

**PHASE 1 PALAEOLOGICAL
ASSESSMENT OF THE PROPOSED
DEVELOPMENT OF THE MAANHAARBERG
132kV POWER LINE REFERRED TO AS THE
HYDRA-PHIRI LINE AT DE AAR,
EMTHANJENI LOCAL MUNICIPALITY,
PIXLEY KA SEME DISTRICT MUNICIPALITY,
NORTHERN CAPE PROVINCE**

FOR

**LONGYUAN MULILO DE AAR WIND
POWER**

DATE: 23 March 2017

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Longyuan Mulilo to undertake a Phase 1 Palaeontological Survey, assessing the potential palaeontology impact of the 132kV overhead power line connecting the Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility to the Eskom national transmission grid at Hydra Substation (referred to as the Hydro-Phiri Line) in the Emthanjeni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape Province.

This report complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the upgrade development.

Legal Requirements

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

The development site for the proposed 132kV overhead Hydra-Phiri power line development to connect the Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility to the Hydra Substation is underlain by Permian aged sedimentary rocks of the Ecca and Beaufort Groups as well as Dolerite of the Karoo Supergroup as well as large sections underlain by Quaternary aged windblown sand and alluvium.

Several poorly defined fossils were observed during the field investigation. The potential for finding significant fossils in any excavation into sediments of the Ecca and Beaufort Groups is high. No fossils will be associated with areas underlain by dolerite.

In conclusion:

- The ECO and EOs have been informed of the fact that a High Palaeontological sensitivity was allocated to the areas of the development underlain by rocks of the Ecca Group and a Very High Palaeontological sensitivity is allocated to areas underlain by rocks of the Beaufort Group. Although highly weathered, trace and plant fossils were recorded during the Phase 1 field investigation. All areas allocated a red, orange or green colour in Figure 4 have been visited by a suitably qualified Palaeontologist, or an accredited assistant, during excavations of trenches exceeding 1.5m

in depth into sediments of the Ecca and Beaufort Groups. A protocol for the chance find of fossils has been discussed with the ECO on site.

- These recommendations were included in the EMPr of this project.
- No significant fossils were recorded during the construction period for the project and no further mitigation for Palaeontological Heritage is recommended for this development.

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INTRODUCTION

Background

Gideon Groenewald was appointed by Longyuan Mulilo to undertake a Phase 1 Palaeontological Survey, assessing the potential palaeontology impact of the proposed 132kV overhead power line connecting the Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility to the Eskom national transmission grid at Hydra Substation (referred to as the Hydro-Phiri Line).

Legal Requirements

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

Aims and Methodology

A Phase 1 investigation is often the last opportunity to record the fossil heritage within the development footprint. These records are very important to understand the past and form an important part of South Africa's National Estate.

Following the "*SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports*" the aims of the palaeontological impact assessment are:

- to identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assessing the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources; and

- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to the field investigation a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps (3022 Britstown; 3024 Colesberg) in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc) were identified within the study area and the known fossil heritage within each rock unit was inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

Priority palaeontological areas were identified within the development footprint to focus the field investigator's time and resources. The aim of the fieldwork was to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The likely impact of the proposed development on local fossil heritage was determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the minimal extent of bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

Table 1 Palaeontological sensitivity analysis outcome classification

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008, 2009) (Groenewald et al., 2014).	
RED	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
GREEN	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.
BLUE	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on

	<p>significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Minimum requirement is a Phase 1 site inspection and/ or a “Chance Find Protocol” Report. Collection of a representative sample of potential fossiliferous material is recommended.</p>
<p style="text-align: center;">GREY</p>	<p>Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during emplacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits. Minimum requirement is a Phase 1 field investigation and/or a “Chance Find Protocol” Report.</p>

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

Scope and Limitations of the Phase 1 Investigation

The scope of a phase 1 Investigation includes:

- an analysis of the area’s stratigraphy, age and depositional setting of fossil-bearing units;
- a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports;
- data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged);
- where feasible, location and examination of any fossil collections from the study area (e.g. museums); and

- an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The investigation focussed on the bedrock exposure where excavations would most probably require palaeontological monitoring.

The results of the field investigation are used to predict the potential of buried fossil heritage within the development footprint. In some investigations, this involves the examination of similar accessible bedrock exposures, such as road cuttings and quarries, along roads that run parallel to or across the development footprint.

