PALAEONTOLOGICAL IMPACT ASSESSMENT (PIA) for

the proposed Hercules, Hartebeesthoek, Jupiter and Roodekraal Solar Energy Facilities (SEF) and Electrical Grid Infrastructure (EGI) near De Aar in the Emthanjeni Local Municipality, Pixley ka Seme District Municipality, Northern Cape Province

FOR

TerraMare Archaeology (Pty) Ltd

Daptocephalus leoniceps - Museum für Naturkunde, Berlin

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Scientific Specialist
Dr Gideon Groenewald, Hon Research Fellow ESI Wits University
Cell: 078 713 6377

EXECUTIVE SUMMARY

Gideon Groenewald was appointed to undertake a Phase 1 Palaeontological Assessment Survey and a site visit for the proposed Hercules, Hartebeesthoek, Jupiter and Roodekraal Solar Energy Facilities (SEF) and associated Electrical Grid Infrastructure (EGI) near De Aar in the Emthanjeni Local Municipality, Pixley ka Seme District Municipality, Northern Cape Province. For the sake of simplicity, the term "**Hercules SEF**" will be used in reference to all the solar PV areas in this discussion document.

This Phase 1 Survey is done to prepare a "Chance Find Protocol" (CFP) document to assist with possible future field visits and to complete a Phase 2 PIA (if required) since large parts of the development site is underlain by geological formations with an inferred very high sensitivity for Palaeontological Heritage (SAHRIS Database).

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 (revised 2017). 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 geology underlying the Hercules, Hartebeesthoek, Jupiter and Roodekraal SEF/EGI development envelopes comprises the Adelaide Subgroup of the Beaufort Group and dolerite of the Karoo Supergroup. Much of the development envelope is covered by deep soils and colluvium. Rocks of the Adelaide Subgroup are world renowned for significant finds of Palaeontological Heritage objects, including highly significant fossils from the *Daptocephalus* AZ.

No well-preserved fossils were recorded in these rock formations during the palaeontological site visit of 14th and 15th September 2024. The conclusion is that the potential for finding significant invertebrate and trace-fossils, in any excavation of more than 1m into sediments of the Adelaide Subgroup, Beaufort Group of the Karoo Supergroup is **high.**

It is however very important to note that, although a high sensitivity rating is allocated to large areas underlain by Adelaide Subgroup geology, the actual impact per site of excavation might be limited. Although it is imperative to indicate the very high sensitivity on the initial maps, the *modus operandi* of the project palaeontologist, when appointed, must be to train the ECO and team members to implement the "Chance Find Protocol". The full-time presence of a professional palaeontologist would be preferred during construction into the areas allocated a red colour, but it might be much less expensive to

train the ECO and project staff to know what to look for during excavation and inform the palaeontologist of a significant find immediately. Fossils recorded during construction must be curated and moved to the institute indicated by SAHRA.

1.1 Recommendations

- The EAP and developer must be informed that significant areas are underlain by rocks with a high sensitivity for palaeontological heritage. The areas underlain by dolerite will have a very low to insignificant sensitivity for palaeontological heritage.
- All excavations that will expose sedimentary strata may contain significant fossils. The appointment of a palaeontologist to do a comprehensive Phase 2 PIA assessment (fossils collection during construction) will be a minimum requirement for monitoring of excavations of more than 1m into the Adelaide Subgroup strata.
- The project will require the implementation of a formal “Chance Find Protocol” that will need to be upgraded during the construction phase of the project.
- Recommendations for palaeontological monitoring and mitigation must be included in the EMPr which must be submitted to SAHRA for comment.

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3 INTRODUCTION

Gideon Groenewald was appointed to undertake a Phase 1 Palaeontological Assessment Survey and a site visit for the proposed Hercules, Hartebeesthoek, Jupiter and Roodekraal Solar Energy Facilities (SEF) and associated Electrical Grid Infrastructure (EGI) near De Aar in the Emthanjeni Local Municipality, Pixley ka Seme District Municipality, Northern Cape Province. For the sake of simplicity, the term "**Hercules SEF**" will be used in reference to all the solar PV areas in this discussion document.

This Phase 1 Survey is done to prepare a "Chance Find Protocol" (CFP) document to assist with possible future field visits and to complete a Phase 2 PIA (if required) since large parts of the development site is underlain by geological formations with an inferred Very High sensitivity for Palaeontological Heritage (SAHRIS Database).

3.1 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 (revised 2017). 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.

4 AIMS AND METHODOLOGY

A Phase 1 site investigation is often the only opportunity to record the fossil heritage within a development envelope. These fossil 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 aim of the palaeontological impact assessment is to:

- Identify exposed and subsurface rock formations that are considered to be palaeontologically significant.
- Assess the level of palaeontological significance of these formations.
- Comment on the impact of the development on these exposed and/or potential fossil resources.
- Make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to a field investigation, a preliminary desktop assessment of the topography and geology of the study area was made using appropriate 1:250 000 geological information (3024 Colesberg) in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc.) were identified 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 wider **"Hercules"** Cluster footprint to focus the field investigator's time and resources. The aim of the desktop survey 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 (Groenewald, 2022).

The likely impact of the proposed development on local fossil heritage is determined based on the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged.

The different sensitivity classes used are explained in Table 3-1 below.

Table 4-1 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., 2009; Almond and Pether, 2009, 2008; Groenewald, 2012; 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 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. At least one site visit by a competent palaeontologist is compulsory. 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 intrusion 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. At least one site visit by a suitably qualified palaeontologist is recommended.

Field work during this survey as well as literature surveys indicated that the rock units that may be exposed by the development of the Hercules SEF/EGI are those of the potentially fossiliferous Adelaide Subgroup, a well-known rock sequence of the Karoo Supergroup that contains highly significant palaeontological heritage (Groenewald D.P., Day O.D., Cameron R. P-C. and Rubidge B.S., 2022; MacRae, 1999; McCarthy and Rubidge, 2005; Rubidge (ed), 1995; Smith et al., 2020; Viglietti et al., 2017).

4.1 Assumptions and Limitations

The scope of the Phase 1 PIA 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.
- Review of 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).

- An on-site investigation to assess the identified palaeontologically sensitive areas within the wider “Hercules” Cluster project area, including a formal palaeontological collection if fossils are of collectable quality. The investigation focuses on bedrock exposures 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 area. In some investigations, including this study, 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 area.

4.2 Locality and Proposed Development

The project comprises the proposed development of the Hercules, Hartebeesthoek, Jupiter and Roodekraal Solar Energy Facilities (SEF) and associated Electrical Grid Infrastructure (EGI) near De Aar in the Emthanjeni Local Municipality, Pixley ka Seme District Municipality, Northern Cape Province.

Within the “**Hercules**” SEF/EGI project development area a project development envelope comprising four smaller areas, has been defined. The assessment below assumes that the PV panels, substation and construction activities will be limited to this development envelope. This assessment also includes the Electric Grid Infrastructure Figure 1) and therefore comprises the total footprint of the electricity distribution from the SEF to the preferred Main Transmission Substation (MTS).

The development envelope is characterised by a variable geomorphological setting. On the one hand, wide Karoo plain landscapes underlain by deep sandy to loamy soils resulting from the weathering of the underlying geology. On the other hand, typical rugged Karoo landscape with isolated koppies (buttes, mesas and table mountains) resulting from differential weathering of dolerite sills.

It is important that the Environmental Assessment Practitioner (EAP) as well as the developer understands the *modus operandi* of palaeontolotgical impact assessments in large projects.

The professional palaeontologist will indicate a very high sensitivity for palaeontological heritage in rock units where there is a very high likelihood of finding significant fossil remains (in this case body fossils of Karoo vertebrates) in an exposed rock outcrop area of 100 m^2 or basically 20 m x 5 m. During fieldwork, this scenario will be duplicated and the entire study area will be scanned for outcrops of fossiliferous rocks. Where significant evidence for vertebrate fossils are recorded in outcrop areas of 100 m^2, the rock unit is

mapped as “very highly sensitive” because it is **very highly likely** that activities associated with the development of the “**Hercules**” SEF will expose significant fossils.

