PHASE 1 PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE CONSTRUCTION OF THE ACWA POWER KHANYISA IPP PROJECT, ASH DISPOSAL SITE AND BULK WATER SUPPLY PIPELINE SOUTH OF EMALAHLENI, EMALAHLENI LOCAL MUNICIPALITY, NKANGALA DISTRICT MUNICIPALITY, MPUMALANGA PROVINCE

For:

HIA CONSULTANTS

AURECON SOUTH AFRICA (PTY) LTD

DATE: 01 March 2017

By

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Aurecon South Africa (Pty) Ltd to undertake a Phase 1 Palaeontological Impact Assessment to confirm the potential Palaeontological Impact of the Construction of the ACWA Power Khanyisa IPP Project and associated Infrastructure, including a Power Plant Site, Ash Disposal Site and Pipeline near eMalahleni in the Emalahleni Local Municipality, Nkangala District Municipality, Mpumalanga Province. The study refers to proposed development areas where the Palaeontology might be impacted on by the construction activities.

This report forms part of the Environmental Impact Assessment and 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 development.

The ACWA Power Khanyisa IPP Project and associated Infrastructure, including a Power Plant Site, Ash Disposal Site and Pipeline near Witbank in the Emalahleni Local Municipality, Nkangala District Municipality, Mpumalanga Province, is underlain by Permian aged sandstone and interbedded shale, with very well developed coal beds of the Vryheid Formation, Ecca Group, Karoo Supergroup. Trace fossils are present in the siltstone layers. Iron enriched plant remains were observed in the sandstones. Very well-defined, but unidentified plant remains, albeit charcoal, is present in the coal samples on site. These plant remains are small and relatively sparse. They are thus not deemed to have a high palaeontological significance. The potential for finding well-defined plant fossils during the exposure of shale beds not associated with high coal grades, still remains very high, and the sections of the study area where sandstone and shale of the Vryheid Formation might be uncovered have thus been allocated a Very High Sensitivity for Palaeontology.

It is recommended that:

1. The EAP and the ECO of the project be informed of the possibility of finding well-defined plant and trace fossils in exposures of rocks of the Vryheid Formation. If fossils are observed they must be recorded and the palaeontologist must be informed of the finds in accordance with the “Chance Find Protocol” (CFP) report that must form part of the EMP of the project.
2. This Phase 1 Palaeontological Impact Assessment and the CFP must be included in the EMPr for the project.

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1. INTRODUCTION

1.1. Background

Gideon Groenewald was appointed by Aurecon South Africa (Pty) Ltd to undertake a Phase 1 Palaeontological Impact Assessment to confirm the potential Palaeontological Impact of the Construction of the ACWA Power Khanyisa IPP Project and associated Infrastructure, which includes a Power Plant Site, Ash Disposal Site and Pipeline near eMalahleni in the Emalahleni Local Municipality, Nkangala District Municipality, Mpumalanga Province. The study refers to proposed development areas where the Palaeontology might be impacted on by the construction activities.

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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;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

1.1. Aims and Methodology

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 identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess 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 (2528 Pretoria; 2628 East Rand) 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. The different sensitivity classes used are explained in Table 1.1 below.

Table 1.1 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 etal.,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. A "Chance Find Protocol" is compulsory for these areas.
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 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. Collection of a representative sample of potential fossiliferous material is recommended.

GREY	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 implacement 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.

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.

1.2. 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) and
- where feasible, examination of fossil collections from the study area (e.g. museums).
- do an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The investigation should focus on the sites where bedrock excavations would definitely require palaeontological monitoring.

The results of the field investigation are then 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.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The project involves the construction of the ACWA Power Khanyisa IPP Project, close to eMalahleni, Mpumalanga Province (Figure 2.1). For details of development design see formal proposals in EIA documentation by Aurecon South Africa (Pty) Ltd.