Locality and Proposed Development

The town of De Aar is situated in the Emthanjeni Municipality of the Pixley ka Seme District in the Northern Cape. Numerous renewable energy projects are proposed for the De Aar area. The Hydra-Phiri line is constructed towards the south of De Aar.

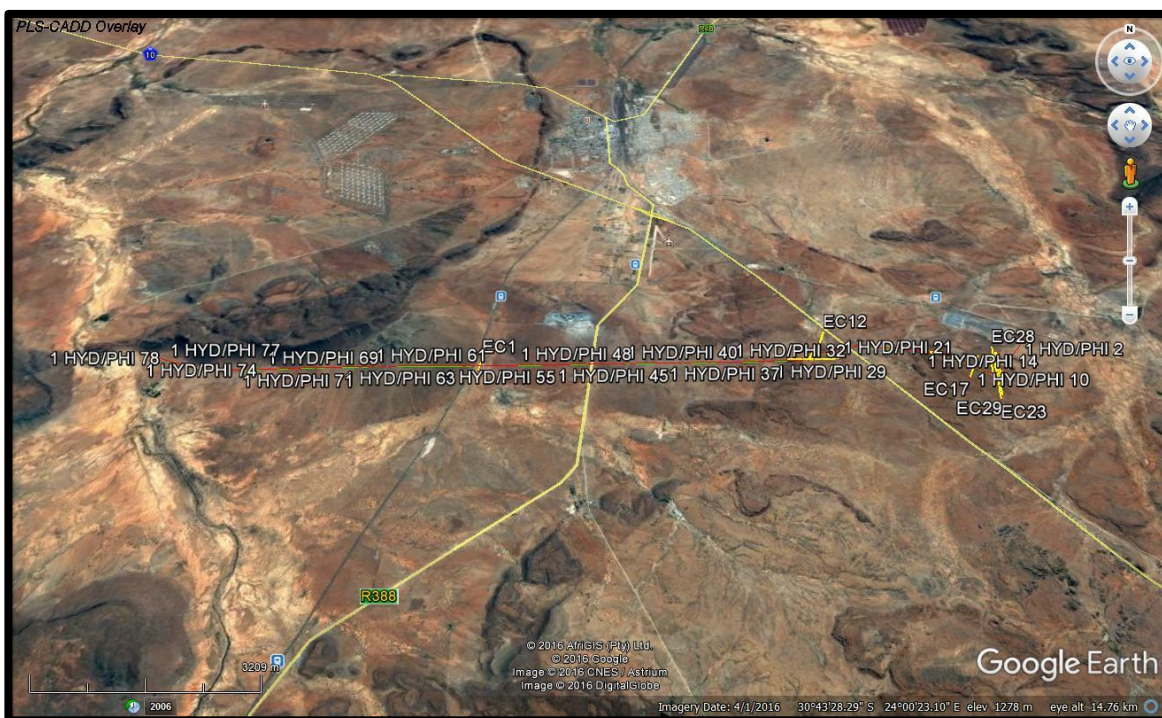


Figure 1 Layout of the 132kV Hydra-Phiri line south of De Aar.

The line will be constructed from steel monopole poles. These poles weigh approximately 1 200 kg each and vary in height from approximately 17.4m to 21m. The size of the footprint depends on the type of pole, i.e. whether it is a self-

supporting, guyed suspension or an angle strain pole structure. The size of the footprint ranges from 0.49m² to 3.61m², with the larger footprint associated with the guyed suspension and angle strain pole used as bend/strain structures.

The average span between two towers is 200m, but can vary between 250m and 375m depending on the ground profile (topography) and the terrain to be spanned. The self-supporting structure (suspension pole) is typically used along the straight sections of the power line, while the guyed intermediate or guyed suspension and angle strain structures are used where there is a bend in the power line alignment. The servitude width for a 132 kV Sub-transmission line is 31m. Existing roads will be used and 4x4 jeep tracks will only be developed for access to the transmission route where no roads currently exist.

The final tower sizes and positions were confirmed following Environmental Authorisation and after negotiations with landowners.

GEOLOGY

The study area is mainly underlain by Permian sedimentary rocks of the Karoo Supergroup (Figure 2). These Permian sedimentary rocks are classified as the Tierberg Formation (Pt) of the Ecca Group of the Karoo Supergroup and the Abramskraal Formation (Pa) of the Adelaide Subgroup of the Beaufort Group, Karoo Supergroup. Jurassic Dolerite (Jd) sills dominate the hilltops while the low laying areas consist of recent Quaternary (^) Alluvium deposits.