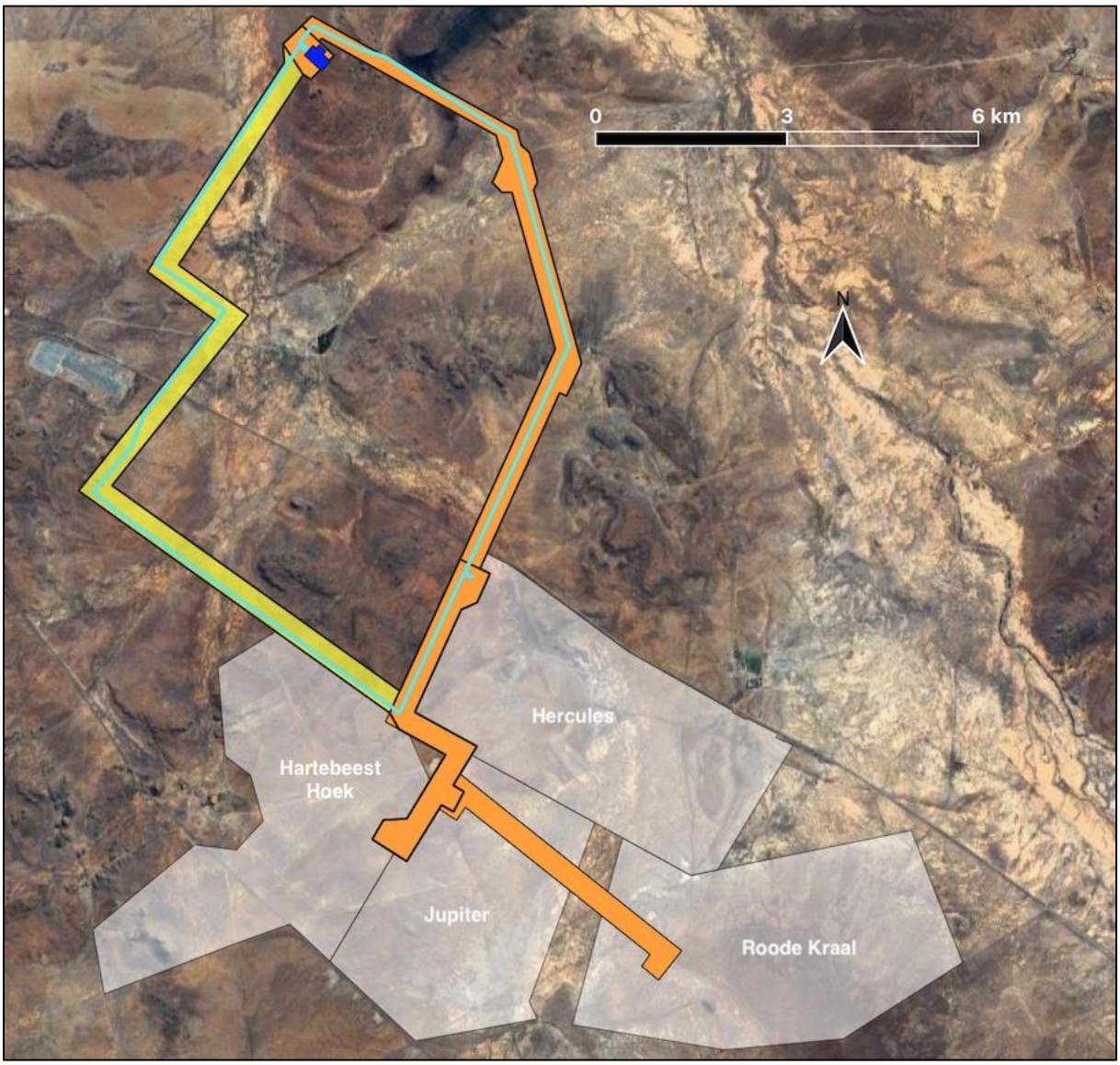


Figure 1: Locality and layout of the “Hercules” SEF and the associated Electricity Grid Infrastructure at De Aar

If this is proven, the palaeontologist must train the Environmental Complaince Officer (ECO) and dedicated members of the technical team of the contractor, to recognise “significant” fossils. The ECO and Resident Engineer will then communicate an urgent call to the appointed palaeontologist to come onto site to remove the fossil.

It will be impractical and too expensive to employ a full-time professional palaeontologist to “wait and see” on the construction site.

The aim of a well-planned “Chance Find Protocol” (which must be part of the EMPr of this project) will be to recover fossils without causing “standing time”. If this process is well-planned, no un-planned standing time needs to be generated as a result of palaeontological heritage discoveries.

5 GEOLOGY OF THE STUDY AREA

The “**Hercules**” SEF/EGI development envelope is underlain by sets of highly significant geological units that vary in age from Permian to Quaternary aged sediments with evidence of very early life. Jurassic aged dolerites of the Karoo Supergroup will not contain fossils.

Extensive areas are underlain by rocks of the Adelaide Subgroup of the Beaufort Group and dolerite of the Karoo Supergroup (Figure 2).

5.1 Karoo Supergoup

5.1.1 Beaufort Group, Adelaide Subgroup (Pa)

The Adelaide Subgroup, which extends throughout the southern Karoo Basin, is the lowest subgroup of the Beaufort Group and consists of a variety of rock types including fine-grained sandstone, siltstone and mudstone. A very high number of vertebrate fossils are present in the study area. Mudstones are generally greenish (or blueish) grey, and greyish-red, interbedded with yellow sandstones and siltstones (Groenewald, 2021, 1996; Groenewald D.P., Day O.D., Cameron R. P-C. and Rubidge B.S., 2022; MacRae, 1999; McCarthy and Rubidge, 2005).

The Electricity Grid Infrastructure to the MTS points is underlain by similar geological formations (Figure 2)

The depositional environment of the Adelaide Subgroup is interpreted as a high sinuosity meandering river environment controlled by the northward warping of the foreland Karoo Basin (Figure 3).

The study area falls in a region where the transition from the western subdivision of the Adelaide Subgroup to the eastern subdivision is prominent and the consensus is that the dominant lithological unit is the Balfour Formation.

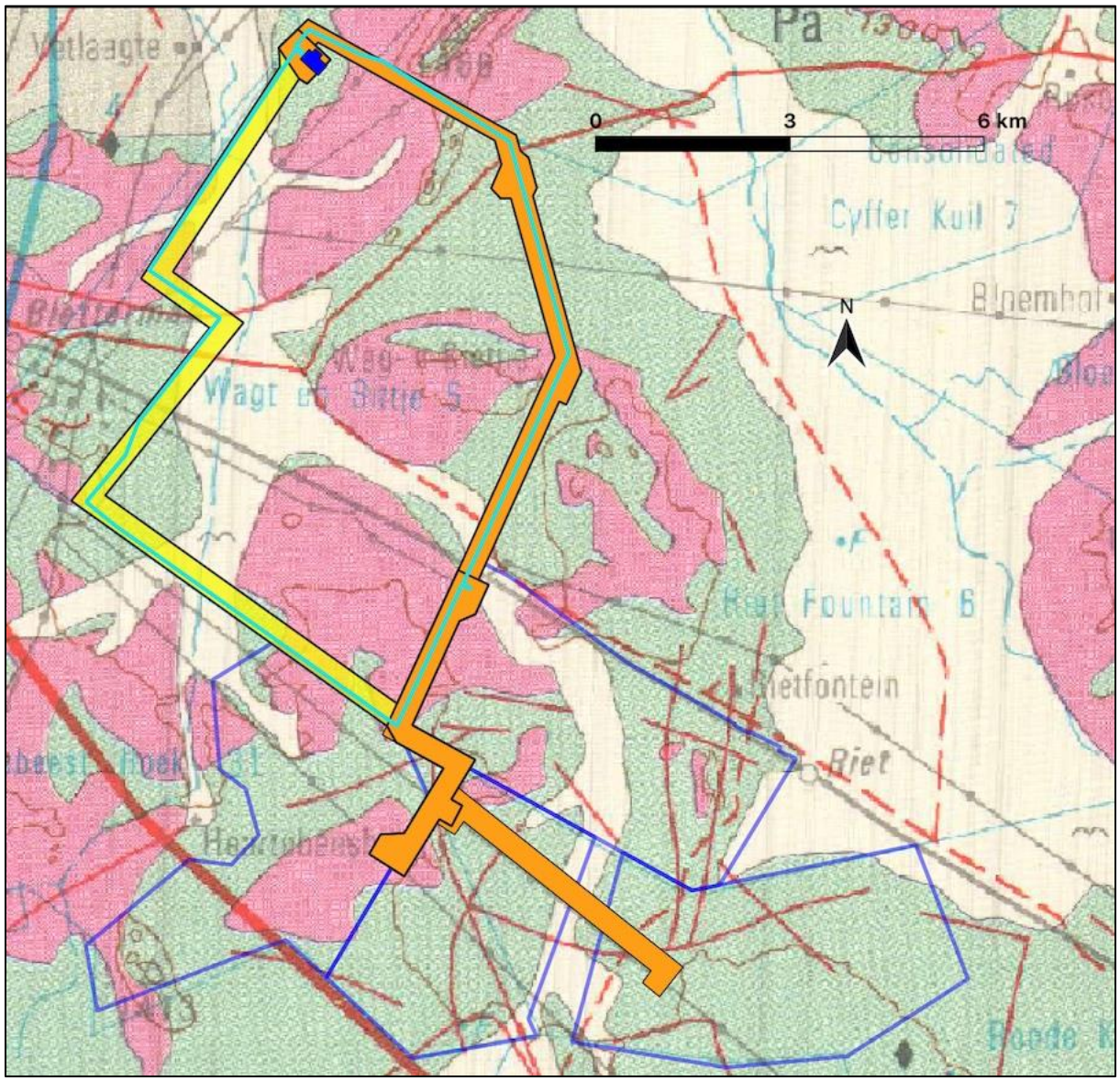


Figure 2: The study area of the "Hercules" SEF is underlain by sedimentary rocks of the Adelaide Subgroup (Pa), dolerite (Jd) and Alluvium. Source: 1:250 000 scale geological map 3024 Colesberg (Council for Geoscience)

