PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED CONSTRUCTION OF UP TO A 132KV POWER LINE AND ASSOCIATED INFRASTRUCTURE FOR THE PROPOSED KALKAAR CONCENTRATING SOLAR THERMAL POWER PROJECT ON THE REMAINDER OF PORTION 1 OF THE FARM KALKAAR 389 NEAR JACOBSDAL, FREE STATE AND NORTHERN CAPE PROVINCES

Prepared for:

PGS Heritage (Pty) Ltd

(EA – DEA Ref: 14/12/16/3/3/1/1577)

2 September 2016 (ver1)
19 January 2017 (ver2)

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EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS Heritage to conduct the EIA Report for the proposed construction of a 132kV Power Line and Associated Infrastructure for the evacuation of power from the Proposed Kalkaar Concentrating Solar Thermal Power Project on the Remainder of Portion 1 of the Farm Kalkaar 389 near Jacobsdal, Free State and Northern Cape Provinces ("Power line Project"). According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the Power line Project footprint, and to assess the impact of the construction and operation of the Power line Project on the palaeontological resources.

The Power line Project footprint is completely underlain by lower Permian sediments of the Ecca Group of the Karoo Basin (White Hill and Prince Albert Formations), Late Permian Volksrust Formation, and the Karoo Dolerite Suite and Quaternary deposits. The Power line Project footprint as a whole is a fairly flat lying terrain with grassy vegetation cover in places as well as a few thorn trees. The Karoo dolerite Suite is unfossiliferous and the sensitivity in the Quaternary sediments is low. Although the palaeontological sensitivity of the Whitehill, Prince Albert and Volksrust Formations is rated as high to very high, scarcity of fossil-bearing sediments and lack of exposure at the proposed sites indicate that the impact on palaeontological material is **negligible and regarded as insignificant.**

It is therefore recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, pending the discovery or exposure of any fossil remains during the construction phase.

Should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted immediately. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

The specialist involved would require a collection permit from SAHRA. Fossil material must be curated in an approved collection (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

Table 1: Power line Project – Comparative Assessment

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	**Preference**	**Reasons**
POWER LINE CORRIDORS		
Corridor 1 Kalkaar Solar Thermal Power Project to Jacobsdal Link	No preference	The fossil heritage in the development area is low/negligible Formations include Prince Albert; Volksrust Formations and Karoo Dolerite
Corridor 2 Alternative 1 Kalkaar CSP via Kimberley DS to Boundary Substation	No Preference	The fossil heritage in the development area is low/ negligible. Formations include: Prince Albert, White Hill and Volksrust Formations, dolerite and Quaternary sediments
Corridor 2 Alternative 2 Kalkaar CSP via Kimberley DS to Boundary Substation	No Preference	The fossil heritage in the development area is low/ negligible. Formations include: Prince Albert , White Hill and Volksrust Formations and Quaternary sediments

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1 INTRODUCTION

Environmental authorization was obtained for the proposed 200MW Concentrated Solar Power (CSP) facilities on the Remainder of Portion 1 of the Farm Kalkaar 389 near Jacobsdal in the Free State Province in September 2015. SolarReserve South Africa (Pty) Ltd appointed SiVEST, as the independent Environmental Assessment Practitioner (EAP), to undertake the required Basic Assessment processes for the proposed construction of a 132kV Power Line and Associated Infrastructure for the evacuation of power from the Proposed Kalkaar Concentrating Solar Thermal Power Project on the Remainder of Portion 1 of the Farm Kalkaar 389 near Jacobsdal, Free State and Northern Cape Provinces ("Power line Project").

PGS Heritage was appointed by SiVEST South Africa (Pty) Ltd to undertake a Heritage Impact Assessment (HIA) that forms part of the Environmental Impact Report (EIA) for the Power line Project.

The preferred evacuation point for the electricity generated by the Power line Project is from the Jacobsdal Substation via the Project Substation (which is situated on the Power line Project Site) and terminating at the Kimberley Distribution Substation ('KDS') to Boundary Substation near Kimberley. As such, in order to evacuate the electricity generated by the Power line Project, this environmental authorisation process was undertaken to assess the environmental feasibility of the Power line Project to the aforementioned interconnection point. Importantly, it must be noted that the grid connection solution proposed for the Power line Project will only be finalised by Eskom at the Budget Quote stage of Eskom's Load and Demand Network Integration Studies. The preliminary Load and Demand Network Integration Studies have however shown that Eskom may require that the Power line Project is to evacuate power not only via the KDS to the Boundary Substation but also to the Jacobsdal Substation.