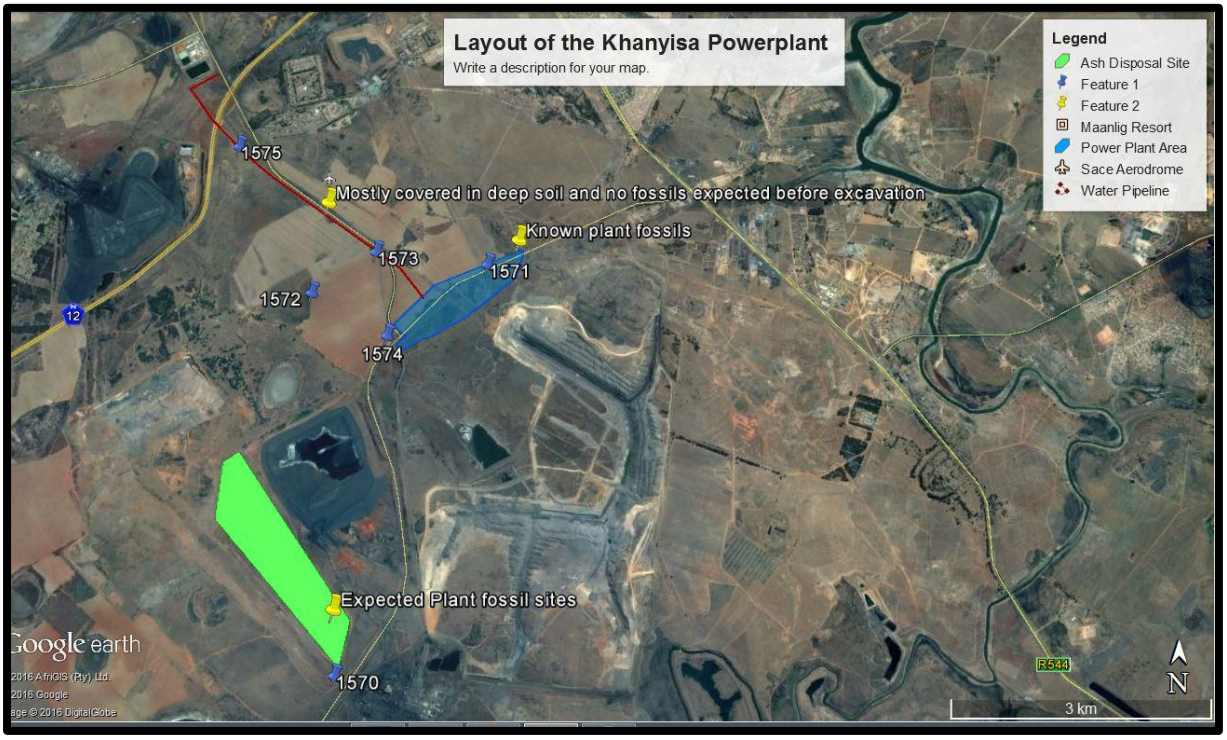


Figure 2.1 Layout of the proposed Khanyisa Power Station Facility with sites for the Ash Disposal, the Power Plant Area and the Water Pipeline

