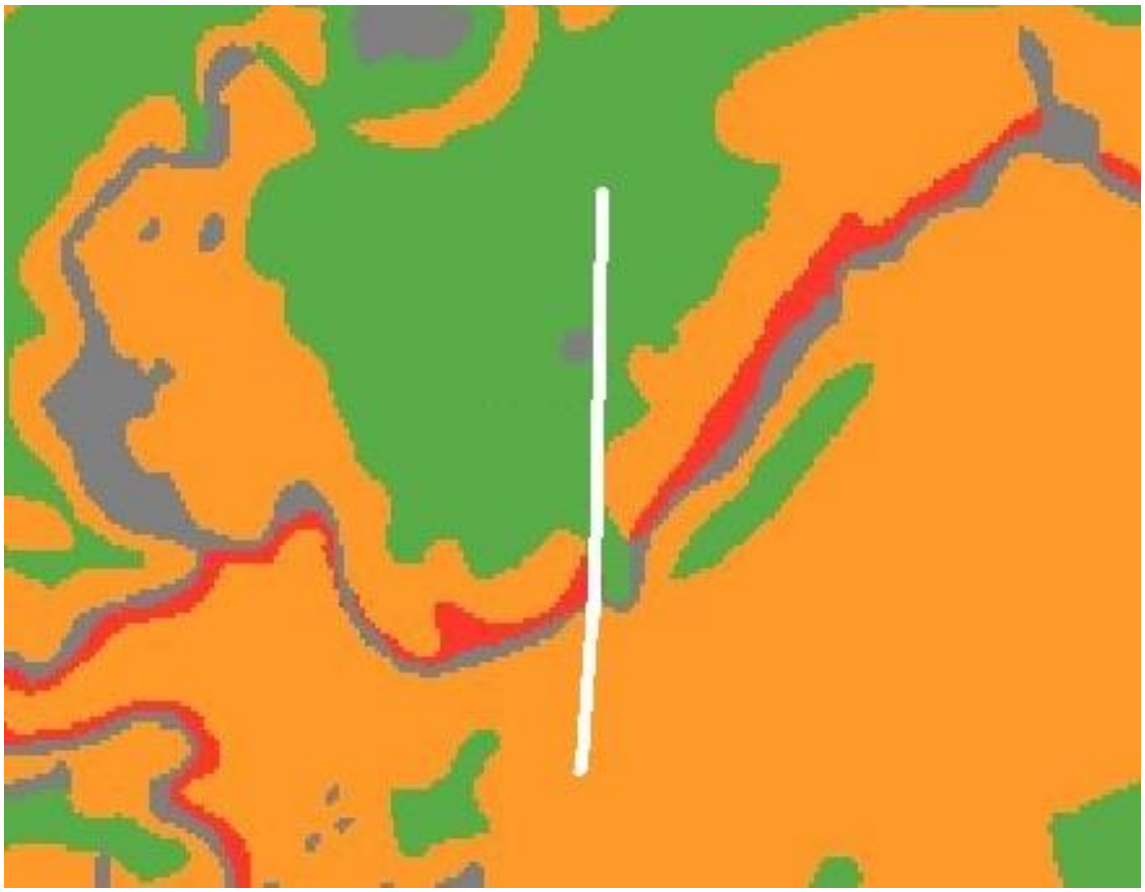
Figure 11: Site 8 Quarry (30°04'48.37"S 23°39'48.62"E)

Figure 12: Site 9 facing north

Figure 13: Detail of central area of study site

Figure 14: Whitehill Formation shale at Site 4

7. Palaeontological assessment of the study site



(The study area is indicated with the white line)

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.

Figure 15: Palaeontological sensitivity of the region (SAHRA, 2018)

The Prince Albert Formation is considered to be of Moderate Palaeontological importance (Figs. 2 & 15). Fossils of marine invertebrates such as cephalopods, lamellibranchs and brachiopods, vertebrates such as sharks and palaeoniscoid fish (see Fig. 4), plants (petrified wood and palynomorphs) and trace fossils (worm burrows, fish tracks and coprolites) have been found near the base of this formation in the vicinity of Douglas, north of the study site (Almond & Pether, 2008; Johnson *et al.*, 2009).