The Tierberg Formation

The Tierberg Formation (Pt) is interpreted as offshore non-marine mudrocks with distal turbidite beds, prodeltaic sediments and represented by greenish weathering shale with subordinated siltstone and sandstone (Johnson *et al*, 2006).

The Abramskraal Formation

The Abramskraal Formation (Pa) is interpreted as fluvial sediments with channel sandstones (meandering rivers), thin mudflake conglomerates interbedded with floodplain mudrocks (grey-green, purplish), pedogenic calcretes, playa lake and pond deposits and occasional reworked volcanic ashes (Johnson *et al*, 2006 and Almond & Pether, 2008). The Abramskraal Formation is represented by blue-grey mudstone, sandstone and siltstone.

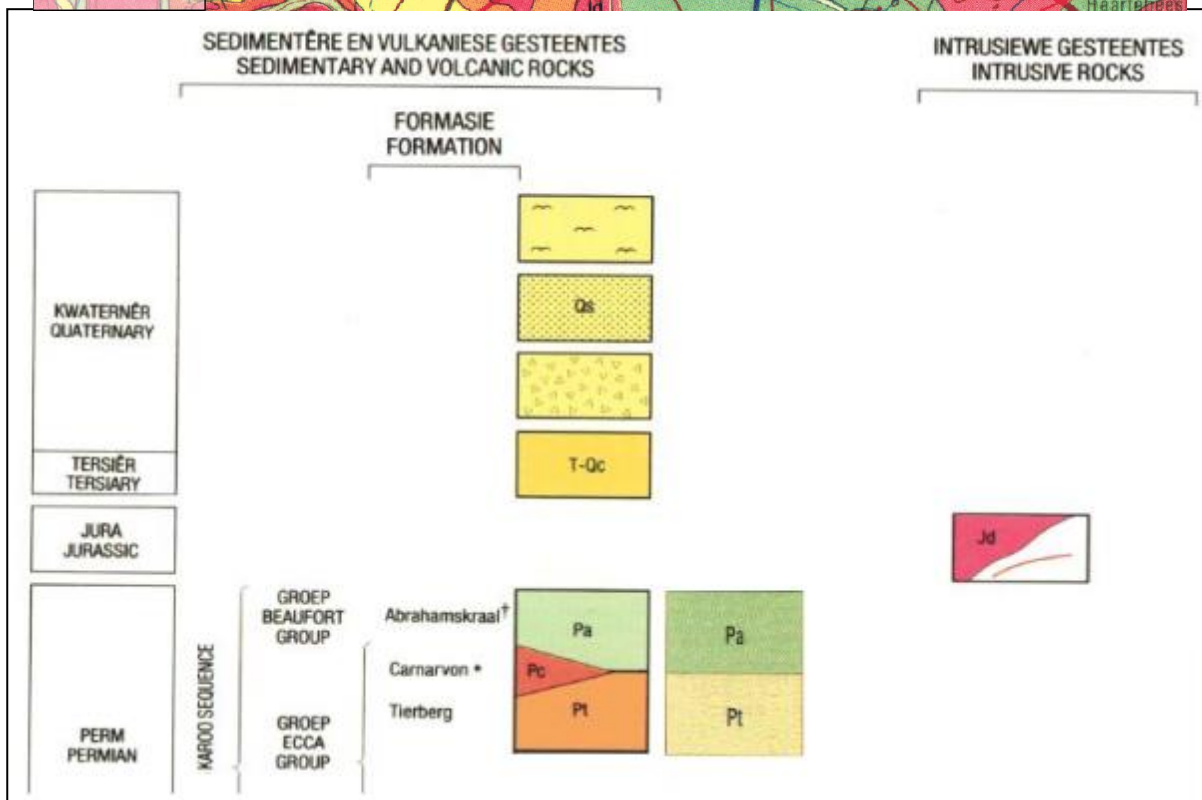
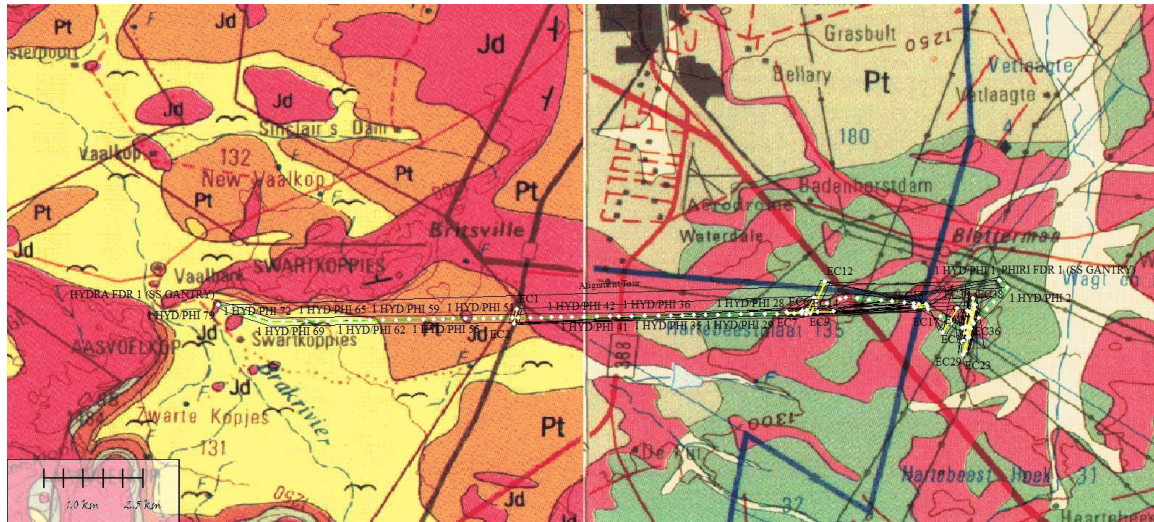