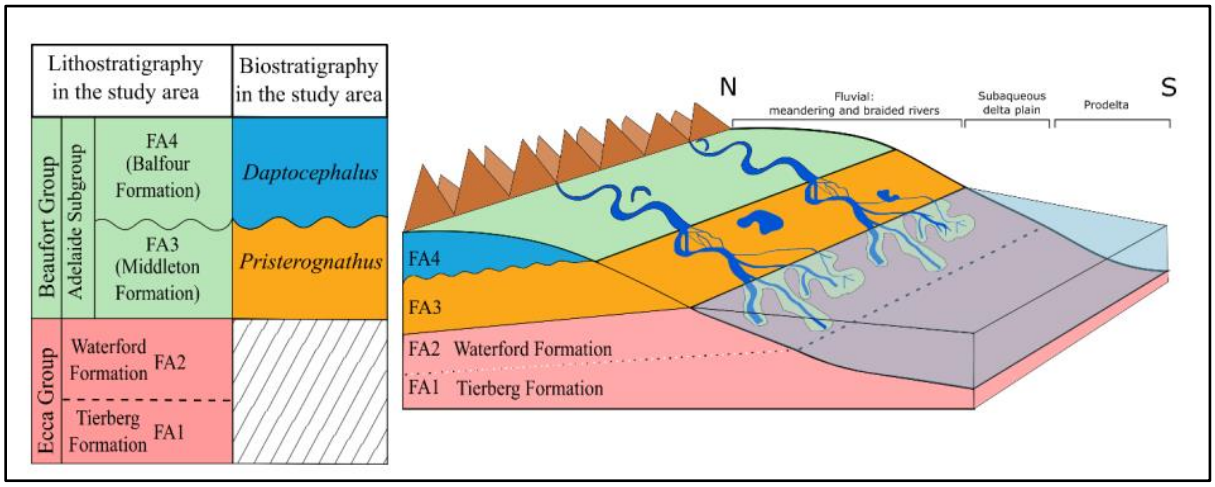


Figure 3 Depositional environments related to the Ecca and Beaufort Groups in the Study area (David Groenewald, pers comm, 2021)

5.1.1.1 Balfour Formation

The Balfour Formation in the "**Hercules**" SEF/EGI development area is characterised by greyish-blue to green-grey and red-coloured mudstone with thinly bedded yellow-brown sandstone. Well-defined outcrops are limited to quarries and several isolated erosion dongas on the steeper sides of the many hills associated with dolerite sill intrusions surrounding the development area.

The more expansive plains are invariably underlain by green-grey and red mudstone as well as siltstone of the Adelaide Subgroup. The rocks of the Adelaide Subgroup are however, covered in thin (1m) to thick (2m) layers of loamy sand (Figure 4).

Figure 4 Typical exposure of mudstone and fine-grained siltstone that underlies the extensive Aeolian sand deposits in the "Hercules" SEF development envelope.

Excavation for foundations of turbines and solar panels might therefore expose very highly significant fossil bearing strata (Figure 5). With proper mitigation this highly negative impact will be changed into a very highly positive impact.

Figure 5 Well-defined basal contacts of the sandstone with mudstone. The transitional palaeo-environments are rich in vertebrate fossil remains.

Sandstone bodies are relatively thin (1,5m) lenticular sandstone with well-defined sharp basal contacts with underlying mudstone. These contact zones are important palaeo-environmental indicators and in the "**Hercules**" SEF/EGI development area the outcrops invariably contain significant palaeontological heritage items, including vertebrate fossil bones (Figure 5).

6 PALAEONTOLOGY

The palaeontological heritage of the Adelaide Subgroup and specifically the Balfour Formation forms part of the extremely highly rated treasures of the South African Karoo. Following years of investigations, the latest consensus is that the lithological unit contains one of the most significant extinction events (Permian/Triassic extinction) and it therefore leads to our conclusion that the palaeontological sensitivity of the study area must be regarded as of global significance.

The impact rating will be **high negative** if no mitigation is proposed, whereas mitigation (collecting and recording of significant fossils) will contribute significantly towards our understanding of the Permian/Triassic extinction event, resulting a **positive impact** of low significance.

Field observations and personal experience in the "**Hercules**" SEF/EGI development envelope indicate that the geological sequence falls in the upper part of the Adelaide Subgroup, Beaufort Group (Figure 3) and thus correlates with the Balfour Formation to the east of Hanover. This stratigraphic setting places the development envelope in the *Daptocephalus* Assemblage zone (Smith et al., 2020); Previously known as the *Dicynodon* Assemblage Zone; (Rubidge (ed), 1995).

The *Daptocephalus* AZ overlies the *Cistecephalus* AZ and is characterised by the co-occurrence of *Daptocephalus leoniseps* and *Theriognathus microps* (Viglietti et al., 2017). Although the upper boundary is not preserved in the study area, the lower boundary is defined by the first appearance datum of the above species. Other genera that are expected in the study area include *Aulacephalodon, Oudenodon, Dicynodon, Procynosuchus delaharpeae* and *Lystrosaurus maccaigi* (MacRae, 1999; McCarthy and Rubidge, 2005; Rubidge (ed), 1995; Viglietti et al., 2017)

Following a detailed desktop survey of existing data, we confirm the fact that large areas in the "**Hercules**" SEF/EGI development envelope is underlain by very highly sensitive geological formations (Figure 6). The "Hercules" SEF/EGI development envelope is underlain by deep soil cover (colluvial plains) are indicated as moderately sensitive (green) since deep excavation (>1,5m) can expose significant fossils. Sites underlain by dolerite (grey) will have a very low significance for palaeontology.

7 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 was predicted as very highly significant, due to the potential abundance of Permian aged fossils in the Beaufort Group.

Dolerite will not contain any significant fossil remains.

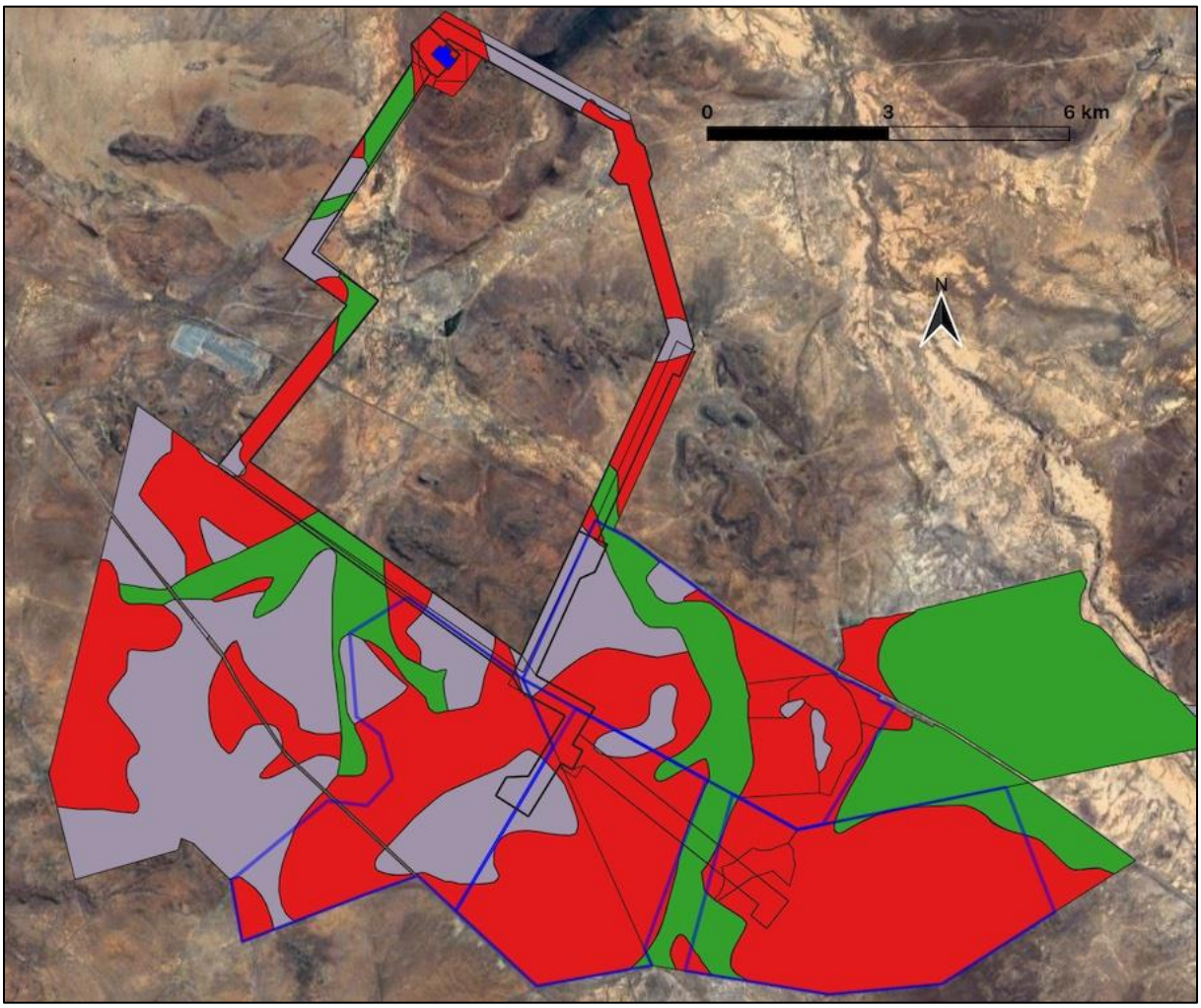


Figure 6: Palaeontological sensitivity for the "Hercules" SEF and associated EGI envelope. The palaeontological sensitivity is based on the SAHRIS palaeo-sensitivity map (see Table 3-1 and https://sahris.sahra.org.za/map/palaeo). Red = very high, green = moderate, grey = very low

8 FIELD INVESTIGATIONS

Dr Gideon Groenewald, experienced fieldworker, visited the site of the proposed "**Hercules**" SEF/EGI on Saturday 14th and Sunday 15th September 2024.