Figure 16: The palaeoniscoid fish *Ichnolepis bancrofti* (SAM-9338, iZiko South African Museum)

The Whitehill Formation is regarded as having a Very High Palaeontological Sensitivity (see Figs. 2 & 15). Fossils of a variety of palaeoniscoid fish (Fig. 16) and arthropods such as *Notocaris tapscotti* (Fig. 17) are common in the Whitehill Formation. This formation is famous for the fossils of the swimming reptile *Mesosaurus* (Fig. 18) that also occur in South America (Oelofsen & Araujo, 1987). Rare insect wings (Fig. 19) and cephalochordates have also been found in this formation. Palynomorphs, petrified wood and other sparse vascular plant remains such as *Glossopteris* leaves and lycopods have been found in this formation (Almond & Pether, 2008; Johnson *et al*., 2009).

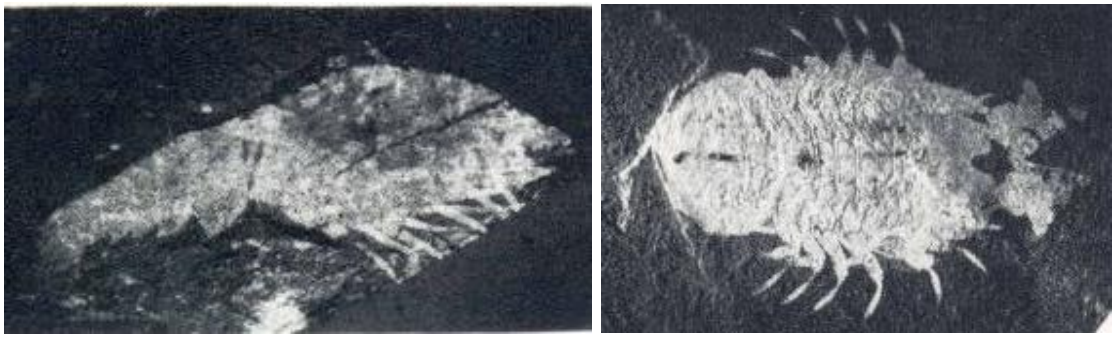


Figure 17: Fossils of the crustacean *Notocaris tapscotti* from the Whitehill Formation (adapted from: Kensley, 1974)

