DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF A PROPOSED SOLAR POWER FARM TO BE LOCATED ALONG THE WESTERN MARGIN OF THE FARM RUBY VALE 266 R PTN 2, NEAR OLIFANTSHOEK, NORTHERN CAPE PROVINCE

16 December 2019

Prepared for:
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Prepared for:

Environamics CC

Prepared By:

Dr B.D. Millsteed

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EXECUTIVE SUMMARY

It is proposed to construct a solar power farm approximately ca. 31.5 km southwest of Oliphantshoek, ca. 44 km northwest of Matsap, and ca. 44 km west of Postmasburg in the District Municipality of Siyanda, Magisterial District of Postmasburg, Northern Cape Province. The proposed solar power project is to be located within the farm Ruby Vale 266 Remaining Extent of Portion 2. All infrastructure proposed to constitute this project will be located within the confines of 1:50 000 topographic map 2822BA. However, the southern portion of the farm Ruby Vale 266 Remaining Extent of Portion 2 occurs within 1:50 000 map 2822BC. The project area is composed of two (2) portions (named A and B herein) of 300 ha each (i.e., cumulatively 600 ha). A ca. 4.28 km long powerline is envisaged that will connect the project area to the Lewensaar Substation; the later will connect the electricity generation facility to the national power grid.

Environamics CC, has been appointed as independent consultants, to undertake the compilation of a Draft Scoping Report (DSR) to be submitted to the Department of Environmental Affairs. Environamics CC has appointed BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the Heritage Impact assessment report that will form part of the EMP.

The project area is underlain by Palaeoproterozoic strata of the Brulsand Subgroup, Volop Group, Oliphantshoek Supergroup. It is the outcrop of this unit that forms the areas of topographically elevated land to the north and south of the project area. The combined outcrop of the Brulsand Subgroup and stratigraphically older Matsap Subgroup (Volop Group, Oliphantshoek Supergroup) strata form the Langberg to the east of the project area. The area underlying the planned infrastructure consists of unconsolidated, superficial Cainozoic regolith of the Kalahari Group (probably the Gordonia Formation). Diagenetic calcrete may underly the Kalahari Group, and crop out in the interdune areas.

The Kalahari Group strata are known to be fossiliferous, although in the case of the Gordonia Formation fossils are not common. Diagenetic calcrete may underly Gordonia Formation sands or crop out in interdune areas; the calcretes are unfossiliferous. The bedrock strata underlying the entire area are unfossiliferous. The Brulsand Subgroup strata are also unfossiliferous.

The activities within two project areas (areas A and B) will entail the generation of approximately 115 MW of electrical power each (cumulatively 230 MW), through photovoltaic (PV) panels. The total footprint of the two project areas will be approximately 300 ha.

The aerial extents of the two project areas (areas A and B) will be almost completely populated with solar power panels. The individual solar panels will be connected to the

power grid via a network of buried powerlines. These powerlines will be emplaced and buried in shallow excavations. The power generation infrastructure of the project will be connected to the national power grid via a connecting powerline. The connecting powerline extends from the Lewensaar Substation to the north-eastern corner of area B; thence along the margin of area B until the north-eastern corner of area B. Most of each solar power panel will be constructed above ground level. It is expected that the impact of the construction of the solar panels upon the underlying geology will be the excavation of a small, shallow excavation (<1 m deep and < 2 m^2) that will accommodate the concrete foundation for the panel. The individual solar panels will be connected to the power grid via a network of buried powerlines. These powerlines will be emplaced in shallow excavations < 1 m deep. It is evident that the proposed project infrastructure will only negatively impact upon the upper-most 1 m of the land surface.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. The geographical extent of the impacts of the project will be restricted to the project area. The duration of any negative effects will be permanent. The intensity/magnitude of any potential negative impacts are assessed as being very high. The negative effects are irreversible (in the absence of mitigation protocols). This damage will result in marginal loss of the palaeontological heritage resource in the project area. The probability of these negative effects is, however, unlikely. The calculation of the cumulative effects of this project is problematic for palaeontological materials; the project has, however, been assessed as having negligible cumulative effects using the standardised criteria utilized in this report. When the above impact assessments are aggregated, the significance of the proposed negative effects is assessed as being negative low impacts.