The proposed project will consist of the following: (information provided By PSG Heritage) (Fig 2)

- Construction of Tern power lines or equivalent of a 132kV power line from the proposed CSP Project to the proposed Jacobsdal, Kimberley and Boundary substations and all the necessary expansion and changes to Eskom infrastructure at the substations.
- The grid connections that will be assessed include the following:
    i. Jacobsdal Link = approximately 19km in length;
    ii. CSP Project via Kimberley DS to Boundary Substation Alternative 1 = approximately 61km in length; and
    iii. CSP Project via Kimberley DS to Boundary Substation Alternative 2 = approximately 62km in length.
- Install 48 core optical ground wire (OPGW) on the power line.
- Build 2-3 bay substations next to the approved substations on the CSP Project Site. Proposed substations will be approximately 100m x 100m – one for Eskom and one for the Project site.
- Inclusive of all cable trenches.

- Install 10 x 25m lighting/lightning masts.
- Building of an access road to the substation.
- Building of a standard control room (5.5m x 12m) with top entry and cable racks. This will include a sewage system, air-conditioning and energy efficient lighting.
- Installation of a security fence with entrance gates.
- 1 x 132kV line bay and 1 x 132kV metering bay at each connection substation.
- Installation of a required Control Plant, AC/DC, Metering, SCADA and Telecoms.
- V drain extension of substation for drainage purposes.
- And or all extensions required (132kV yard, fencing etc.) of the connecting Eskom Assets i.e. Kimberley DS / Boundary / Jacobsdal Substation

The power lines will consist of a series of towers located approximately 100-200m apart depending on the terrain and soil conditions). The tower type used will be determined (based on load and other calculations) during the final design stages of the power lines. However, it is likely that the bird friendly mono-pole self-supporting intermediate suspension (single steel pole) structure will be used in combination with various other structures which are usually applied as follows:

- The mono-pole guyed intermediate suspension structures are normally installed at obvious rocky terrains, where the foundations can have a huge cost impact.
- The mono-pole angle suspension structures are used on slight angles up to 23°.
- The mono-pole strain structures are used as 0° in-line strainers with four diagonal stays and at angles from 1° to 110° with a variety of stay configurations to suit the specific application. The structure is also used as a terminal in situations where lines approach towards the substation feeder bay at an angle larger than 45°.
- The H-pole are used for horizontal applications to cross over or under existing power lines where clearances are a problem and are used as terminal structures with an in-line approach to the substation feeder bay.
- The 3-pole strain structures are normally used at very long spans crossing rivers, valleys, etc. These are very expensive structures; therefor it is not used very often.

The height of the single steel pole structure ranges between 18m and 26.5m. Where the proposed power line is aligned parallel to an existing power line the option of restringing the existing line as an alternative to building a new power line will be investigated. Sections of the existing power line where restringing is possible will be determined during the final design stages. The exact location of the towers will also be investigated during the final design stages of the power lines