3. GEOLOGY

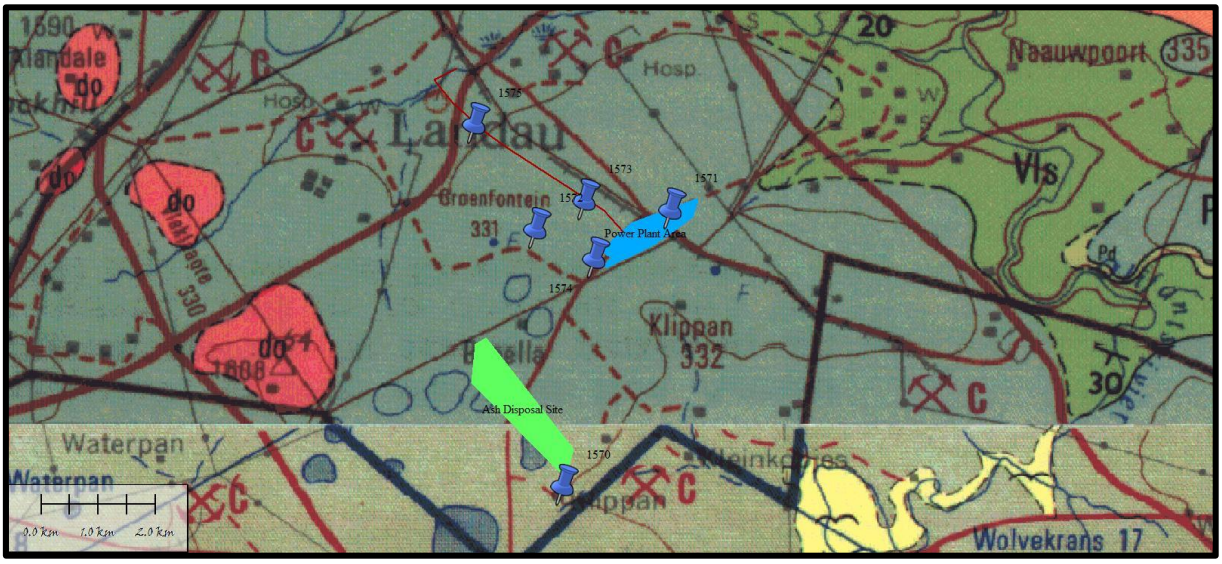


Figure 3.1 The entire site of the development is underlain by rocks of the Vryheid Formation, Ecca Group, Karoo Supergroup.

The study area is underlain by sedimentary rocks of the Permian aged Vryheid Formation (Pv), Ecca Group, Karoo Supergroup (Figure 3.1). The entire study area is covered in soil of up to 2m depth, and this cause a major problem in terms of the identification of significant fossil finds before construction.

3.1. Karoo Supergroup, Ecca Group

3.1.1. Vryheid Formation (Pv)

The Vryheid Formation consists predominantly of grey sandstone with interbedded prominent coal beds and lenses of shale and grit. The sediments are interpreted as having been deposited on a sandy shoreline, beyond which lay vast swamplands. The plant material that accumulated within these swamps formed the coal deposits that are mined today (Johnson et al, 2009).

The lack of outcrops in this part of the Karoo Basin contributes to the lack of information on the palaeontology of the area. Mining of coal beds in the Vryheid Formation however, provides a unique opportunity to study the plant fossils that make up the carbonaceous rock units and this opportunity must be utilized to its full potential during this project development. For details of actions needed to ensure proper management of Palaeontological Heritage, see the "Chance Find Protocol" document prepared for this project.

4. PALAEONTOLOGY OF THE STUDY AREA

4.1. Vryheid Formation

The Vryheid Formation is well-known for the occurrence of coal beds that resulted from the accumulation of plant material over long periods of time. Plant fossils described by Bamford (2011) from the Vryheid Formation are; *Azaniodendron fertile, Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Glossopteris > 20 species, Hirsutum 4 spp., Scutum 4 spp., Ottokaria 3 spp., Estcourtia sp., Arberia 4 spp., Lidgetonnia sp., Noeggerathiopsis sp. and Podocarpidites sp.*

According to Bamford (2011), little data has been published on these potentially fossiliferous deposits. Good fossil material is likely around the coal mines and yet in other areas the exposures may be too poor to be of interest. When they do occur fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites. In the interests of heritage and science, however, such sites should be well recorded, sampled and the fossils kept in a suitable institution.
Although no vertebrate fossils have been recorded from the Vryheid Formation, invertebrate trace fossils have been described in some detail by Mason and Christie (1986). It should be noted, however, that the aquatic reptile, *Mesosaurus*, which is the earliest known reptile from the Karoo Basin, as well as fish (*Palaeoniscus capensis*), have been recorded in equivalent-aged strata in the Whitehill Formation in the southern part of the basin (MacRae, 1999). Indications are that the Whitehill Formation in the main basin might be correlated with the mid-Vryheid Formation. If this assumption proves correct, there is a possibility that Mesosaurus could be found in the Vryheid Formation.

The late Carboniferous to early Jurassic Karoo Supergroup of South Africa includes economically important coal deposits within the Vryheid Formation of Natal. The Karoo sediments are almost entirely lacking in body fossils but ichnofossils (trace fossils) are locally abundant. Modern sedimentological and ichnofaunal studies suggest that the north-eastern part of the Karoo basin was marine. In KwaZulu-Natal a shallow basin margin accommodated a prograding fluviodeltaic complex forming a broad sandy platform on which coal-bearing sediments were deposited. Ichnofossils

include U-burrows (formerly *Corophioides*) which are assigned to ichnogenus *Diplocraterion* (Mason and Christie, 1986).

5. 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. The palaeontological sensitivity of the area underlying the power plant development can be described as significant due to the potential abundance of Permian aged plant fossils known to occur within the Vryheid Formation.