The topography of the area is undulating, with very few isolated Karoo koppies. The general landscape is dominated by extensive, deeply weathered middle slopes and extensive foot slopes (covered in deep colluvial deposits) ending in poorly-defined, albeit limited, valley floors, of the local streams and the main rivers of the area. The natural veld has been almost destroyed by extensive agricultural activities that include intensive grazing plains that covers more than 80% of the landscape (Figure 7).

Figure 7: Grazing plains with deep colluvium cover in the study area.

Detailed observations were recorded across the area that will form part of the Hercules Cluster and observations were recorded photographically at GPS points (Figure 8).

Photographic recordings of geological information and fossils occurring in the outcrops are presented in Table 7-1 below. These photographic recordings might be the only records of Palaeontological Heritage for this project.

The site visit was limited to accessible roads as well as hiking into area of specific interest in terms of a very high likelihood of finding significant fossils. Due to time constraints, it was not possible to visit all the potential outcrops. The survey however confirmed the high likelihood of finding significant fossils wherever excavation of bedrock of the Adelaide Subgroup occurs.

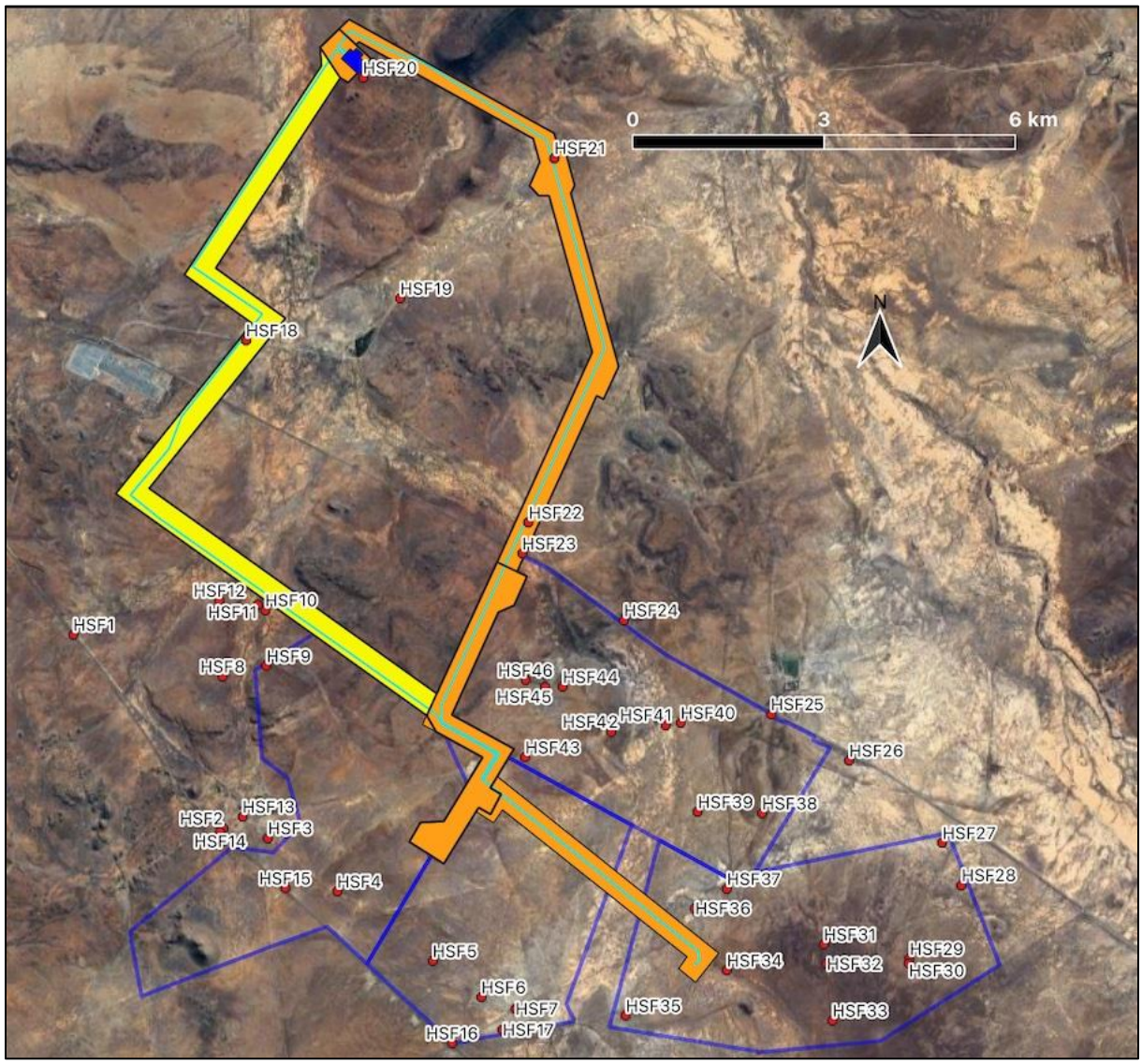


Figure 8: Specific points (yellow pins) visited during the field assessment of the SEF sites as well as the routes for the Electricity Grid Infrastructure towards the proposed MTS sites. See Table 7-1.

Table 8-1 Photographic records of observations during the impact assessment. For localities see Figure 9.

Photo	Coordinates	Comments	Photographic Record
HSF1	30.745958° S 24.080347° E	Extensive plains with shallow soils and calcrete layers dominate the lower parts of the study area. The shallow calcrete overlies mudstone of the Adelaide Subgroup.	
HSF2	30.769374° S 24.101496° E	Sub-outcrops of sandstone and mudstone of the Adelaide Subgroup. These extensive sub-outcrops are highly sensitive for palaeontological heritage and might be rich in vertebrate fossil remains where excavations exceeds 1m in depth.	
HSF3	30.770554° S 24.107783° E	Sub-outcrops of sandstone and mudstone of the Adelaide Subgroup. Extensive calcrete deposits mask the suboutcrop of dolerite and mudstones. These extensive sub-outcrops are highly sensitive for palaeontological heritage and might be rich in vertebrate fossil remains where excavations exceeds 1m in depth.	
HSF4	31.277297° S 24.361718° E	Sub-outcrops of sandstone and mudstone of the Adelaide Subgroup. These extensive sub-outcrops are highly sensitive for palaeontological heritage and might be rich in vertebrate fossil remains where excavations exceeds 1m in depth.	

HSF5	30.785415° S 24.130987° E	Weathered, intensely fractured red-coloured mudstone of the Adelaide Subgroup. Very high sensitivity for palaeontological heritage.	
HSF6	30.789781° S 24.137849° E	Extensive grazing land with shallow sandy soils	
HSF7	30.791167° S 24.142655° E	Very high water tables, associated with the mudstone and sandstone of the Balfour Formation, Adelaide Subgroup and dolerite of the Karoo Supergroup. No fossils were recorded	
HSF7	30.791167° S 24.142655° E	The larger part of the study area with extensive agricultural development and grazing by sheep. The area is underlain by rocks of the Adelaide Subgroup.	

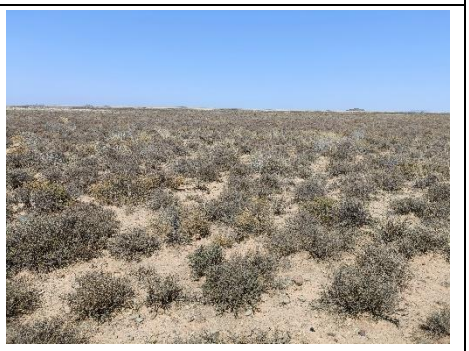
HSF8	30.751003° S 24.101416° E	Excavations for foundations might expose significant fossils. The deep red coloured soils might however indicate suboutcrop of dolerite that will not contain any fossils.	
HSF9	30.749745° S 24.107578° E	The larger part of the study area with extensive agricultural development and grazing by sheep. The area is underlain by rocks of the Adelaide Subgroup. Very highly significant fossil expected during excavations of more than 1m depth.	
HSF10	30.742990° S 24.107391° E	Deep sand, mostly Aeolian and colluvium covering vast plains in the study area. These sediments overly the very highly sensitive sandstone and mudstone of the Adelaide Subgroup and excavations will most probably not be deep enough to expose fossils.	
HSF11	30.742320° S 24.106313° E	Colluvium and sand covers the highly significant mudstone and sandstone of the Adelaide Subgroup. Excavation into the surface material to more than 1,5m will probably expose highly significant fossil remains.	