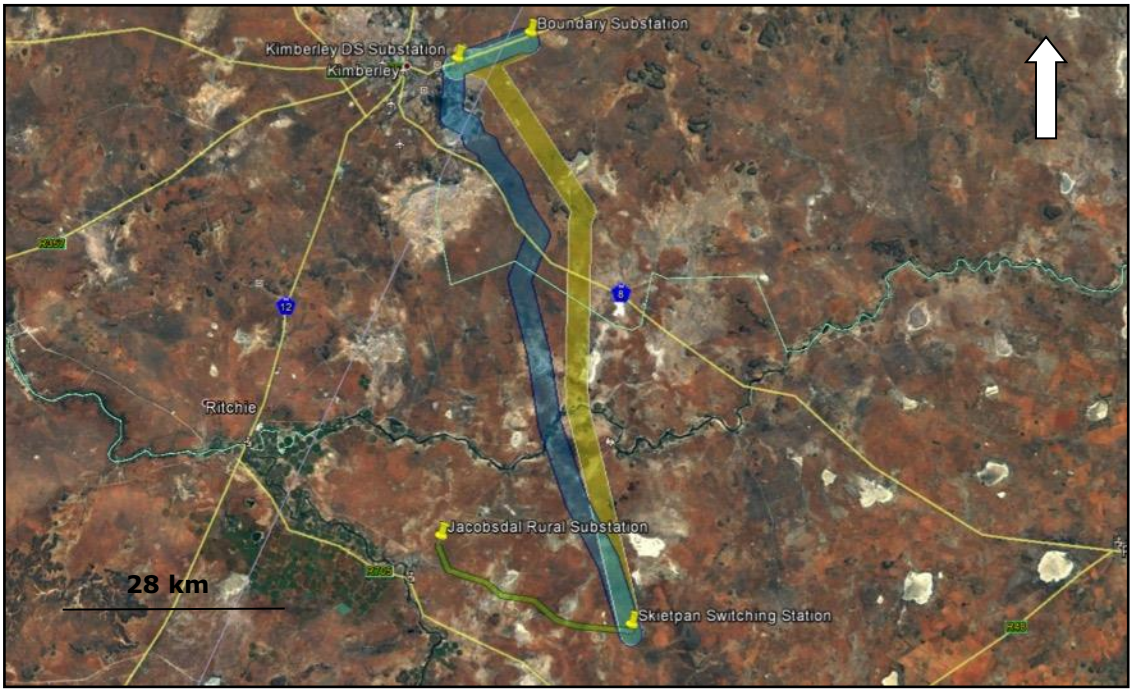

Figure 1. Google Earth image (2016) of the proposed location of the proposed 132 KV power line and associated infrastructure near Kimberly and Jacobsdal. Corridor 1 Kalkaar Solar Thermal Power Project to Jacobsdal Link (outlined in green). Corridor 2 Alternative 1 Kalkaar CSP via Kimberley DS to Boundary Substation (outlined in blue). Corridor 2 Alternative 2 Kalkaar CSP via Kimberley DS to Boundary Substation (outlined in yellow).