The majority of the identified possible negative impacts will occur during the operational phase of the project. The negative impacts that prevail during the operational phase will be remedied during the decommissioning phase when the project infrastructure is removed. No mitigation procedures are required during the decommissioning phase.

To mitigate any potential negative impacts that my result from the construction phase the following mitigation procedures (numbered 1-4 below) are recommended: -

1. A thorough site investigation by a palaeontologist as part of a Full Palaeontological Impact Assessment prior to the commencement of construction
2. The investigation should cover the regions identified as areas A and B (where the solar collection panels will be erected) as well as the area underlying the route of the electrical cable connecting areas A and B to the Lewensaar Substation
3. A Full Palaeontological Impact Assessment report should be compiled and submitted to SAHRA for its consideration and recommendations
4. Should scientifically or culturally significant fossil materials exist within the project area any negative impact upon them should be mitigated by:

- Its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution.
- Should the fossils be sufficiently scientifically significant and excavation be either impossible they should be protected completely and preserved *in situ* by erecting a fence around the area containing them

In summary, this desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to the suggested mitigation protocols being put in place.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1 INTRODUCTION

It is proposed to construct a solar power farm approximately 31.5 km southwest of Oliphantshoek, ca. 44 km northwest of Matsap, and ca. 44 km west of Postmasburg in the District Municipality of Siyanda, Magisterial District of Postmasburg, Northern Cape Province (Figure 1). The proposed solar power project is to be located within the farm Ruby Vale 266 Remaining Extent of Portion 2. All infrastructure proposed to constitute this project will be located within the confines of 1:50 000 topographic map 2822BA but the southern portion of the farm Ruby Vale 266 Remaining Extent of Portion 2 occurs within 1:50 000 map 2822BC. Figure 2 shows that the project area is composed of two portions (named areas A and B herein) of 300 ha each (i.e., cumulatively 600 ha). The approximate co-ordinates of the centre points of these two areas is approximately latitude -28.212484°, longitude 22.556260° and latitude -28.224259°, longitude 22.546771° respectively. A ca. 4.28 km long powerline is envisaged that will connect the project are to the Lewensaar Substation; the later will connect the electricity generation facility to the national power grid.

Environamics CC has been appointed as independent consultants, to undertake the compilation of a Draft Scoping Report (DSR) to be submitted to the Department of Environmental Affairs. Environamics CC has appointed BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the Heritage Impact assessment report that will form part of the EMP.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study were as follow: -

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area
- Provide an overview of the applicable legislative framework
- Describe and quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions supplied by Environamics CC
- Describe mitigation measures to address impacts during the construction, operation, and decommissioning stages
- Describe cumulative impacts of the project on paleontological resources in both the local study area regional study area and the proponent’s plans to manage those effects
- Make recommendations concerning future work programs as, and if, necessary
- Supply the client with geo-referenced GIS shapefiles of any sensitive areas