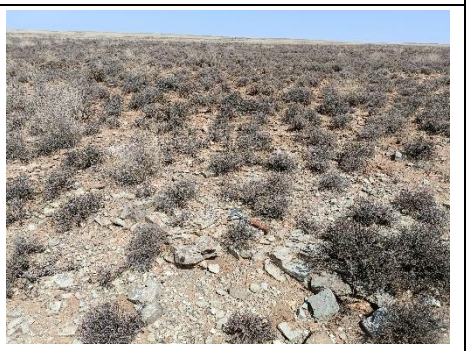
HSF12	30.741833° S 24.100960° E	Deep red coloured soils are most probably an indication of sub-outcrop of dolerite and no fossils are expected.	
HSF13	30.767955° S 24.104199° E	Outcrops of mudstone and siltstone of the Adelaide Subgroup on the sides of the hills in the study area. The presence of significant outcrops of mudstone must be considered as very highly sensitive geological environments in this development	
HSF13	30.767955° S 24.104199° E	Outcrops of mudstone and siltstone of the Adelaide Subgroup on the sides of the hills in the study area. The presence of significant outcrops of mudstone must be considered as very highly sensitive geological environments in this development.	
HSF14	30.769735° S 24.101078° E	Deep (2m) sandy soils overlying sedimentary rocks of the Adelaide Subgroup as well as dolerite of the Karoo Supergroup. No fossils were observed in the Quaternary aged calcrete deposits.	

HSF15	30.776612° S 24.110202° E	Deep (2m) sandy soils overlying sedimentary rocks of the Adelaide Subgroup as well as dolerite of the Karoo Supergroup. No fossils were observed in the Quaternary deposits.	
HSF16	30.795329° S 24.133744° E	Green-grey mudstone outcrops of the Adelaide Subgroup. These outcrops are few and far between due to extensive sand and colluvium cover in the study area. The fact that fossils are invariably found in the smallest of outcrops on site bears witness to the extremely rich collection of fossils in this study area.	
HSF17	30.793703° S 24.140867° E	Areas underlain by sub-outcrops of dolerite is usually characterised by calcrete formations that might indicate higher water tables. No fossils were observed in the calcrete on site.	
HSF18	30.710361° S 24.104682° E	Part of the Grid Infrastructure is underlain by extensive calcrete deposits. No fossils were observed.	

HSF19	30.705294° S 24.126407° E	Artefacts of dolerite used for milling of food stuff. These rocks are indications that the areas were inhabited by humans for many years	
HSF20	30.678576° S 24.121175° E	Deep red coloured soils on highly weathered sub-outcrops of dolerite. No fossils observed	
HSF21	30.688297° S 24.148122° E	Excavations for road material. Exposure of mudstone and sandstone of the Adelaide Subgroup. Fossils observed include trace fossils as well as highly fractured vertebrate remains	
HSF21	30.688297° S 24.148122° E	Well-defined ripple-mark structures with trace fossils indicating shallow water conditions in an extensive floodplain environment.	

HSF21	30.688297° S 24.148122° E	Well-defined small-scale ripple marks indicating shallow water conditions and interference ripples caused by either wind action or two opposing water currents on the floodplains. Small scale trace fossils are associated with these ripple structures	
HSF21	30.688297° S 24.148122° E	Highly weathered fossil bone. Part of the jawbone of an unidentified animal, with a well-defined tusk preserved in the jawbone.	
HSF21	30.688297° S 24.148122° E	Highly weathered fossil bone. The presence of the fossilised bone in these outcrops is an indication of the potential to find fossils during excavation of more than 1m depth in the study area.	
HSF22	30.732414° S 24.144524° E	Typical open plains with Karoo vegetation and calcrete. No fossils observed	

HSF23	30.736138° S 24.143596° E	Relatively deep sandy soils and some Aeolian sand dunes with very few outcrops. No fossils observed.	
HSF24	30.744206° S 24.157932° E	The study area of the Hercules SEF is underlain by shallow sandy soils on weathered mudstone of the Adelaide Subgroup. No fossils observed, but fossils are expected in all excavations that exceeds 1m in depth.	
HSF25	30.755568° S 24.178637° E	Very shallow soils on sandstone outcrops of the Adelaide Subgroup. No fossils were observed.	
HSF26	30.761175° S 24.189668° E	Calcareous soils overlying sub-outcrops of the Adelaide Subgroup. Excavations of more than 1m depth can expose fossils, but no fossils were observed during this investigation	

HSF27	30.771141° S 24.202823° E	Sub-outcrop of dolerite sills cover large areas and in these geological setting no fossils are expected.	
HSF28	30.776226° S 24.205511° E	Grass and Karoo bushes growing on shallow sandy soils that covers extensive plains in the study area.	
HSF29	30.785133° S 24.198172° E	Outcrop of dolerite where the chance find of fossils is very low to insignificant. In the central part of the study area large dolerite sills are part of the geological heritage and no fossils are expected.	
HSF30	30.785667° S 24.198090° E	Grass and Karoo bushes growing on shallow sandy soils that covers extensive plains in the study area	

HSF31	30.783404° S 24.186090° E	Aeolian dune sand covering large areas in the Hercules SEF. Very few outcrops and no fossils observed.	
HSF32	30.785741° S 24.186512° E	Shallow sandy soils on sub-outcrop of dolerite and sediments of the Adelaide Subgroup. No fossils observed	
HSF33	30.792606° S 24.187317° E	Shallow sandy soils on sub-outcrop of dolerite and sediments of the Adelaide Subgroup. No fossils observed	
HSF34	30.786548° S 24.172432° E	Open plains underlain by sedimentary rocks of the Adelaide Subgroup, and dolerite, covered in windblown sand and colluvium.	

HSF35	30.792018° S 24.158209° E	Open plains underlain by sedimentary rocks of the Adelaide Subgroup and weathered dolerite, covered in calcrete, windblown sand and colluvium. Shallow water tables can lead to seepages into pan-environments.	
HSF36	30.779033° S 24.167958° E	Sandstone and mudstone outcrops of the Adelaide Subgroup. These outcrops are specifically very highly sensitive for palaeontological heritage.	
HFS36	30.779033° S 24.167958° E	Fossilised remains of bone in a coprolite. The specific part of the Hercules SEF will be very highly sensitive for fossil remains.	
HSF37	30.776675° S 24.172441° E	Sub-outcrop of dolerite. No fossils observed	

HSF38	30.767565° S 24.177388° E	Outcrops of greenish-grey mudstone and sandstone of the Adelaide Subgroup with clay-pellet conglomerates and bone beds. These sedimentary rocks are very highly sensitive for palaeontological heritage	
HSF38	30.767565° S 24.177388° E	Outcrops of greenish-grey mudstone and sandstone of the Adelaide Subgroup with clay-pellet conglomerates and bone beds. These sedimentary rocks are very highly sensitive for palaeontological heritage	
HSF39	30.767390° S 24.168328° E	Relatively shallow soils on mudstone and sandstone of the Adelaide Subgroup. Excavations for foundations will invariably expose significant fossiliferous sediments.	
HSF40	30.756611° S 24.165916° E	Shallow soils and outcrops of sandstone of the Adelaide Subgroup. The sedimentary rocks are very highly sensitive for palaeontological heritage.	

HSF41	30.756863° S 24.163804° E	Colluvium in sheet flow deposits on extended plains in the study area. These shallow soils are overlying very highly sensitive geological formations of the Adelaide Subgroup. Excavations of more than 1m deep will have a high chance of exposing fossils.	
HSF42	30.757678° S 24.156179° E	Sub-outcrops of dolerite with typical plants (yellow flowering plants) associate with weathered dolerite in the landscape.	
HSF43	30.760779° S 24.144040° E	Relatively shallow soils (colluvium) with sparse Karoo vegetation. Excavation for foundations might expose sedimentary rocks or dolerite bedrock.	
HSF44	30.752263° S 24.149310° E	Deep (2m) colluvium in the valley floors of this section of the development. The colluvium and in some cases alluvium is allocated a medium sensitivity for palaeontological heritage.	

HSF45	30.752259° S 24.146805° E	Deep alluvial and colluvium soils and sub-outcrops of mudstone of the Adelaide Subgroup and dolerite. These areas have a medium sensitivity for palaeontological heritage.	
HSF46	30.751479° S 24.144086° E	Windblown sand and deep alluvium in the study area. No fossils were expected and no fossils observed	

9 PALAEONTOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact (Figure 6) of the development is based on the initial mapping assessment and literature reviews.