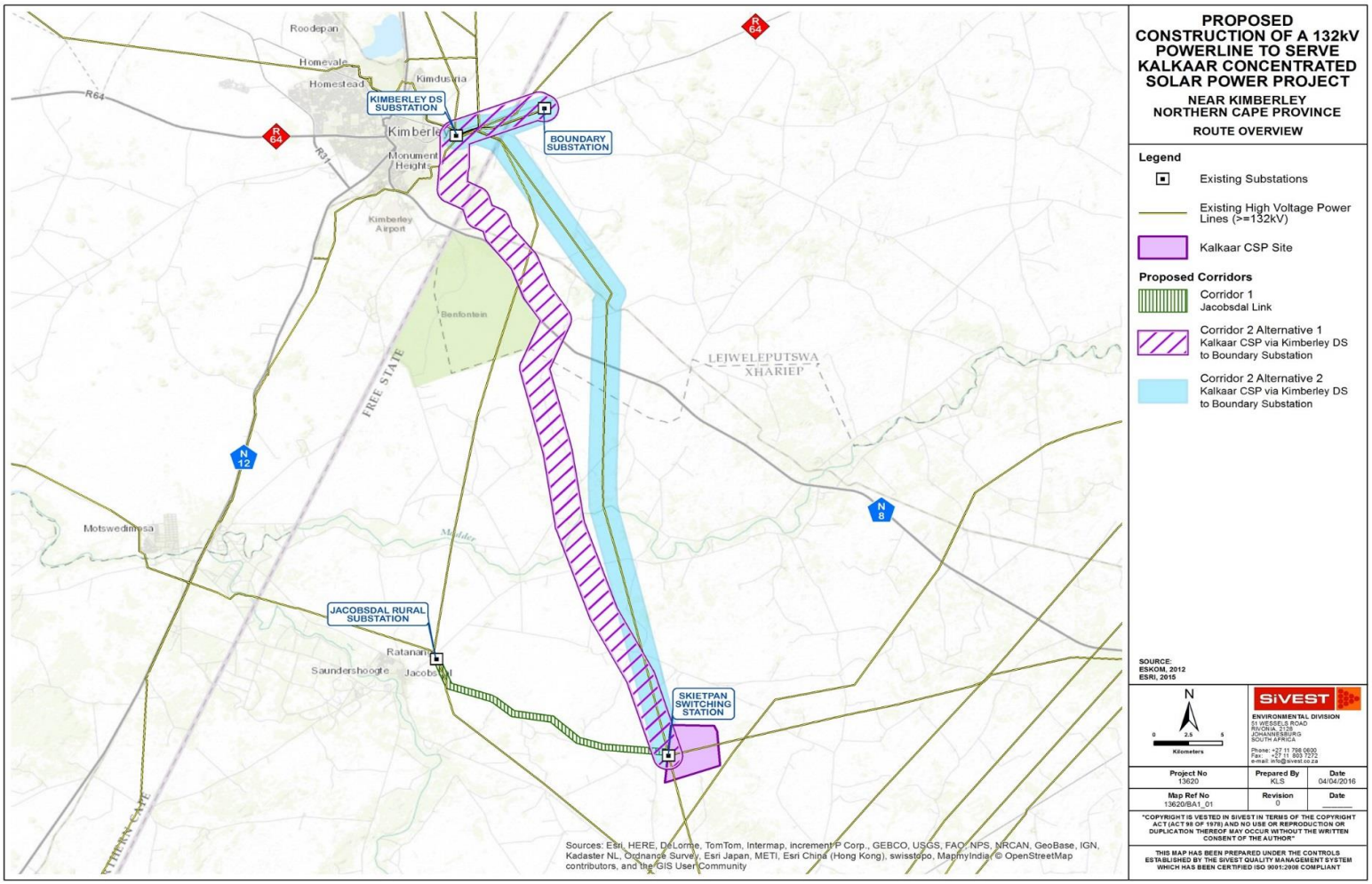

Figure 2. The location of the proposed up to a 132 KV line and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Norther Cape Province. (Map provided by SiVest Environmental Devision).

1.1 LEGISLATION

1.2 GENERAL MANAGEMENT GUIDELINES

1. The National Heritage Resources Act (Act 25 of 1999) states that, any person who intends to undertake a development categorised as-

(a) the construction of a road, wall, transmission line, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;

(b) the construction of a bridge or similar structure exceeding 50m in length;

(c) any development or other activity which will change the character of a site-

  (i) exceeding 5 000 m^2 in extent; or

  (ii) involving three or more existing erven or subdivisions thereof; or

  (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

  (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA.SAHRA;

(d) the re-zoning of a site exceeding 10 000 m^2 in extent; or

(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

Cultural Heritage in South Africa is governed by the National Heritage Resources Act (Act 25 of 1999). This Palaeontological Environmental Impact Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the above mentioned Act. In accordance with Section 38, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 25 OF 1999

- The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
- No person may, without a permit issued by the responsible heritage resources authority—
  - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
  - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

- trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
  - serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order; and/or
  - carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.

2 Objective

According to the SAHRA APM Guidelines: Minimum Standards for the Archaeological and 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.

The objective is thus to conduct a Palaeontological Impact Assessment, which forms of part of the Heritage Impact Assessment (HIA) and the Basic Assessment (BA) Report, to determine the impact of the development on potential palaeontological material at the site.

When a palaeontological desktop/scoping study is conducted, the potentially fossiliferous rocks (i.e. groups, formations, members, etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is collected from published scientific literature; fossil sensitivity map; consultations with professional colleagues, previous palaeontological impact studies in the same region and the databases of various institutions may be consulted. This data is then used to assess the palaeontological sensitivity of each rock unit of the study area on a desktop level. The

likely impact of the proposed development on local fossil heritage is subsequently established on the basis of the palaeontological sensitivity of the rocks and the nature and scale of the development itself (extent of new bedrock excavated).

If rocks of moderate to high palaeontological sensitivity are present within the study area, a Phase 1 field-based assessment by a professional palaeontologist is necessary. Generally, damaging impacts on palaeontological heritage occur during the construction phase. These excavations will modify the existing topography and may disturb damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study.

When specialist palaeontological mitigation is suggested, it may take place prior to construction or, even more successfully, during the construction phase when new, potentially fossiliferous bedrock is still exposed and available for study. Mitigation usually involves the careful sampling, collection and recording of fossils as well as relevant data concerning the surrounding sedimentary matrix. Excavation of the fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. With appropriate mitigation, many developments involving bedrock excavation will have a *positive* impact on our understanding of local palaeontological heritage.

3 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The development footprint is completely underlain by lower Permian sediments of the Ecca Group of the Karoo Basin (White Hill and Prince Albert Formations) Late Permian Volksrust Formation, the Karoo Dolerite Suite and Quaternary deposits (Fig.3).

An extremely small portion of the development area is underlain by the **Whitehill Formation** (Fig 3; Corridor alternative 2). This formation consists of finely-laminated carbon-rich mudrocks of Early to Mid Permian (Artinskian) age. These distinctive sediments were laid down about 278 Ma (million years ago) in a wide shallow, brackish to freshwater basin (Ecca Sea) that stretched across southwestern Gondwana, from southern Africa into South America. Near surface weathering of these highly-carbonaceous sediments produces pale grey to cream colours that are readily seen in satellite images where the bedrock is exposed.