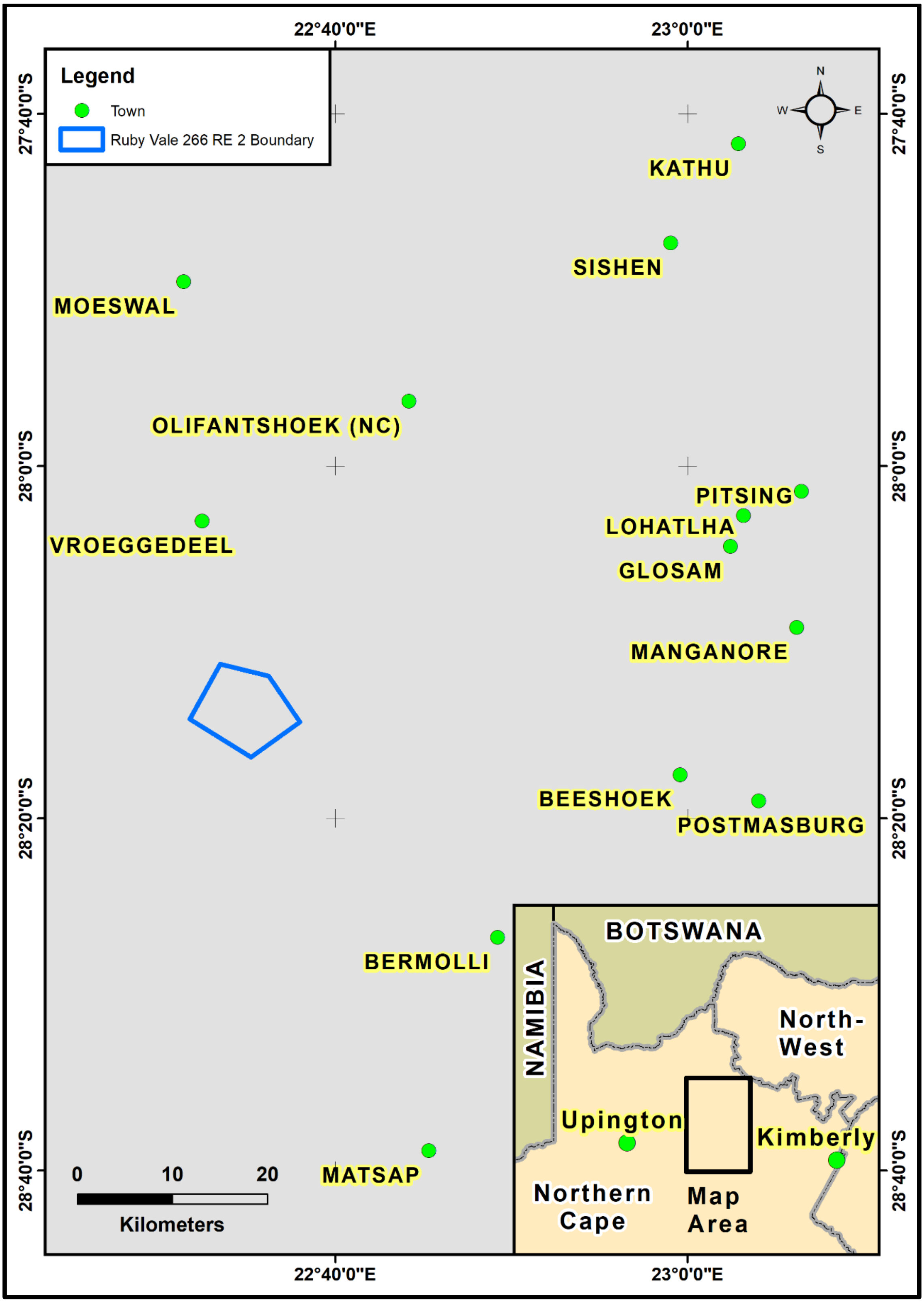

Figure 1: Location map showing the boundary of the farm Ruby Vale 266 Remaining Extent of Portion 2.