6. FIELD INVESTIGATION

Dr Gideon Groenewald, an experienced and accredited Palaeontologist, visited the site of the ACWA Power Khanyisa IPP Project development as well as the site for the Bulk Water Supply Pipeline connecting the eMalahleni Reclamation Plant with the Power Station on Wednesday 1 March 2017. Well-defined and representative samples of Fossiliferous geological formations were recorded in the vicinity of the development and this report refers to these excavated material as well as the areas where most of the geological outcrops are covered in either deep natural soil or man-made rehabilitation mounds Figure 6.1).

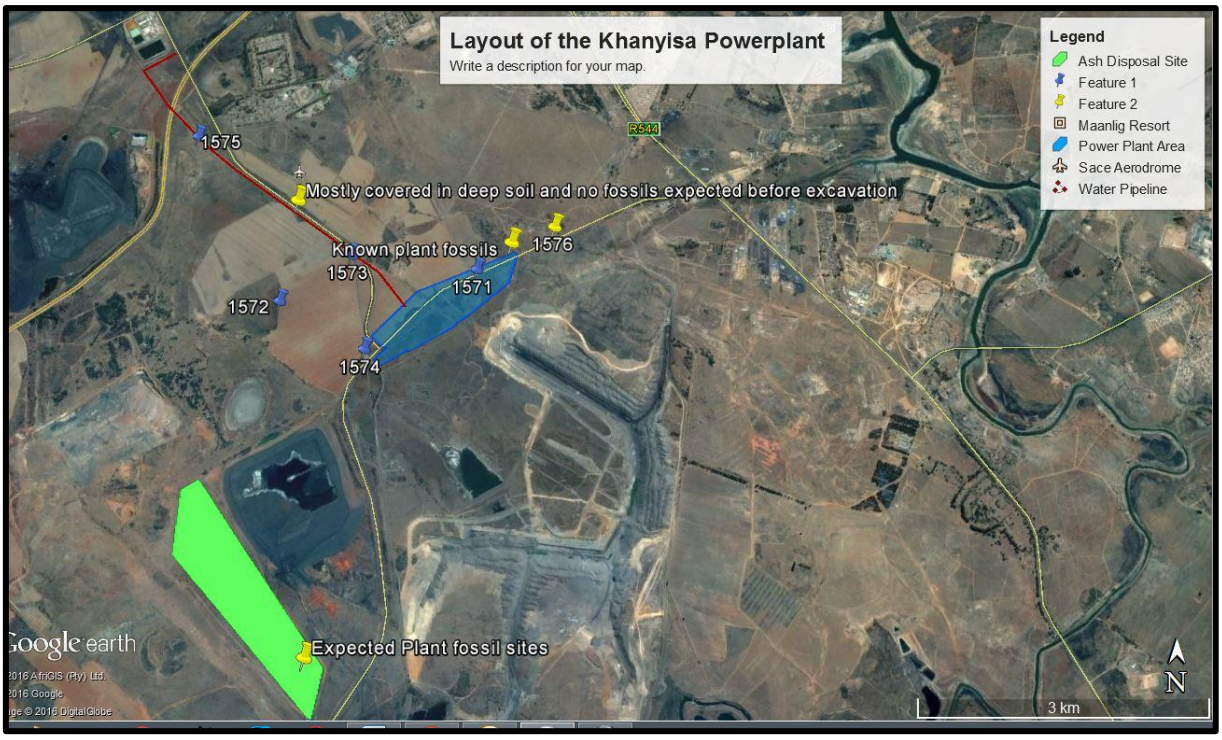


Figure 6.1 Observation points recorded in Table 6.1

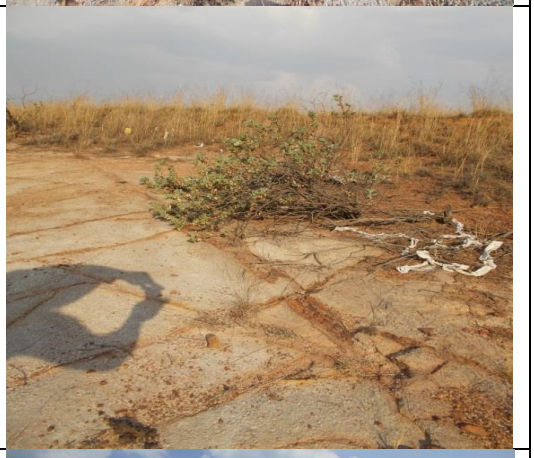
The topography of the study area is undulating, with the coal deposits associated with near horizontal bedding of coarse-grained sandstone and interbedded, dark-grey shales of the Vryheid Formation. Man-made outcrops of Vryheid Formation sandstone and siltstone are present in all the excavations in this region. In the study area the geological formations are covered in relatively deep soils and only a few man-made outcrops were observed in excavation trenches and unwanted shale and sandstone on site. Field observations (Figure 6.1), made during the investigation include:

- Poorly defined trace fossils associated with interbedded siltstone of the Vryheid Formation (Table 6.1). No attempt was made to identify these structures, other than recording them as possible trace fossils resembling *Scolithos* traces.

- Several poorly-defined albeit iron enriched plant fossils were observed in outcrops of the Vryheid Formation sandstone.
- The dumping sites contained coal and carbonaceous shale blocks with very well-defined plant remains. No attempt was made to identify the fossils and a description of how future discovery of these shale deposits with plant remains, must be handled, is discussed in the "Chance Find Protocol" report that must form part of the EMPr of this project.

Table 6.1 Photographic information on site

Photo no	GPS(no) Coordinates	Description	Photograph
1	(1570) S26° 00.569' E29° 12.863'	Man-made outcrops of significant Fossiliferous shale and sandstone in the dump sites where rehabilitation was done	