The field investigation confirms that the "**Hercules**" SEF/EGI development envelope is underlain by rocks that range from the very highly sensitive sandstone and mudstone of the Adelaide Subgroup to the very low sensitivity dolerite of the Karoo Supergoup of South Africa. Following observations during the field investigation as well as data obtained from previous palaeontological impact assessments in this region, it is our professional opinion that the very high sensitivity in large areas can be reduced to high (Figure 9).

The excavations for the construction of the proposed "**Hercules**" SEF/EGI will probably expose rocks of the Adelaide Subgroup, Beaufort Group of the Karoo Supergroup which has a very high sensitivity for palaeontological heritage. The ECO must be on the lookout for vertebrate, invertebrate, insect, plant as well as trace fossils.

It is very important to note that, although the indications are that large areas in the study area are very highly sensitive for palaeontological heritage, the fossils will most probably only be found where excavations of deeper than 1.5m are planned.

10 IMPACT ASSESSMENT

10.1 Impact Assessment Methodology

Impacts are rated according to the prescribed impact assessment methodology presented below. The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring, including possible irreversibility of impacts and/or loss of irreplaceable resources, and the **probability** that the impact will occur.

The criteria used to determine impact consequence are presented in Table 9-1 below.

Table 10-1: Criteria used to determine the consequence of the impact

Rating	Definition of Rating	Score
A. *Extent* *– the area (distance) over which the impact will be experienced*		
Local	Confined to project or study area or part thereof (e.g. the development envelope and immediate surrounds)	1
Regional	The region (e.g. Municipality or Quaternary catchment)	2
(Inter) national	Nationally or beyond	3

B. ***Intensity***– *the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources*		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered and/or irreplaceable resources[1] are lost	3
C. ***Duration***– *the timeframe over which the impact will be reversed*		
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years or irreversible	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as follows:

Table 10-2: Method used to determine the consequence score

***Combined Score* (A+B+C)**	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Once the consequence was derived, the probability of the impact occurring was considered, using the probability classifications presented in the table below.

Table 10-3: Probability classification

Probability– *the likelihood of the impact occurring*	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

[1] Defined as important cultural or biological resource which occur nowhere else, and for which there are no substitutes.

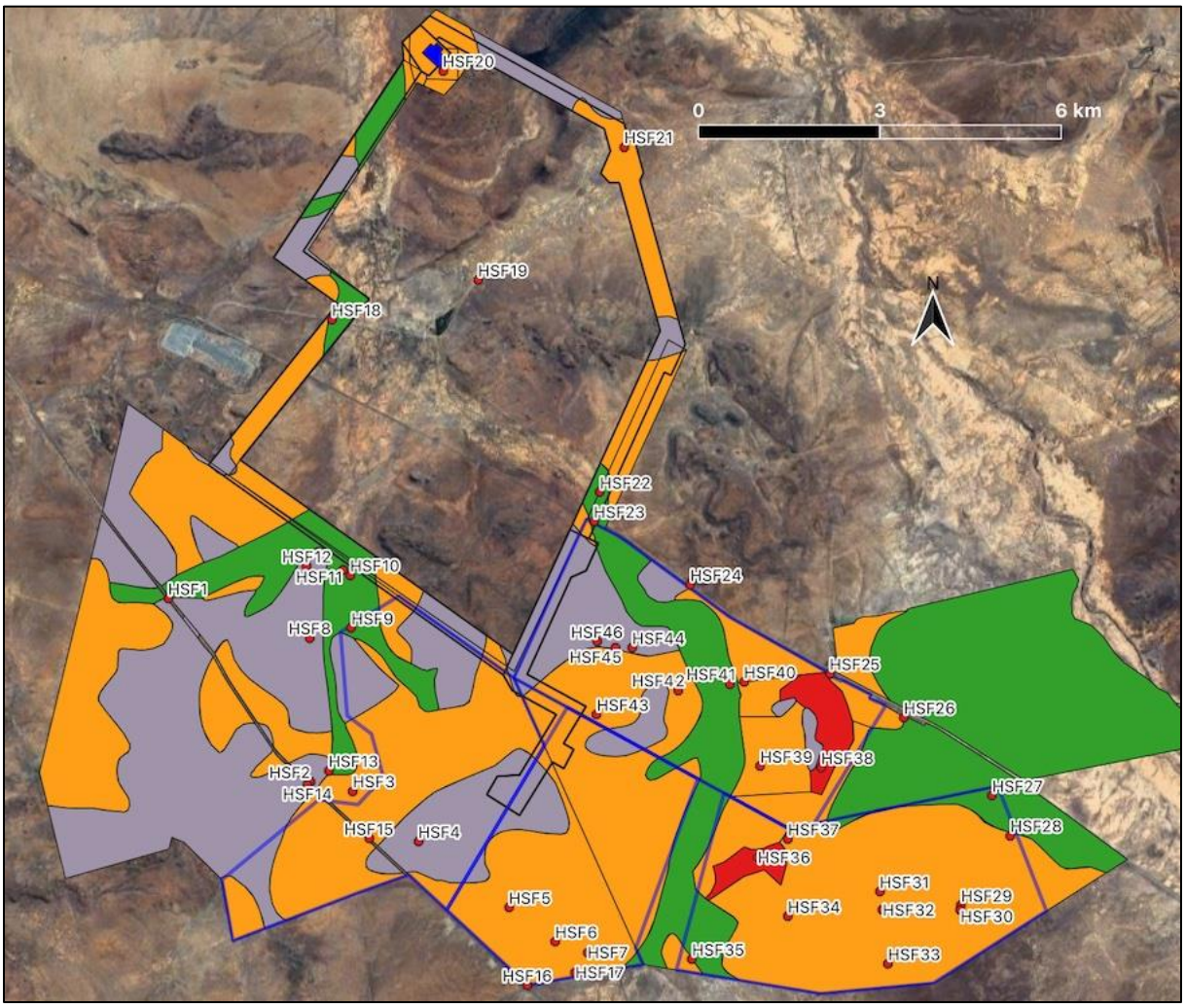


Figure 9: The very high sensitivity of the Adelaide Subgroup is reduced to highly sensitive.

The overall **significance** of impacts was determined by considering consequence and probability using the rating system prescribed in the table below.

Table 10-4: Impact significance ratings

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	Low	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	Medium	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	High	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**
	Very High	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

Finally the impacts were also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below.

Table 10-5: **Impact status and confidence classification**

Status of impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
Confidence of assessment	
The degree of confidence in predictions based on available information, professional judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **INSIGNIFICANT**: the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity/development.
- **VERY LOW**: the potential impact is very small and **should not** have any meaningful influence on the decision regarding the proposed activity/development.
- **LOW**: the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity/development.
- **MEDIUM**: the potential impact **should** influence the decision regarding the proposed activity/development.
- **HIGH**: the potential impact **will** affect the decision regarding the proposed activity/development.
- **VERY HIGH**: The proposed activity should only be approved under special circumstances.

Practicable mitigation and optimisation measures are recommended and impacts are rated in the prescribed way both without and with the assumed effective implementation of mitigation and optimisation measures. Mitigation and optimisation measures are either:

- **Essential**: measures that must be implemented and are non-negotiable; and

- **Best Practice:** recommended to comply with best practice, with adoption dependent on the proponent's risk profile and commitment to adhere to best practice, and which must be shown to have been considered and sound reasons provided by the applicant if not implemented.

10.2 Impacts Associated with the "Hercules" cluster SEF

These impacts will be largely direct and will arise from the physical changes to the environment required for the construction of the "**Hercules**" SEF facility.
For the purposes of this assessment, it has been assumed that the entire development envelope will be required for the SEF and that there will be disturbance across the development envelope.
Impacts are likely to arise from the following project activities:

- The levelling of the development envelope to obtain a north-south slope with a maximum fall of ~ 17 degrees;
- The excavation of foundations for the PV mounting structures to depths of between 1.4 m to 3 m, depending on ground conditions;
- The creation of a raised (earthworks based) platform to accommodate the earthing mat needed for the substation and
- Earthmoving to create access roads.

"Hercules" SEF Impacts: Construction Phase

The following potential construction phase impacts were identified and assessed for the "Hercules" SEF:

- Loss of, or damage to palaeontological resources.

Potential Impact: Loss of, or Damage to Palaeontological Resources

The PIA indicates that earthworks and excavations for the MTS more than 1 m deep are likely to encounter the fossil-bearing shales and siltstones of the Adelaide Subgroup which underlie the Quaternary sands across much of the development envelope.

The extent of any impacts to the Adelaide Subgroup sediments will be **localised** and limited to the footprints of the activities which disturb them. The non-renewable nature of such resources, however, means that where impacts do occur, their intensity will be **high**, the effects will be **permanent** and the consequence rating is thus **high**.

The presence of these fossil-bearing sediments across much of the development envelope suggests it is **probable** that construction activities will intersect and impact this resource.

The impact rating for palaeontological resources in the development envelope is thus assessed to be **high** and the status of the impact will be **negative**.

The level of confidence in this assessment of impacts is **high**.

The implementation of mitigation measures (collection and recording of significant fossils and palaeontological data) will contribute significantly towards our understanding of the Permian/Triassic extinction event and would result in a **positive** impact of **low** significance.