Fossil Heritage of the Whitehill Formation includes:

- mesosaurid reptiles
- palaeoniscoid fish
- small eocarid crustaceans
- insects
- trace fossils (king crab track ways, shark coprolites)
- palynomorphs (organic-walled spores and pollens)
- petrified wood (mainly of primitive gymnosperms, silicified or calcified)
- sparse vascular plant remains (Glossopteris leaves, lycopods etc)

Almost the whole development area (central area) is in the **Prince Albert Formation** (Fig.3). Marine to hyposaline basin plain mudrocks occur with minor volcanic ashes, phosphates and iron stones, post-glacial mudrocks is also present at the base of the Prince Albert Formation. The sediments usually appear dark on satellite images because the outcrop is mantled in gravels rich in ferromanganese minerals (Gravel clasts frequently have a shiny-black patina of "desert varnish"). This unit of Early Permian (Asselian / Artinskian) age was formerly known as "Upper Dwyka Shales"

The fossil assemblage of the Prince Albert Formation is basically trace fossils. This trace fossil assemblage of the non-marine *Mermia* Ichnofacies, is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails), are generally found in basinal mudrock facies of the Prince Albert Formation.

The **Volksrust formation** is present in the north eastern and southern portion of the development footprint (Fig. 3). This formations consists of by basinal mudrocks with phosphatic/carbonate/sideritic concentrations and minor coals

The fossil biota of the postglacial mudrocks of the Volksrust Albert Formation include

- trace fossils
- temnospondyl amphibian remains
- invertebrates, minor coals and other plants, organic microfossils
- trace fossil assemblages

Karoo Dolerite Suite. The Karoo Dolerite Suite is a widespread network of basic igneous bodies (dykes, sills) that were intruded into sediments of the Main Karoo Basin in the Early Jurassic Period (approximately 183 million years ago). These igneous rocks are unfossiliferous.

Late Caenozoic superficial deposits The Quaternary deposits (2.6 million years old to recent) comprise of unconsolidated aeolian sands that are windblown sand and dunes. These sediments might contain a very wide range of possible fossil remains, though these are often sparse, including mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms and other microfossil groups. Plant fossils including fossilized wood and pollen grains have also been recorded in the Quaternary deposits. Fossils are generally very difficult to recognize in the Aeolian deposits and fossils are normally associated with localized concentrations of material associated with calcrete beds close to water ways.