Figure 2 Geology of the Study Area

Karoo Dolerite

Dolerite (Jd) is a very hard igneous rock that intruded the sedimentary layers and can occur either as sills or dykes. Sills can be from a few meters to tens of meters thick.

Quaternary Deposits

The Quaternary Deposits consist of alluvial deposits, deposited by rivers in the valley floors.

PALAEONTOLOGY

PRELIMINARY ASSESSMENT RESULTS

The palaeontological sensitivity was predicted after identifying potentially fossiliferous rock units; ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself (Desktop PIA, 2012). The palaeontological sensitivity was predicted as highly significant, due to the potential abundance of Permian aged fossils, including trace, plant, invertebrate and vertebrate fossils, in the Ecca and Beaufort Groups.

FIELD INVESTIGATION

Dr. Gideon Groenewald, experienced fieldworker, visited the site of the proposed Hydro-Phiri Power line in the Emthanjeni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape Province on 17 to 19 August 2016 and again on 6 and 8 September 2016. The topography of the area is mostly rugged mountains sides, and relatively flat “table mountain” topography where hills are capped with resistant dolerite sill outcrops. The site of the proposed development is on all landform terrains of the landscape, varying from crests, middle slopes to footslopes and valley floors where large parts of the land surface is in some way or another altered by human development. This includes road infrastructure, informal housing development, ploughed fields, etc.

The soil cover vary from shallow to very deep Avalon, Hutton and Clovelly soil forms to deep Estcourt, Rensburg and Valsrivier soil forms on the middle and footslopes to mostly Dundee soils in the valley floors. Wetlands are commonly associated with dolerite sill features and seepages are in some places displayed during the wet season. Weathering is in most cases shallow, leading to the exposure of fossil material.

Excavations for the new development will expose mostly siltstone and shale of the Ecca and Beaufort Groups and it is highly likely that significant fossils will be exposed in the mudstone layers. This includes the illusive insect remains that abounds in these rocks, but could not be found during this field session, mostly because of time constraints. The presence of the well-defined mudstone layers

with carbonaceous layers as well as confirmation of the exposure of green mudstone, is a clear indication of the possible presence of insect remains and the “Chance Find Protocol” will include the procedures that the contractor must follow to record these important finds.

Observations were recorded at different GPS stations (Figure 3 and Table 2).