The operation and decommissioning of the "**Hercules**" SEF is **unlikely** to result in direct impact to or the loss and destruction of fossil material.

Potential impacts on palaeontological resources arising from the from the construction of the MTS facility are assessed in
Table **10-8** as follows:

Table 10-6: Significance of loss of or damage to palaeontological resources from the "Hercules" SEF

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Permanent 3	**High** **7**	Probable	**HIGH**	– ve	High
Essential mitigation measures: • A Chance Finds Protocol must be implemented during the construction phase of the project. • A suitably qualified and experienced palaeontologist must be appointed to monitor any excavations into the Adelaide Subgroup strata and recover any significant fossils encountered. • The palaeontologist must train the ECO and dedicated members of the technical team of the contractor, to recognise "significant" fossils. • Fossils recorded during construction must be curated and moved to the institute indicated by SAHRA. • The EMPr must be submitted to SAHRA for comment.								
With mitigation	Local 1	Low 1	Permanent 3	**Low** **5**	Probable	**LOW**	+ ve	High

Table 10-7: "Hercules" SEF Impacts: Operation Phase

Impacts to heritage resources arising from operation of the Hercules SEF are not anticipated.

10.3 Impacts Associated with the Hercules EGI

This section will describe and rate the impacts associated with the Hercules EGI, comprising the switching station portion of the substation within the development envelope and two 132 kV powerline route alternatives to three alternative MTS locations. As with the SEF itself, the impacts to heritage resources arising from the EGI will be largely direct and will arise from the physical changes to the environment required for the construction of the grid infrastructure.

Impacts are likely to include:

- The levelling of the switching station site and the creation of a raised (earthworks based) platform to accommodate the required earthing mat;
- The excavation of foundations for the lattice structures or steel monopole pylons which will have an average footprint of ~11 x 11 m and foundations up to ~4.5 m deep;
- Earthmoving to create a service road within a 32 m wide servitude along the powerline route.

EGI Impacts: Construction Phase

The following potential construction phase impacts were identified and assessed for the EGI:

- Loss of, or damage to palaeontological resources.

Potential Impact: Loss of or Damage to Palaeontological Resources

The PIA indicates that earthworks and excavations for the "**Hercules**" SEF EGI more than 1m deep are likely to encounter the fossil-bearing shales and siltstones of the Adelaide Subgroup which underlie the Quaternary sands across much of the development envelope.

The extent of any impacts to the Adelaide Subgroup sediments will be **localised** and limited to the footprints of the activities which disturb them. The non-renewable nature of such resources, however, means that where impacts do occur, their intensity will be **high**, the effects will be **permanent** and the consequence rating is thus **high**.

The presence of these fossil-bearing sediments across much of the development envelope suggests it is **probable** that construction activities will intersect and impact this resource.

The impact rating for palaeontological resources in the development envelope is thus assessed to be **high** and the status of the impact will be **negative**.
The level of confidence in this assessment of impacts is **high**.
The implementation of mitigation measures (collection and recording of significant fossils and palaeontological data) will contribute significantly towards our understanding of the Permian/Triassic extinction event and would result in a **positive** impact of **low** significance.
The operation and decommissioning of the **"Hercules"** SEF is **unlikely** to result in direct impact to or the loss and destruction of fossil material.
Potential impacts on palaeontological resources arising from the from the construction of the "**Hercules**" SEF facility are assessed in
Table **10-8** as follows:

Table 10-8: Significance of loss of or damage to palaeontological resources from the Hercules EGI

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Permanent 3	**High** **7**	Probable	**HIGH**	– ve	High
Essential mitigation measures: • A Chance Finds Protocol must be implemented during the construction phase of the project. • A suitably qualified and experienced palaeontologist must be appointed to monitor any excavations into the Adelaide Subgroup strata and recover any significant fossils encountered. • The palaeontologist must train the ECO and dedicated members of the technical team of the contractor, to recognise "significant" fossils. • Fossils recorded during construction must be curated and moved to the institute indicated by SAHRA. • The EMPr must be submitted to SAHRA for comment.								
With mitigation	Local 1	Low 1	Permanent 3	**Low** **5**	Probable	**LOW**	+ ve	High

EGI Impacts: Operation Phase

Operational phase impacts to palaeontological resources arising from the Hercules EGI are not anticipated.

10.4 Overall Project Impact

The overall impact i.e. the combined impact of SEF and EGI components of the project are identified and described in this section.

Overall Potential Impacts (SEF and EGI): Construction Phase

Potential Impact: Loss of, or Damage to Palaeontological Resources

The site visits to the Hercules SEF and EGI areas have indicated that Overall, the extent of impacts to palaeontological sites and material arising from the construction of both the SEF and its associated EGI will be **localised** and limited to the footprints of the activities which disturb them.

The non-renewable nature of such resources, however, means that where impacts do occur, their intensity will be **high** overall and **permanent**. The consequence rating is thus **high** for both.

The recorded presence of palaeontological material in both the Hercules SEF development envelope and the EGI corridor indicates that overall, construction activities will **definitely** intersect and impact this resource.

The overall impact rating for archaeological resources in the Hercules SEF development envelope and the EGI corridor thus remains **high** and the status of the impact remains **negative**.

The overall level of confidence in this assessment of impacts is **high**.

Overall Potential Impacts (SEF and EGI): Operation Phase

Overall operational phase impacts to heritage resources arising from the project as a whole (SEF and EGI) are not anticipated.

10.5 Existing Impacts to Heritage Resources

There are currently no obvious threats to palaeontological resources within the "**Hercules**" SEF or EGI corridor, aside from the natural degradation, weathering and erosion that affects archaeological sites and materials.

Disturbance of fossils by animals, by farming activities and by vehicles can occur, and the erosion of geological formations results in the slow degrading of fossils. Generally, these impacts are of low, negative significance.

10.6 The No-Go Alternative

If the project is not constructed, then the SEF development envelope and EGI corridor would stay as they currently are (impact significance of **low negative**). Although the palaeontological impacts with implementation would be greater than the existing impacts, the loss of socio-economic benefits is more significant and suggests that the No-Go option is less desirable in palaeontological heritage terms.

10.7 Levels of Acceptable Change

Any impact to a palaeontological or other heritage resource is deemed unacceptable until such time as the resource has been inspected by a suitable specialist, and mitigated or studied further, if necessary.

10.8 Evaluation of Impacts Relative to Sustainable Social and Economic Benefits

Section 38(3)(d) of the NHRA requires an evaluation of the impacts on palaeontologcal heritage resources relative to the sustainable social and economic benefits to be derived from the construction of the Hercules SEF and associated EGI.

The palaeontological heritage potential of the area to be affected by the construction of the Hercules SEF and EGI is low. In contrast, the potential sustainable social and economic benefits that are likely to accrue from the contribution the project will make to the development of a sustainable energy supply for South Africa and the Northern Cape are likely to outweigh any impacts to heritage resources, particularly if the mitigation measures set out in respect of the various heritage resources are successfully and diligently implemented.

10.9 Cumulative Impacts

For the purposes of this report, cumulative impacts are defined as ‘direct and indirect impacts that act together with existing or future potential impacts of other activities or proposed activities in the area / region that affect the same resources and / or receptors’.

For the most part, cumulative effects or aspects thereof are too uncertain to be quantifiable, due mainly to a lack of data availability and accuracy. This is particularly true of cumulative effects arising from potential or future projects, the design or details of which may not be finalised or available and the direct and indirect impacts of which have not yet been assessed.

For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities.

- **Activities Considered**

Activities within a 30 km radius of the "**Hercules**" SEF development envelope and EGI corridor that potentially have cumulative impacts with the proposed project and which are considered in the cumulative impact assessment are shown in Table 9-14 and comprise:

Table 10-9: Renewable energy projects within 30 km of the "Hercules" Cluster corridor included in the cumulative impact assessment

Project	DFFE Reference	Capacity	EA Status	Estimated extent
Total Area				

- **Cumulative Impact Analysis**

Cumulative impacts to heritage resources arising from the "Hercules" SEF, its associated EGI and the associated De Aar Clusters are expected to be of **low negative** significance before mitigation. They will occur during the construction phase of the various projects, since there is the possibility that heritage resources (archaeological and palaeontological resources in particular) will be present within the final authorized project footprints and that they will be impacted by construction activities.

11 CONCLUSIONS

The geology underlying the Hercules, Hartebeesthoek, Jupiter and Roodekraal SEF/EGI development envelopes comprises the Adelaide Subgroup of the Beaufort Group and dolerite of the Karoo Supergroup. Much of the development envelope is covered by deep soils and colluvium. Rocks of the Adelaide Subgroup are world renowned for significant finds of Palaeontological Heritage objects, including highly significant fossils from the *Daptocephalus* AZ.