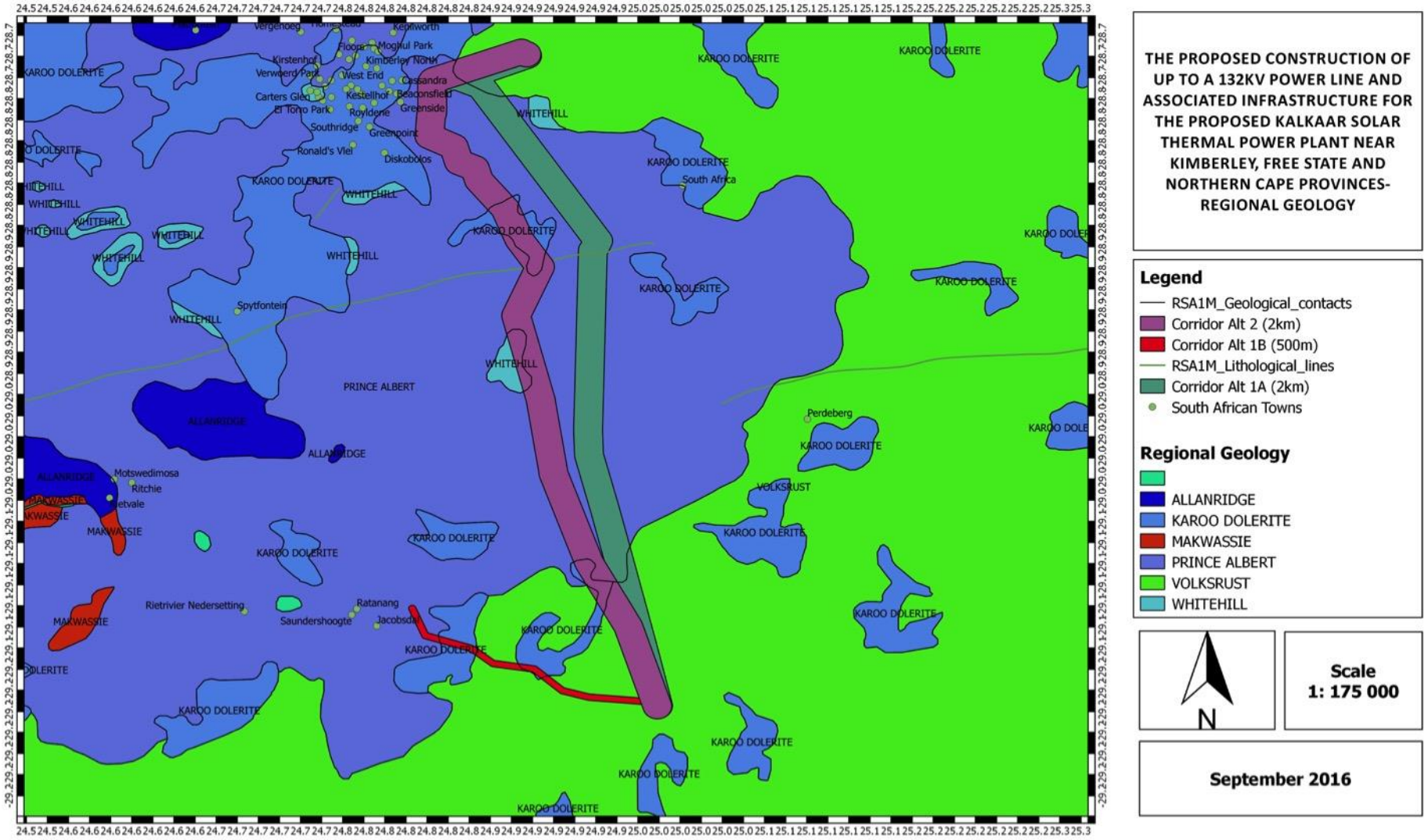

Figure 3. The surface geology of the proposed Power line Project.

4 GEOGRAPHICAL LOCATION OF THE SITE

Project Location

The Power line Project footprint is located mainly within the Free State Province with a fairly small portion situated near Kimberley in the Northern Cape Province. The Power line Project traverses the Lejweleputswa District Municipality including the Tokologo Local Municipality in the Free State, and the Frances Baard District Municipality including the Sol Plaatjie Local Municipality in the Northern Cape Province. The development footprint consists of mainly mining, industrial (renewable energy generation facilities), agricultural activities and urban as well as residential areas.

Proposed Route Corridor Alternatives (Information provided by PGS Heritage)

For the power line component, three corridors have been provided for assessment. Two of the three corridors are up to 2km (1km either side of the centre line) wide originating from the Power line Project Site routing via the KDS to the Boundary Substation. The aforementioned two corridors will serve as alternatives to each other for the comparative assessment. An additional corridor of 500m in width (250m either side of the centre line) is required for the Power line Project interconnection solution, from the Jacobsdal Substation to the CSP Project Site before evacuating the power to the Boundary-Kimberley substations. This route is not subject to an alternative assessment, but environmental considerations will be applied to determine the alignment best suited to the receiving environment within this corridor.

Note that Eskom dictates the size of the servitude and there is a possibility that larger servitudes will be required. However, at this stage, it is anticipated that the registered servitude width will be 31 metres (15.5 metres either side of the centre line) or unless otherwise required by Eskom.

The three power line corridors include the following:

- Corridor 1 – Jacobsdal Link = approximately 19km in length;
- Corridor 2 Alternative 1 – CSP Project via Kimberley DS to Boundary Substation Alternative 1 = approximately 61km in length; and
- Corridor 2 Alternative 2 – CSP Project via Kimberley DS to Boundary Substation Alternative 2 = approximately 62km in length.

The proposed power line will also include all associated infrastructure as required (including but not limited to access roads, control rooms, security systems etc.).

5 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the Power line Project was conducted on 1 September 2016, to assess the potential risk to palaeontological material in the footprint of the Power line Project. A physical field-survey was conducted on foot and in a motor vehicle within the Power line Project footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2016) topographical and geological maps and other reports from the same area were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

5.1 ASSUMPTIONS AND LIMITATIONS

The accuracy and reliability of desktop Palaeontological Impact Assessments, as components of heritage impact assessments, are normally limited by the following restrictions:

- Old fossil databases that have not been kept up-to-date or are not computerised. These databases do not always include relevant locality or geological information. South Africa has a limited number of professional palaeontologists that carry out fieldwork and most development study areas have never been surveyed by a palaeontologist
- The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- Impact studies and other reports (*e.g*. of commercial mining companies) - is not readily available for desktop studies.