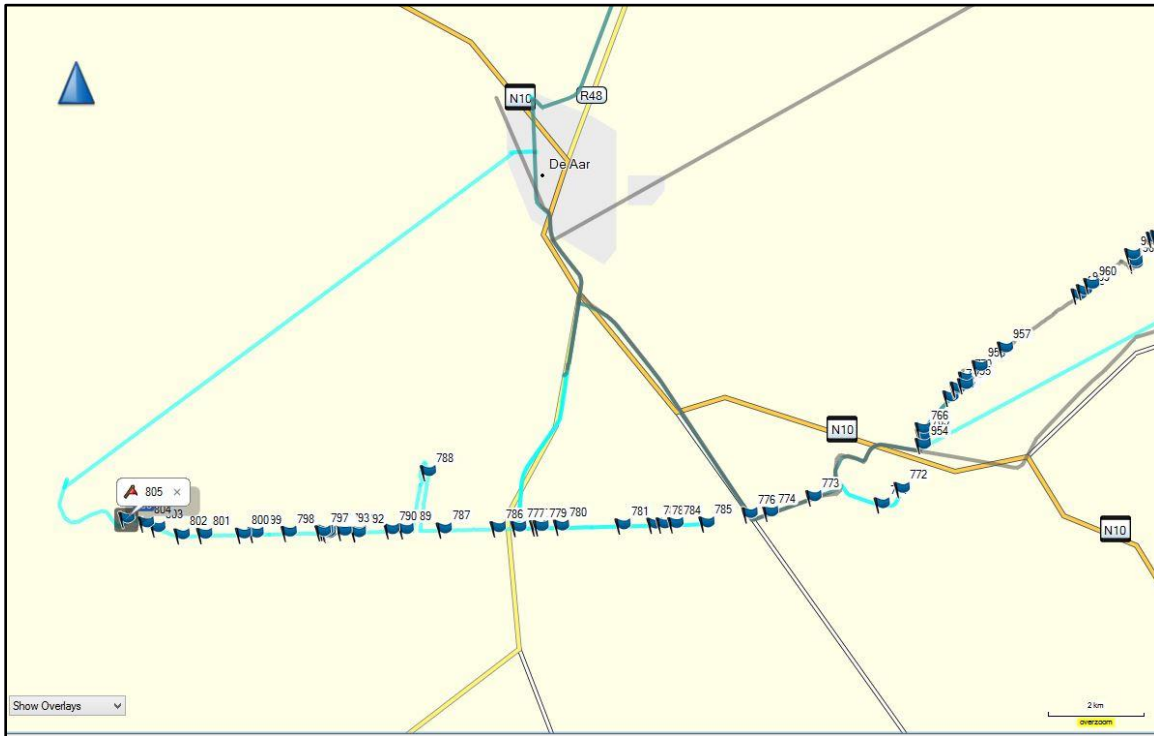









Figure 3 Observation GPS points with photographic recording of information (Table 2)





For reference to observation points the study area is enlarged to allow for numbers of GPS stations to be revealed in the figures. The GPS points indicate specific points where outcrops of shale and sandstone were investigated for the presence of fossils. Weathering is not very deep (<1m) and outcrops of suitable rocks for finding of fossils are well preserved. It is however important to note that the areas indicated as having a moderate to high potential to reveal significant Palaeontological Heritage need to be noted by the ECO, Conco EO and Longyuan EO. Detailed inspection of all excavations was not possible as time spent on site did not allow for timeous investigations of all excavations. These areas will need careful inspection during the construction phase. A methodology statement was communicated to the ECO and the Environmental team of this project.





Table 2 attempts to give the reader an overview of the outcrop characteristics of the inspection points discussed. The most important points for inspection by the ECO was discussed on site, with photographic illustrations of the kind of outcrop that might reveal significant plant, trace, insect as well as vertebrate fossils in this extremely sensitive geological terrain for Palaeontological Heritage.



Table 2 Record of Photographic Observations. For GPS points see Figure 3.

Photo	(GPS station) Coordinates	Comments	Photographic Record
1	(765) S30° 42.412' E24° 05.932'	Exposure of the Beaufort Group mudstone mostly part of the Adelaide Subgroup and Dicynodon Assemblage Zone. Exposure of bedrock will be restricted to excavation sites and chances of finding fossils are very high. The mudstones are particularly important in terms of the possible presence of vertebrate remains	
2	(766) S30° 42.338' E24° 05.924'	Highly sensitive geological formations with intrusions of dolerite in the foreground where no fossils are expected	
3	(767) S30° 41.986' E24° 06.304'	Deeply exposed sediments of the Beaufort Group with very high potential to find fossils. Due to time constraints little time was spent to collect fossils from these exposures and the ECO and EOs must note these potentially rich fossil beds in the study area	