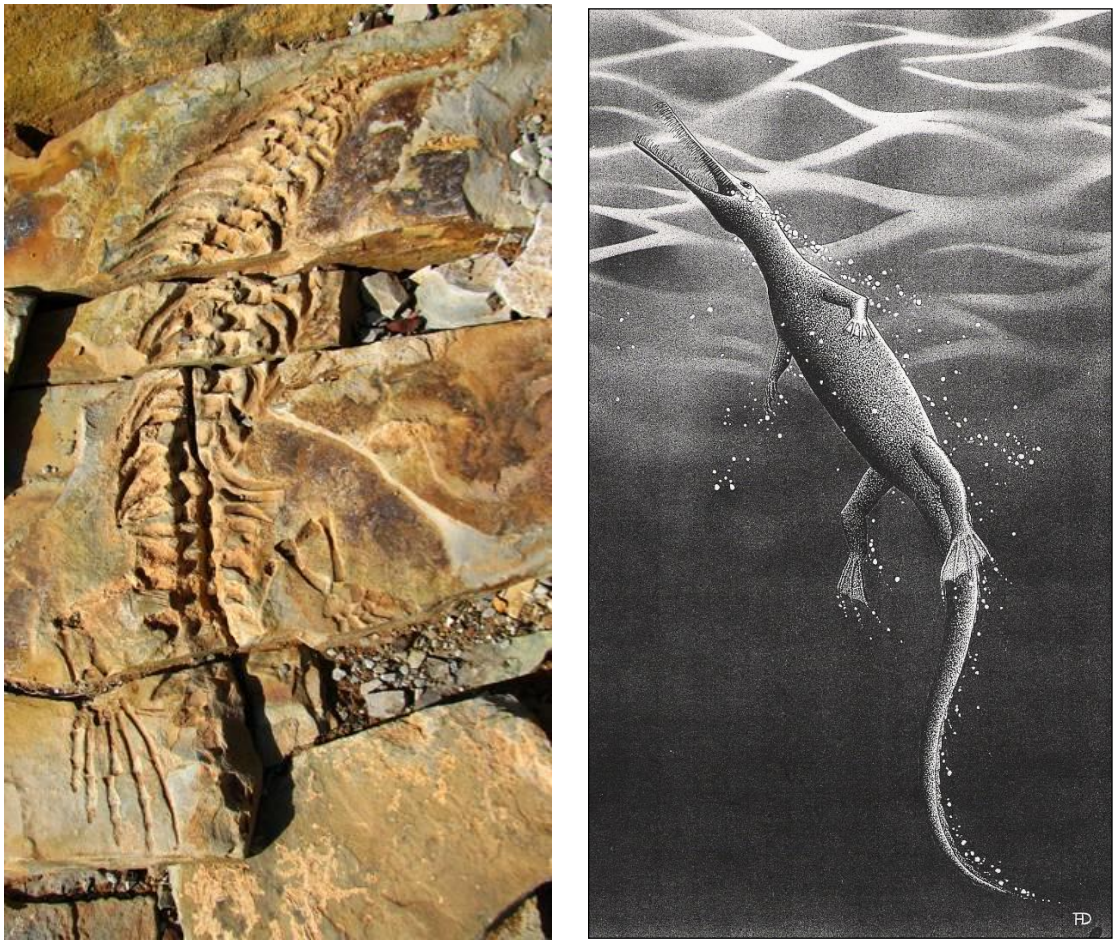


Figure 18: *Mesosaurus* fossil skeleton (left) and reconstruction (right)

Figure 19: Paraplecopteran insect wing fragments from the Whitehill Formation (adaped from (McLachlan & Anderson, 1977)

The Tierberg Formation is considered to be of Moderate Palaeontological Sensitivity (see Figs. 2 & 15). Disarticulated microvertebrate remains such as fish teeth and scales may be found in some of the concretions (Potgieter, 1974). Invertebrate remains in this formation include sponge spicules. Trace fossils such as *Nereites* (see Fig. 20) and *Planolites* (see Fig. 21) are common. Plants are represented by leaf imprints and petrified wood (Almond & Pether, 2008; Johnson et al., 2009).

Figure 20: *Nereites* (https://www.maine.gov/dacf/mgs/explore/fossils/bedrock/trace.htm)

Figure 21: *Planolites* (http://ichnology.ku.edu/invertebrate_traces/tfimages/planolites.html)

The fossil record of the Tertiary to Recent sediments that constitute the Gordonia Formation and the surface calcrete is sparse, occurs sporadically and is low in diversity. The fossils that have been discovered in the Tertiary to Recent calcretes in the area 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).

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Oelofsen, B.W. & Araujo, D. (1987). *Mesosaurus tenuidens* and *Stereosternum tumidum* from the Permian Gondwana of both southern Arica and South America. *South African Journal of Science* 83: 370-372.

Partridge, T.C., Botha, G.A. & Haddon, I.G. (2009). Cenozoic deposits of the interior. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The geology of South Africa*, pp. 585-604. Geological Society of South Africa, Johannesburg.

Potgieter, G.J.A. (1974). The geology of an area south of Kimberley. Unpublished MSc dissertation, University of the OFS, Bloemfontein.

8. Conclusion and recommendations:

No fossils were found during the site visit. The study area is largely covered by sandy soil and sparse vegetation and there are few outcrops along the study site. The presence of the Whitehill Formation shales in a quarry adjacent to the study site was confirmed however. It is inevitable that this very highly sensitive formation will be encountered during development especially around 30°04'00.05"S 23°39'58.1"E. Regardless of the sensitivity of the geological formations encountered at the study site, fossils are not common and there is a low chance of finding any during this type of construction. If any fossils are found during development however, the ECO should take the following steps:

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:
Dr JF Durand (Sci. Nat.)
BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP), Higher Education Diploma (RAU), PhD Palaeontology (WITS)