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on the possible occurrence of fossils in an unexplored area. Desktop studies of this nature therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a Palaeontological Impact Assessment may be significantly improved through field-survey by a professional palaeontologist.

6 FIELD OBSERVATIONS

The photographs shown below were taken on a site visit to the Power line Project near Jacobsdal on 1 September 2016.

The Power line Project footprint is completely underlain by lower Permian sediments of the Ecca Group of the Karoo Basin (White Hill and Prince Albert Formations), Late Permian Volksrust Formation, and the Karoo Dolerite Suite and Quaternary deposits. The Power line Project footprint as a whole is a fairly flat lying terrain with grassy vegetation cover in places as well as a few thorn trees. The Karoo dolerite Suite is unfossiliferous and the sensitivity in the Quaternary sediments is low.

Although the palaeontological sensitivity of the Whitehill, Prince Albert and Volksrust Formations is rated as high to very high, scarcity of fossil-bearing sediments and lack of exposure at the proposed sites indicate that the impact on palaeontological material is low.

The windblown nature of the aeolian deposits will, however, make it difficult to identify fossils and it is likely that most of the fossils will only be exposed during the construction phase. Due to the fact that local finds of fossils can be rich, a Moderate Palaeontological Sensitivity has been allocated to the study area.

Figure 4. Jacobsdal rural substation outside Jacobsdal. Corridor 1 – Kalkaar CSP to Jacobsdal Substation (corridor approximately 19km in length)

Figure 5. Typically flat terrain, vegetation and Quaternary sediments on Corridor 1**.**

Figure 6. Typical pan in Corridor 1.

Figure 7. Skietpan switching station at the end of Corridor 1 and the beginning of Corridor 2 Alternatives 1 and 2.

Figure 8. Flat terrain on Corridor 2 Alternative 1.

Figure 9. Outcrops with vegetation on Corridor 2 Alternative 2**.**

Figure 10. Vegetation and examples of thick Quaternary sediments along the Modderrivier.

7 IMPACT ASSESSMENT

An assessment of the impact significance of the Power line Project on local fossil heritage is presented here.

7.1 Nature of the impact

The excavations and site clearance will involve excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research. According to the Geology of the development site there is a **possibility** of finding fossils.

7.2 Sensitive areas

The development footprint is completely underlain by lower Permian sediments of the Ecca Group of the Karoo Basin (White Hill and Prince Albert Formations), Late Permian Volksrust Formation, and the Karoo Dolerite Suite and Quaternary deposits.

The Karoo dolerite Suite is unfossiliferous and the sensitivity in the Quaternary sediments is low. Although the palaeontological sensitivity of the Whitehill, Prince Albert and Volksrust Formations is rated as high to very high, scarcity of fossil-bearing sediments and lack of exposure at the proposed sites indicate that the impact on palaeontological material in the development footprint is **low**.

7.3 Geographical extent of impact

The impact on fossil materials and thus palaeontological heritage will be limited to the construction phase when new excavations into fresh potentially fossiliferous bedrock take place. The extent of the area of potential impact is thus restricted to the project site and therefore categorised as **local**.

7.4 Duration of impact

The expected duration of the impact is assessed as potentially permanent to **long term**. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be **permanent.**

7.5 Potential significance of the impact

Should the project progress without due care to the possibility of fossils being present at the Power line Project site within the Campbell Rand Subgroup the resultant damage, destruction or inadvertent relocation of any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the development area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

7.6 Severity / benefit scale

The development of the proposed Metals Cluster is **beneficial** not only at a local level, but regional and national levels as well. The facility will provide a long term benefit to the community in terms of creating jobs and would thus provide an economical boost to the area.

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils that were hidden beneath the surface exposures and, as such, would have remained unknown to science.

7.7 Intensity

Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as low.

7.8 Probability of the impact occurring

The sensitivity of the Formations in the development area is considered to be high to very high. The probability of significant impacts on palaeontological heritage during the construction phase is high (definite), but the scarcity of fossil-bearing sediments and lack of exposure at the proposed sites indicate that the impact on palaeontological material in the Power line Project footprint is low.

8 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

8.1 Mitigation

Should fossil material exist within the Power line Project area any negative impact upon it could be mitigated by surveying, recording, describing and sampling of well-preserved fossils by a professional palaeontologist. This should take place after initial vegetation clearance has taken place but *before* the ground is levelled for construction. Excavation of fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.