4	(772) S30° 43.003' E24° 05.636'	Exposure of Beaufort Group sediments with high potential to find fossils. No fossils were observed or collected during this very brief site visit and bedrock is covered in thin layer of red sand.	
5	(777) S30° 43.418' E24° 00.413'	Shallow soils on dolerite outcrops, no fossils expected and no fossils observed	
6	(778) S30° 43.413' E24° 00.671'	Unidentified trace fossils are present in fine-grained sandstone of the Beaufort Group. Weathering is shallow and most of the excavations will reach the bedrock in this region	
7	(782) S30° 43.389' E24° 02.267'	Deep colluvial cover and sand. The ECO and EOs must be aware of the presence of these units and inform the Palaeontologist if fossils are observed.	

8	(783) S30° 43.387' E24° 02.393'	Sandy cover on dolerite. No fossils expected, no fossils observed.	
9	(786) S30° 43.422' E24° 00.133'	Very deep weathering will lead to destruction of fossils. Exposure of bedrock will be unique opportunities to discover new fossils in this region	
10	(787) S30° 43.434' E23° 59.399'	Outcrop of sandstone-rich sediments of the Beaufort Group where fossils of vertebrates are expected during exposure of bedrock	
11	(789) S30° 43.439' E23° 58.878'	Excavation for quarries provide best options for the discovery of new fossils. No outcrop and no fossils observed, but fossils are expected during excavations	

12	(792) S30° 43.473' E23° 58.228'	Excavation for quarries provide best options for the discovery of new fossils. Soil very shallow and excavation into siltstone and mudstone can reveal significant fossils	
13	(794) S30° 43.479' E23° 57.828'	Deformed plant fossils in the shale of the Beaufort Group. These sites can expose significant fossils of wings of insects in this study area. The sandstone and shale beds can contain significant vertebrate fossils.	
14	(796) S30° 43.453' E23° 57.782'	Sandstone contains unidentified trace fossils that indicates shallower water conditions and environments suitable for soft bodied animals to survive in.	
15	(798) S30° 43.464' E23° 57.285'	Relatively deep sand cover on either dolerite or sedimentary rocks. Excavation into bedrock must be monitored by the ECO and all fossils must be reported to the palaeontologist for proper removal and curation.	

16	(799) S30° 43.474' E23° 56.835'	Extensive areas covered in dolerite sill outcrop and sub-outcrop. No fossils expected and no fossils observed	
17	805 S30° 43.302' E23° 55.077'	Deep soil excavations in alluvium and deeply weathered shale where no fossils were observed during the site inspection	

PALAEONTOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the field investigation. The field investigation confirms that the study area is underlain by dark grey shale of the Tierberg Formation, Eccca Group as well as green-grey shale and yellow-brown sandstone of the Abrahamskraal Formation, Beaufort Group. Large areas are also underlain by dolerite sills and windblown sand. Some areas have shallow weathering and fossils might be discovered during excavation of deeper than 1.5m. The larger part of the terrain is wide plains, associated with valley floors of the major spruit systems where deep alluvial sand covers the bedrock. In rare cases the mudstone and sandstone sediments, mostly the green-grey coloured mudstone and yellow sandstone of the Abrahamskraal Formation, are exposed. Excavations of deeper than 1.5m can expose significant fossils in these formations. The potential sites where fossils are expected were indicated to the ECO and the Environmental Officer during on site discussions (Figure 4) and colour coding is explained in Table 1.

No fossils are expected in the dolerites.

The excavations for the construction of the infrastructure for this development will expose some sediments of the Ecca and Beaufort Groups. Due to weathering,