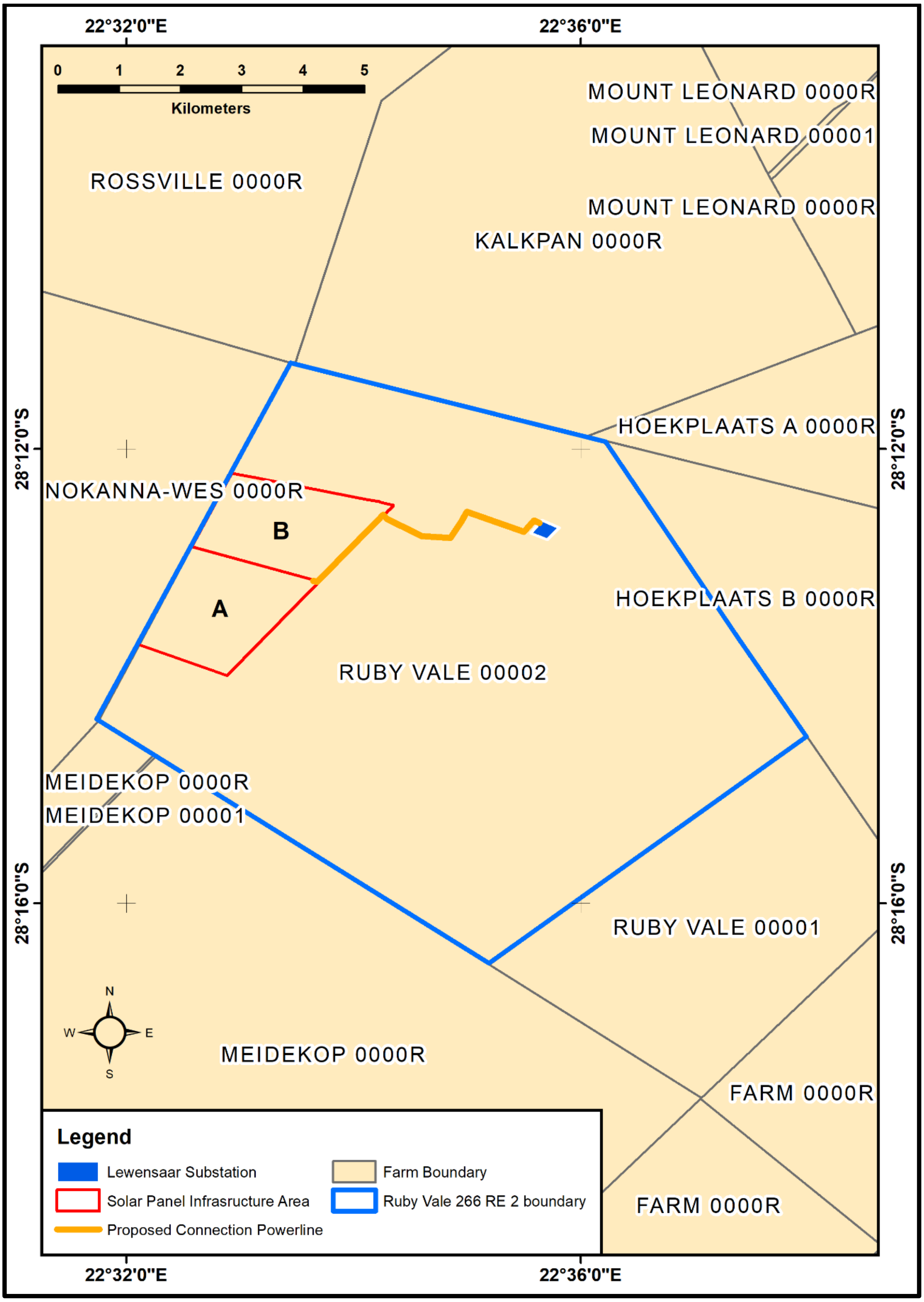

Figure 2: Location of areas A and B (red polygons) and other proposed project infrastructure within the farm Ruby Vale 266 Remaining Extent of Portion 2 (blue polygon).

3 LEGISLATIVE REQUIREMENTS

South Africa's cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

3.1 The National Heritage Resources Act

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures, and sites older than 100 years,
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography,
- Objects of decorative and visual arts,
- Military objects, structures, and sites older than 75 years,
- Historical objects, structures, and sites older than 60 years,
- Proclaimed heritage sites,
- Grave yards and graves older than 60 years,
- Meteorites and fossils,
- Objects, structures, and sites or scientific or technological value.

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures, and equipment of cultural significance,
- Places to which oral traditions are attached or which are associated with living heritage,
- Historical settlements and townscapes,
- Landscapes and features of cultural significance,
- Geological sites of scientific or cultural importance,
- Sites of Archaeological and palaeontological importance,
- Graves and burial grounds,
- Sites of significance relating to the history of slavery,
- Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

3.2 Need for Impact Assessment Reports

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following criteria:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300m in length,
- The construction of a bridge or similar structure exceeding 50 m in length,
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof,
- Re-zoning of a site exceeding 10 000 m^2,
- Any other category provided for in the regulations of SAHRA or a provincial heritage 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. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development upon palaeontological resources of the area proposed to be affected.

3.3 Legislation Specifically Pertinent to Palaeontology*

*****Note: Section 2 of the Act defines "palaeontological" material as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains".

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- 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 that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above-mentioned palaeontological objects may only be disturbed or moved by a palaeontologist and after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that "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.". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act

This Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but is more general in is application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns, and amongst other issues, serve their cultural interests equitably. Further to this point, Section 2(4)(a)(iii) states that disturbances of sites that constitute the nation's cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 RELEVENT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African, a member of the Association of Australasian Palaeontologists, and is a Fellow of the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact Assessment study and shall receive remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either Donaway (Pty) Ltd, the proposed solar farm project or any persons or companies associated with the project.