No well-preserved fossils were recorded in these rock formations during the palaeontological site visit of 14th and 15th September 2024. The conclusion is that the potential for finding significant invertebrate and trace-fossils, in any excavation of more

than 1m into sediments of the Adelaide Subgroup, Beaufort Group of the Karoo Supergroup is **high.**

It is however very important to note that, although a high sensitivity rating is allocated to large areas underlain by Adelaide Subgroup geology, the actual impact per site of excavation might be limited. Although it is imperative to indicate the very high sensitivity on the initial maps, the *modus operandi* of the project palaeontologist, when appointed, must be to train the ECO and team members to implement the "Chance Find Protocol". The full-time presence of a professional palaeontologist would be preferred during construction into the areas allocated a red colour, but it might be much less expensive to train the ECO and project staff to know what to look for during excavation and inform the palaeontologist of a significant find immediately. Fossils recorded during construction must be curated and moved to the institute indicated by SAHRA.

11.1 Recommendations

- The EAP and developer must be informed that significant areas are underlain by rocks with a high sensitivity for palaeontological heritage. The areas underlain by dolerite will have a very low to insignificant sensitivity for palaeontological heritage.
- All excavations that will expose sedimentary strata may contain significant fossils. The appointment of a palaeontologist to do a comprehensive Phase 2 PIA assessment (fossils collection during construction) will be a minimum requirement for monitoring of excavations of more than 1m into the Adelaide Subgroup strata.
- The project will require the implementation of a formal "Chance Find Protocol" that will need to be upgraded during the construction phase of the project.
- Recommendations for palaeontological monitoring and mitigation must be included in the EMPr which must be submitted to SAHRA for comment.

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13 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).

14 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

15 CHANCE FIND PROTOCOL FOR PALAEONTOLOGICAL HERITAGE

15.1 Mitigation for Excavation Impacts on Palaeontological Heritage Resources "Hercules" Cluster

It is essential that the appointed palaeontologist, in consultation with the Project Environmental Manager and the contractors and ECO's of the excavation works develop a short-term strategy for the recovery of significant fossils during the excavation operation. As part of such a strategy, the discussions with the palaeontologist must include:

- Initially, and at least for the *duration of excavation*, visit the site on request of the ECO of the specific construction site, to ensure recording of all potentially significant fossil strata. Due to the longevity of this contractual involvement, it is not possible to have pre-determined timing on further visits and it is a conclusion from present observations, that more frequent visits by the Palaeontologist during excavations into the Karoo Subgroup sediments will **definitely** be required.
- Determine a short-term strategy and budget for the recording of significant fossils (only if deep (>1m) excavations into bedrock is still planned). This Strategy is simply an oral agreement on when the site is to be inspected and what the finds are that might be recorded. The site visit must include an introduction session with all the managers of the Project Team, including training of the ECO and site managers by the appointed palaeontologist, to basically train people to know what to look out for in terms of fossil heritage on site. This action will be required at the start of each individual construction activity for the duration of construction in the "greenfield sections" of the site.
- **Following the site visit on 14th and 15th September 2024, follow-up visits are recommended where excavation into bedrock might expose highly significant fossils.**
- In the case of reporting of any unusual sedimentary structures, the Palaeontologist must be notified, and a site visit must be arranged at the earliest possible time with the Palaeontologist. In the case of the site ECO or the Site Manager becoming aware of suspicious looking material that might be a "Significant Find", the construction must be halted in that specific area and the Project Engineer informed. The Palaeontologist must be given enough time to reach the site and for the removal the material before excavation continues.

15.2 Mitigation Measures Normally Encountered

- Mitigation of palaeontological material must begin as soon as possible and preferably when “trial excavation” takes place. The appointed specialists must acquaint themselves with the operation and determine feasible mitigation strategies.
- A plan for systematic sampling, recording, preliminary sorting and storage of palaeontological and sedimentological samples will be developed during the early stages of the project, in collaboration with the Evolutionary Studies Institute (ESI) at WITS University, which is the closest Institute to the site.
- Mitigation will involve an attempt to capture all rare fossils and systematic collection of all fossils discovered. This will take place in conjunction with descriptive, diagrammatic and photographic recording of exposures, also involving sediment samples and samples of both representative and unusual sedimentary or biogenic features. The fossils and contextual samples will be processed (sorted, sub-sampled, labelled, boxed) and documentation consolidated, to create an archive collection from the excavated sites for future researchers.

Functional responsibilities of the Developer and Project Environmental Managers for the Project

- Ensuring, at their cost, that a representative archive of palaeontological samples and other records is assembled to characterise the palaeontological occurrences affected by the excavation operation.
- Provide field aid, if necessary, in the supply of materials, labour and machinery to excavate, load and transport sampled material from the excavation areas to the sorting areas, removal of overburden if necessary, and the return of discarded material to the disposal areas. In the case of this project, it is foreseen that invertebrate and trace fossils will be present. (*If more fossils of Permian age are exposed, it will be Very Highly significant, and the Palaeontologist will obviously be in close communication with the site ECO to act as required by SAHRA without causing undue standing time for the contractors).*
- “Facilitate” systematic recording of the stratigraphic and palaeo-environmental features of exposures in the fossil-bearing excavations, by allowing time to describe and measure geological sections, and by providing aid in the surveying of positions where significant fossils are found. *(In the case of this specific development, the likelihood of such finds is not very high).*
- Provide safe storage for fossil material found routinely during excavation operations by construction personnel. In this context, isolated fossil finds in disturbed material qualify as “normal” fossil finds.

- Provide covered, dry storage for samples and facilities that is defined as a work area for sorting, labelling and boxing/bagging of samples.
- Costs of basic curation and storage in the sample archive at the ESI, WITS University (labels, boxes, shelving and, if necessary, specifically-tasked temporary employees).

15.3 Documentary Record of Palaeontological Occurrences

- The contractors will, after consultation with the ECO and in collaboration with the Palaeontologist, make the excavation plan available to the appointed specialist, in which the following information are indicated on the plan in the site office at the excavation site. This must be done in conjunction with the appointed specialist and form part of the on-going revision of the "Chance Find Protocol" (CFP) during the excavation stage of the project:
    - Initially, all known specific palaeontological information will be indicated on the plan. This will be updated throughout the excavation period.
    - Locations of samples and measured sections are to be pegged, and routinely accurately surveyed. Sample locations, measured sections, etc., must be recorded three-dimensionally if any significant fossils are recorded during the time of excavation. This information must be recorded during the first site visit and a clearance from the Palaeontologist (e-mail message will suffice) must be followed up with subsequent e-mail communications with the ECO, Site Manager and the PEM.

15.4 Functional Responsibilities of the Appointed Palaeontologist

- Apply for a permit to collect fossils during the lifetime of the Project and establishment of a representative collection of fossils and a contextual archive of appropriately documented and sampled palaeoenvironmental and sedimentological geodata in collaboration with the ESI at WITS University, or the Rhodes University, depending on the Expertise available at each Institute.
- Undertake an initial evaluation of potentially affected areas and of available exposures in excavations. A short training session, inclusive of the PEM, Project Managers and the ECO's or their representatives, was presented during the second site visit to this project.
- On the basis of the above, and evaluation during the early stages of excavation development, in collaboration with the PEM and the contractor management team, more detailed practical strategies to deal with the fossils encountered routinely during excavation, as well as the strategies for major finds must briefly be agreed on.

- Informal on-site training in responses applicable to “normal” fossil finds must be provided for the PEM, ECO and environmental staff by the appointed specialist. This step is will only be arranged following the discovery of significant fossils at the time of the Phase 2 site visits.
- Respond to significant finds and undertake appropriate mitigation.
- Initially, for the first year of operation, and if the PEM or the appropriate ECO indicates significant “strange looking rocks” that might be similar to the fossils indicated to the staff during the information sessions, visit at least once in twelve weeks to “touch base” with the monitoring progress. Document interim “normal” finds and undertake an inspection and documentation of new excavation faces. A strategy for further visits during the life of the excavation must be discussed.
- Transport of material from the site to the Evolutionary Studies Institute (ESI), WITS University or the allocated Institute where an expert on the specific fossils discovered, is presently employed.
- Reporting on the significance of discoveries, as far as can be preliminarily ascertained. This report is in the public domain and copies of the report must be deposited at ESI and SAHRA. It must fulfil the reporting standards and data requirements of these bodies.
- Reasonable participation in publicity and public involvement associated with palaeontological discoveries.

15.5 Exposure of Palaeontological Material

- In the event of construction exposing new palaeontological material, not regarded as normative/routine as outlined in the initial investigation, such as a major fossil find, the following procedure must be adhered to:
    - The appointed specialist or alternates (SAHRA; ESI WITS University; Rhodes University) must be notified by the responsible officer (e.g. the PEM, Chief Engineer, ECO or Contractor Manager), of major or unusual discoveries during excavation, found by the Contractor Staff.
    - Should a major *in situ* occurrence be exposed, excavation will immediately cease in that area so that the discovery is not disturbed or altered in any way until the appointed specialist or scientists from the ESI at WITS University, or its designated representatives, have had reasonable opportunity to investigate the find. Such work will be at the expense of the Developer.
- Some poorly defined impressions of fossils were observed during the first site visit and the palaeontologist cleared the continued excavation on the proviso that any suspicious material will be indicated to the Palaeontologist via emailed photographic information.