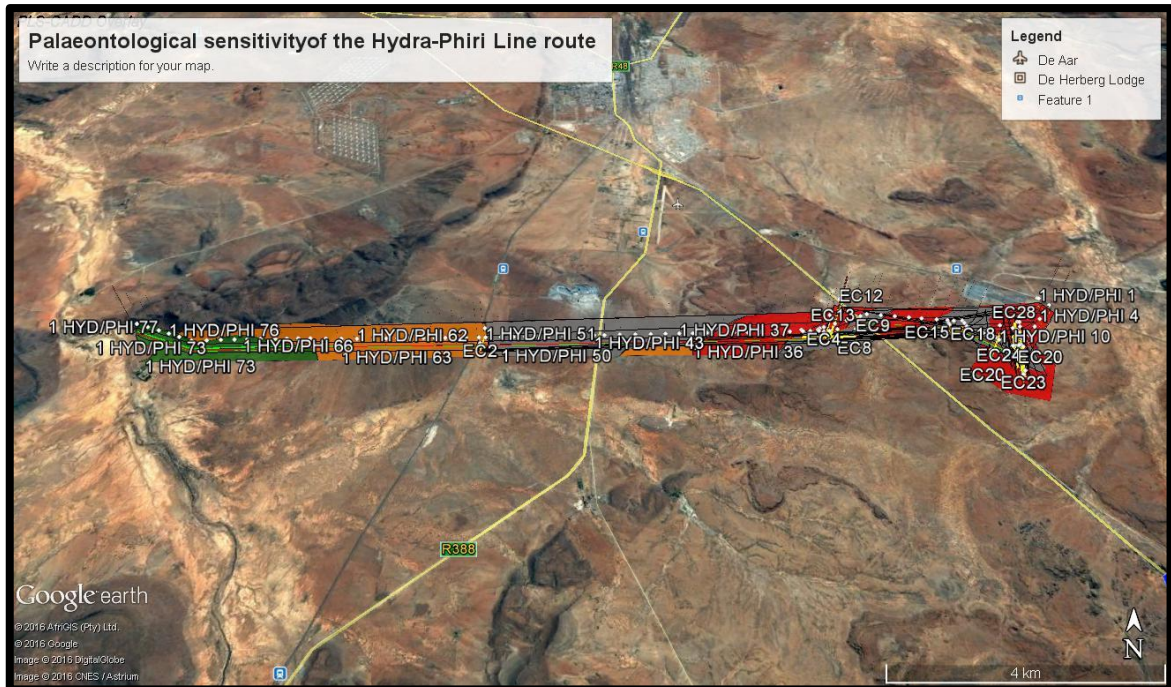


Figure 4 Palaeontological Sensitivity for the area underlying the Hydra-Phiri Line development. For colour coding see Table 1.

no well-preserved fossils were observed during the field investigation.

Exposure of bedrock during excavation might however result in the exposure of significant plant, trace, insect and possibly vertebrate fossils and the high palaeontological sensitivity of the site is restricted to areas underlain by sediments of the Karoo Supergroup. Due to the weathering of the sedimentary rocks and the fact that significant fossils will only be exposed in excavations that exceed 1.5m, the overall Very High significance for Palaeontological Heritage is retained for areas underlain by sediments of the Beaufort Group, whereas the High significance of areas underlain by Ecca shale is also retained.

To ensure that the general discussion on the sensitivity for Palaeontological Heritage can be traced more easily by the reader of this document an attempt was made to refer to specific points of interest in the area studied during the field visit.

CONCLUSION

The development site for the proposed 132kV overhead Hydra-Phiri power line development to connect the Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility at De Aar in the Emthanjeni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape Province, is underlain by Permian aged sedimentary

rocks of the Eccca and Beaufort Groups as well as Dolerite of the Karoo Supergroup as well as large sections underlain by Quaternary aged windblown sand and alluvium.

This Phase 1 Palaeontological Impact Assessment refers to the specific route of the Hydro-Phiri Line towards the southern regions

Several poorly defined fossils were observed during the field investigation. The potential for finding significant fossils in any excavation into sediments of the Eccca and Beaufort Groups is high. No fossils will be associated with areas underlain by dolerite.

In conclusion:

- The ECO and EOs have been informed of the fact that a High Palaeontological sensitivity was allocated to the areas of the development underlain by rocks of the Eccca Group and a Very High Palaeontological sensitivity is allocated to areas underlain by rocks of the Beaufort Group. Although highly weathered, trace and plant fossils were recorded during the Phase 1 field investigation. All areas allocated a red, orange or green colour in Figure 4 have been visited by a suitably qualified Palaeontologist, or an accredited assistant, during excavations of trenches exceeding 1.5m in depth into sediments of the Eccca and Beaufort Groups. A protocol for the chance find of fossils has been discussed with the ECO on site.
- These recommendations were included in the EMPr of this project.
- No significant fossils were recorded during the construction period for the project and no further mitigation for Palaeontological Heritage is recommended for this development.

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeo-ecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.



Dr Gideon Groenewald
Geologist