6 GEOLOGY AND FOSSIL POTENTIAL

Figure 3 shows that the project area is underlain by Palaeoproterozoic strata of the Brulsand Subgroup, Volop Group, Oliphantshoek Supergroup. It is the outcrop of this unit that forms the topographically elevated areas of land to the north and south of the project area. The combined outcrop of the Brulsand Subgroup and stratigraphically older Matsap Subgroup (Volop Group, Oliphantshoek Supergroup) strata form the Langberg to the east of the project area. The area underlying the planned infrastructure consists of unconsolidated, superficial Cainozoic regolith of the Kalahari Group that mantles the bedrock. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

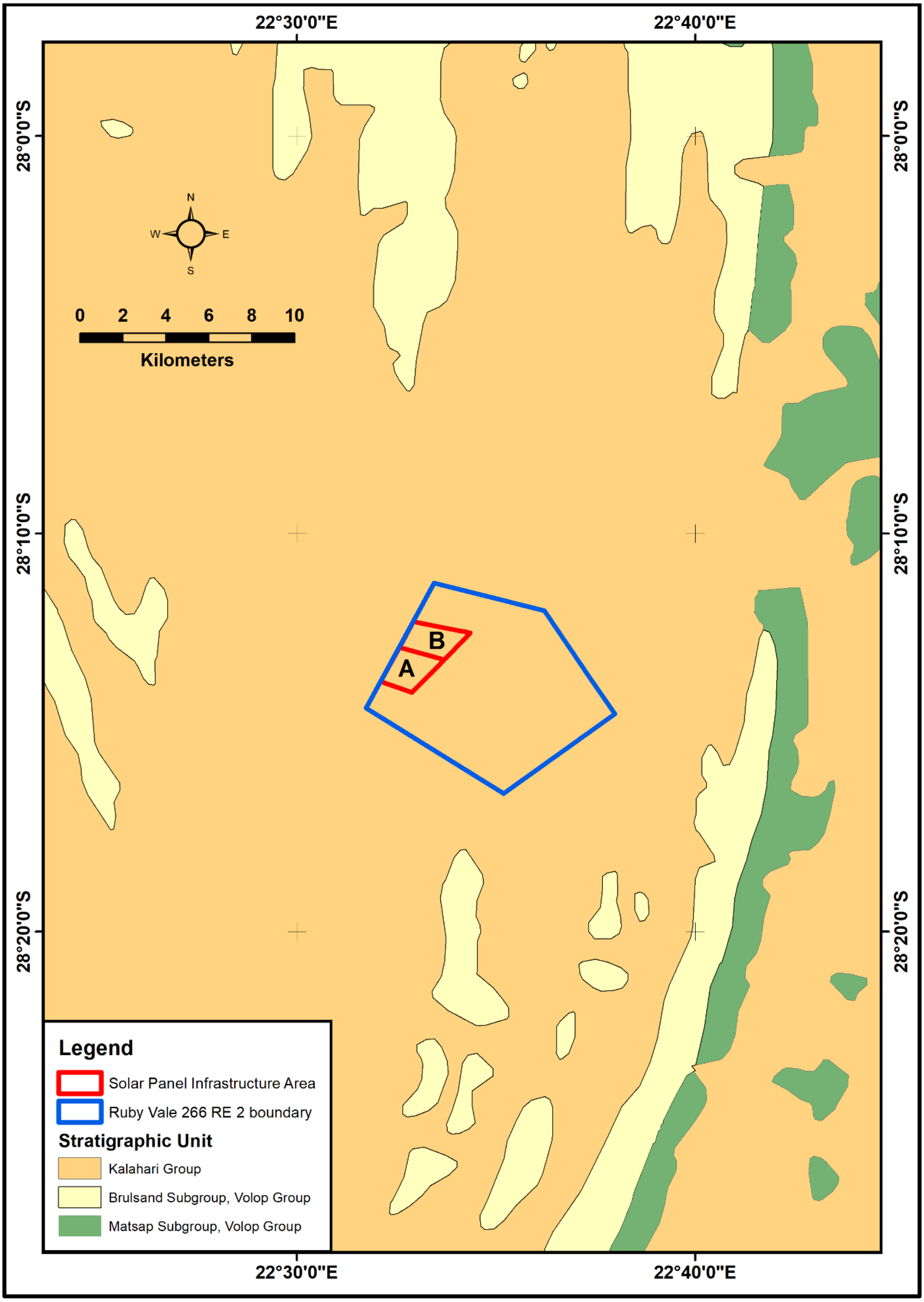

Figure 3: Map of the geological units underlying the project area.