8.2 Degree to which the impact can be mitigated

Recommended mitigation of the inevitable damage and destruction of fossil stromatolites within the Power line Project area would involve the surveying, recording, description and collecting of fossils within the Power line Project footprint by a professional palaeontologist. This work should take place after initial vegetation clearance has taken place but *before* the ground is levelled for construction.

8.3 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category.

8.4 Degree to which the impact may cause irreplaceable loss of resources

Stratigraphic and geographical distribution of Archaean stromatolites within the Campbell Rand Subgroup has been documented in the literature. Weathered stromatolite assemblages have been documented on the Power line Project footprint, although better preserved specimens could be present on other areas in the Campbell Rand Subgroup. By taking a precautionary approach, a significant loss of fossil resources is expected.

8.5 Cumulative impacts

The cumulative effect of the development of the Power line Project is considered to be low. This is as a result of the broader Kimberley and Jacobsdal area not being considered as highly fossiliferous.

9 FINDINGS AND RECOMMENDATIONS

The Power line Project footprint is completely underlain by lower Permian sediments of the Ecca Group of the Karoo Basin (White Hill and Prince Albert Formations), Late Permian Volksrust Formation, and the Karoo Dolerite Suite and Quaternary deposits. The Power line Project footprint as a whole is a fairly flat lying terrain with grassy vegetation cover in places as well as a few thorn trees. The Karoo dolerite Suite is unfossiliferous and the sensitivity in the Quaternary sediments is low. Although the palaeontological sensitivity of the Whitehill, Prince Albert and Volksrust Formations is rated as high to very high, scarcity of fossil-bearing sediments and lack of exposure at the Power line Project indicate that the impact on palaeontological material is low.

10 IMPACT TABLE

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.

IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		

1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects

INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

Table 1. Impact Assessment.

IMPACT TABLE	
Environmental Parameter	*Impact on the Palaeontology Heritage (fossils) of the development footprint*
Issue/Impact/Environmental Effect/Nature (E)	The excavations and site clearance during the construction phase will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research. This impact is likely to occur only during the construction phase. No impacts are expected to occur during the operation phase.
Extent	Corridor 1: Kalkaar CSP to Jacobsdal Substation (approximately 20km in length); Corridor 2 Alternative 1: Kalkaar CSP via Kimberley Distribution Substation to Boundary Substation (approximately 62km in length); and Corridor 2 Alternative 2: Kalkaar CSP via Kimberley Distribution Substation to Boundary Substation (approximately 62km in length
Probability	During the site visit to the development area no fossils were detected. Although the sensitivity of the Formations a considered to be high to very high. The probability of significant impacts on palaeontological heritage during the construction phase is low.
Reversibility	Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category
Irreplaceable loss of resources	Stratigraphic and geographical distribution of fossils within the relevant formations (see findings) has been documented in the literature. During a field assessment fossils were not detected on the development footprint, but

	the possibility that these fossils actually could occur is a possibility (windblown aeolian deposits). By taking a precautionary approach, a significant loss of fossil resources is expected.
Duration	The expected duration of the impact is assessed as potentially permanent to **long term**. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be **permanent**
Cumulative effect	Low Cumulative Impact The cumulative effect of the development area within the proposed location is considered to be low
Intensity/magnitude	Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as low
Significance Rating	*A brief description of the importance of an impact which in turn dictates the level of mitigation required*

	Pre-mitigation impact rating	**Post mitigation impact rating**
Extent	2	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	4	1
Cumulative effect	2	1
Intensity/magnitude	2	1
Significance rating	-20 (high negative)	-6 (low negative)
Mitigation measures	Recommended mitigation of the inevitable damage and destruction of fossil within the proposed development area would involve the surveying, recording, description and collecting of fossils within the development footprint by a professional palaeontologist. This work should take place after initial vegetation clearance has taken place but *before* the ground is levelled for construction Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective.	

	The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category. *Not deemed necessary unless fossils are uncovered during the construction phase.*

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

11 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Elize Butler has an MSc (cum laude) in Zoology specialising in Palaeontology from the University of the Free State (2010). She has been active in Palaeontology since 1993. Her current research interests comprise of Permo-Triassic vertebrate palaeobiology, with a special focus on the End-Permian Mass Extinction. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been conducting Palaeontological Impact Assessments since 2014 and has been a member of the Palaeontological Society of South Africa for 10 years.

12 DECLARATION OF INDEPENDENCE

I, hereby declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.

Sincerely

E. Butler

Palaeontologist

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