2	(1570) S26° 00.569' E29° 12.863'	Hand samples of coal with very well-defined plant remains. No attempt was made to identify the plants and the reader is referred to publications by Bamford (2011) for more detailed descriptions of these fossils	
3	(1571) S25° 57.968' E29° 13.881'	Deep soils, no outcrop, no fossils observed. A previous burrow pit that existed in this region revealed partially preserved plant fossils.	

4	(1576) S25° 57' 46.7" E29° 14' 21.1"	Iron oxide cast of fossils wood in Vryheid Sandtone	
5	(1576) S25° 57' 46.7" E29° 14' 21.1"	Casts of plants in sandstone	
6	(1571) S25° 57.968' E29° 13.881'	Deep soils, no outcrop, no fossils observed. A previous burrow pit that existed in this region revealed partially preserved plant fossils.	
7	(1572) S25° 58.155' E29° 12.613'	Deep soils with no outcrop	

8	(1573) S25° 57.883' E29° 13.070'	Deep soils with no outcrop	
9	(1574) S25° 58.436' E29° 13.166'	Deep soils with no outcrop	
10	(1575) S25° 57.167' E29° 12.037'	Deep soils with no outcrop	

7. **PALAEONTOLOGICAL SENSITIVITY AND SIGNIFICANCE**

The desktop study suggests that the study area is underlain by sedimentary deposits of the Permian aged Vryheid Formation of the Ecca Group, Karoo Supergroup. Rocks of the Vryheid Formation are known to be rich in fossils and it was expected that areas underlain by these rocks would thus be Very Highly sensitive from a Palaeontological Heritage perspective. The field investigation results indeed indicate that trace fossils occur in the siltstone layers and iron enriched plant fossils are mainly associated with the sandstone outcrops. Very well-defined fossil plant fossils, albeit in the form of charcoal, is present in the coal beds on site. The extent of exposure of bedrock during construction of infrastructure foundations are however expected to be extensive and it is therefore recommended that the study area is allocated a Very High Palaeontological sensitivity, as illustrated in Figure 7.1, for the areas that still need to be uncovered during the construction process and that any well-defined plant fossils that might be observed during construction be reported to the ECO in accordance with the "Chance Find Protocol" (CFP) report, that forms an Addendum to this Phase 1 PIA report. Recommendations of the Phase 1 PIA as well as the CFP must be included in to EMpr of this project.