6.1 Brulsand Subgroup, Oliphantshoek Supergroup

6.1.1 Geology

The Palaeoproterozoic strata of the Brulsand Subgroup consists of mainly light grey to white arenites and minor shale (Moen, 2006). These meta-sediments were originally deposited as a terrigenous fluvial clastic wedge along the western margin of the Kaapvaal Craton (Moen, 2006). Isotopic dates obtained from the strata are 1894 ± 48 my (Armstrong, 1987) and 1928 ± 4 my (Cornell, *et al*., 1998). Shortly after deposition of the Oliphantshoek Supergroup the lithological unit was deformed by low-intensity folding and low-angle thrusting. The deformation was associated with the ± 1800 my old Kheis Orogeny (Stowe, 1986; Cornell, *et al*., 1998).

6.1.2 Palaeontologial potential

No fossils are known to occur within the strata of the Olihantshoek Supergroup. Indeed, no fossils are known in any terrestrially deposited strata of Palaeoproterozoic age in South Africa. Stromatolite fossils older than the Oliphantshoek Supergroup strata do exists in the country, but these all occur in marine strata. In addition, the age of the unit predates the development of multicellular life anywhere on Earth and, accordingly, the unit is considered unfossiliferous.

6.2 Gordonia Formation, Kalahari Supergroup

6.2.1 Geology

Figure 3 shows that the land surface underlying the planned project infrastructure is composed of superficial Cainozoic deposits assigned to the Kalahari Group. The outcropping Kalahari Group in the region is composed of several units of differing lithological character and origin; these include fine clay-rich pan deposits, red and grey aeolian sands, sandy soil, and alluvium. A discussion of these lithological groups follows: -

- *Alluvial deposits*
  Most of the alluvial deposits in this region have a yellow-red to reddish-yellow colour due to the underlying leucocratic pink gneisses and granites. These deposits characterise the infill of depressions and valleys and comprise a mixture of sand, silt, and clay (Macey *et al*., 2011).
- *Sandy Soils*
  These fine-grained silty and gypsum-rich soils have a light- to grey-brown colour and weathers to a powdery white dust. The gypsum occurs both as powdery gypsum and as selenite gypsum crystals (desert rose) (Macey *et al*., 2011). The gypsum was

probably formed under lacustrine conditions during the Cainozoic (De Beer *et al*., 2002).

- *Aeolian sand deposits*
  These deposits consist of fine-grained, well sorted red aeolian sands occurring as a generally < 2 m thick veneer covering large parts of the region. The sand is usually thin, but can thicken to form low dunes oriented in a predominantly north-easterly direction (Macey *et al*., 2011). These sands have previously been correlated with the Gordonia Formation of the Kalahari Group. However, Agenbacht (2007) has argued that the extensive distance between and non-physical continuity of these sands with those of the Kalahari Basin demands the use of a separate nomenclature for the local sands.
- *Pan sediments*
  The pans containing these fine clay-rich sediments are relicts of an extensive, north flowing palaeo-drainage system known as the Koa River Geelvloer palaeovalley that fed into the palaeo-orange river near Henkries in the mid-Miocene Epoch. The climate during this time was markedly wetter the drainage systems more active than in subsequent times (Macey *et al*., 2011).

The author's extensive professional experience in the region, as well as interpretation of Google earth imagery of the project area suggests that the lithology present in the project area and its surrounding environs is probably the red, aeolian sands of the Gordonia Formation. The map in Figure 3 suggests that the Gordonia Formation forms a constant, uniform regolith horizon where it occurs. However, as indicated above the unit is generally occurs as a < 2 m thick veneer covering large parts of the region. The author's experience is that the land surface coverage of the Gordonia Formation is inconsistent. There are often exposures of older, underlying geological units or diagenetic calcrete exposed in the interdune areas.