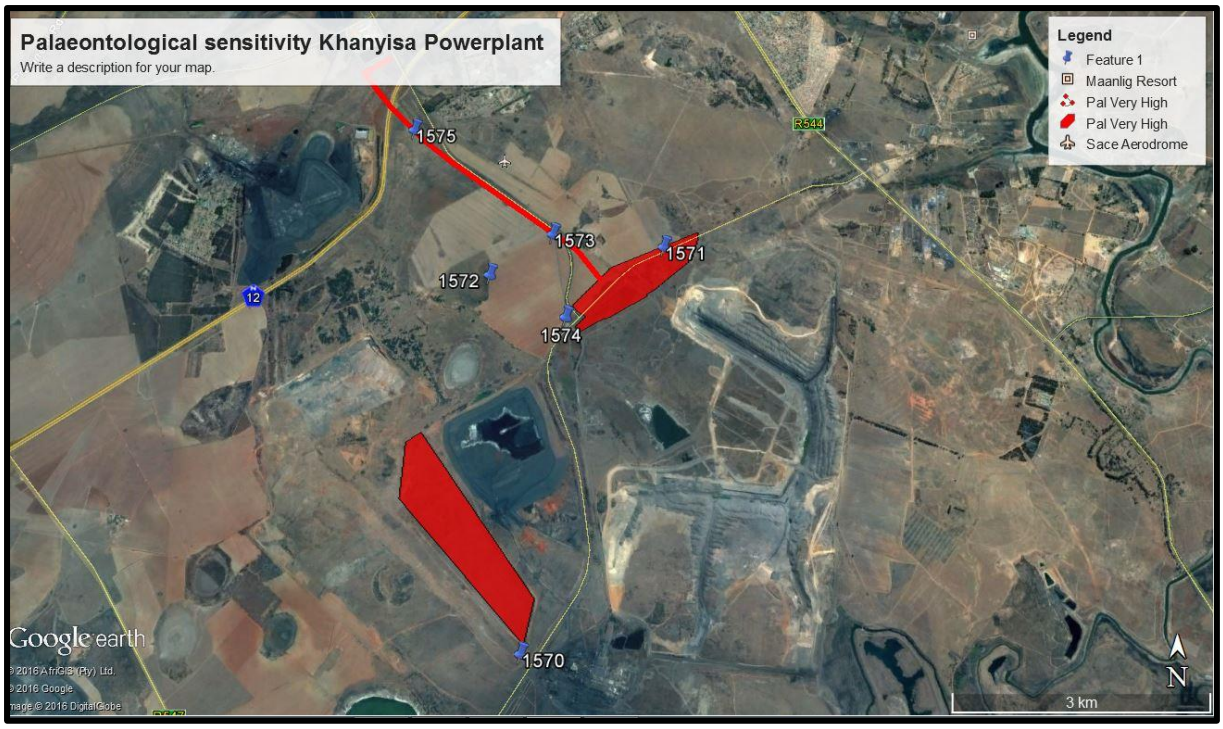


Figure 7.1 Palaeosensitivity of the study area kept as Very Highly sensitive due to nature of development. For explanation of colour coding see Table 1.1

8. CONCLUSION AND RECOMMENDATIONS

The ACWA Power Khanyisa IPP Proejct and associated Infrastructure, which includes a Power Plant Site, Ash Disposal Site and Bulk Water Supply Pipeline near Witbank in the Emalahleni Local Municipality, Nkangala District Municipality, Mpumalanga Province, is underlain by Permian aged sandstone and interbedded shale, with very well developed coal beds of the Vryheid Formation, Ecca Group, Karoo Supergroup. Trace fossils are present in the siltstone layers. Iron enriched plant remains were observed in the sandstones. Very well-defined, but unidentified plant remains, albeit charcoal, is present in the coal samples on site. These plant remains are small and relatively sparse. They are thus not deemed to have a high palaeontological significance. The potential for finding well-defined plant fossils during the exposure of shale beds not associated with high coal grades, still remains very high, and the sections of the study area where sandstone and shale of the Vryheid Formation might be uncovered have thus been allocated a Very High Sensitivity for Palaeontology.

It is recommended that:

3. The EAP and the ECO of the project be informed of the possibility of finding well-defined plant and trace fossils in exposures of rocks of the Vryheid Formation. If fossils are observed they must be recorded and the palaeontologist must be informed of the finds in accordance with the “Chance Find Protocol” (CFP) report that must form part of the EMP of the project.
4. This Phase 1 Palaeontological Impact Assessment and the CFP must be included in the EMPr for the project.

9. REFERENCES

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10. 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 palaeoecological 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).

11. 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