The possibility exists for alluvium (as described above) to be located within and upon the margins of fluvial drainage lines in the area. Similarly, it is also reasonable to expect the possibility of pan sediments within the region. However, no pans or significant fluvial channels appear to be present in the study area.

6.2.2 Palaeontological potential

The Late Pliocene/Early Pleistocene to Recent age aeolian sands of the Gordonia Formation are frequently not fossiliferous. That said, at Bosluis Pan (within reddish aeolian sands of the Cainozoic superficial deposits) are common, spherical calcretised termitarea up to 250 cm across. These termitarea resemble nests constructed by the extant harvester termite *Hodotermes* (Macey *et al*., 2011). There are also smaller nests (8 cm in diameter) resembling those of *Psammatermes* present (De Wit, 1990). It may also be expected that micro-mammal assemblages may be present as they are in the aeolian sands of the Namib Desert).

When considering the fossil potential of the Gordonia Formation it is important to be cognoscente of the reality that the unit frequently does not completely cover the underlying bedrock units (although it may appear to be uniform on geological maps). While the Gordonia Formation may not be commonly fossiliferous, it is important to consider the fossil potential of the underlying bedrock (which may cop out in the interdune areas) when assessing the impact of a project upon the fossil heritage of an area. Thus, on a geological map showing a cover of Gordonia Formation, there may be potential of negatively impacting fossiliferous units at surface.

Where the inter-dune region has superficial deposits of calcrete the genesis of the calcrete is salient to the fossil potential of the unit. The calcrete is diagenetic in origin and formed below the land surface; as such, no fossil material would be expected to occur in the unit. Indeed, where ever exposures of this calcrete have previously been encountered by the author in the region they are unfossiliferous.

The Cainozoic-age surface deposits of the greater central and north-western region of South Africa can be highly fossiliferous in places. There are accumulations of Cainozoic sediments elsewhere within the Northern Cape Province and south-western Namibia region that contain a number of scientifically significant fossil assemblages. These provide invaluable insight into the paleoenvironment and palaeoecology of South Africa during the preceding 15-16 million years (see Figure 4 for the location of the sites discussed below). A summary of the major Cainozoic fossil assemblages within the wider region follows.

A significant Early to Middle Miocene vertebrate fauna has been recorded from the alluvial deposits (gravels, grits, and lenses of clay and sand) of the Koa River palaeovalley system at Bosluis Pan (approximately 60 km northwest of the project area (Figure 4). This fauna has been date to 15-16 Ma. This fauna has been reviewed by Senut *et al*., (1996) and contains rare bones, tusks, molars, and numerous tooth fragments of *Gomphopherium*, crocodile teeth and tortoise shell fragments as well as elephant shrews, giraffids, bovids, a rhinocerotid and a catfish. The fauna is related to, but slightly older famous fauna from Arris Drift (Macey *et al*., 2011). Well-indurated sands with abundant traces are situated between the Miocene fluvial succession at Bosluis Pan and the younger reddish aeolian superficial sands (Macey *et al*., 2011) and horizontally- to vertically oriented rhizoliths occur within the massive red-sand facies in the upper part of the Bosluis Pan succession (De Wit, 1990).

Sediments of Pleistocene and younger age within the Koa River Valley palaeodrainage system at Bosluis Pan and elsewhere in the region contain fragments of egg shells of the modern ostrich as well as shells of the desert snail *Trigonepherus* (Senut and Pickford, 1995; Senut *et al*., 1996).

In the Brandvlei Area (south-east of the project area) and within calcretised basal alluvial facies of the Geelvloer Palaeovalley are bones of anthracotherids (extinct *Hippopotomus*-like artiodactyles) (Macey *et al*., 2011).

Abraded Plio-Pleistocene fossil woods from relict alluvial terraces from the Sak River (just to the north of Brandvlei) includes specimens from the family Polygalaceae (Bamford and De Wit, 1993).

Thick (2 m) shelly coquinas of the small freshwater gastropod *Tomichia ventricosa* occur at elevations up to 10 m above the present-day floor of the Swartkolkvloer, approximately 50 km south-west of Brandvlei (Kent and Gribnitz, 1985). These shells have been radiocarbon dated to latest Pliocene (Macey *et al*., 2011). These snails are characteristic of brackish to saline ponds.

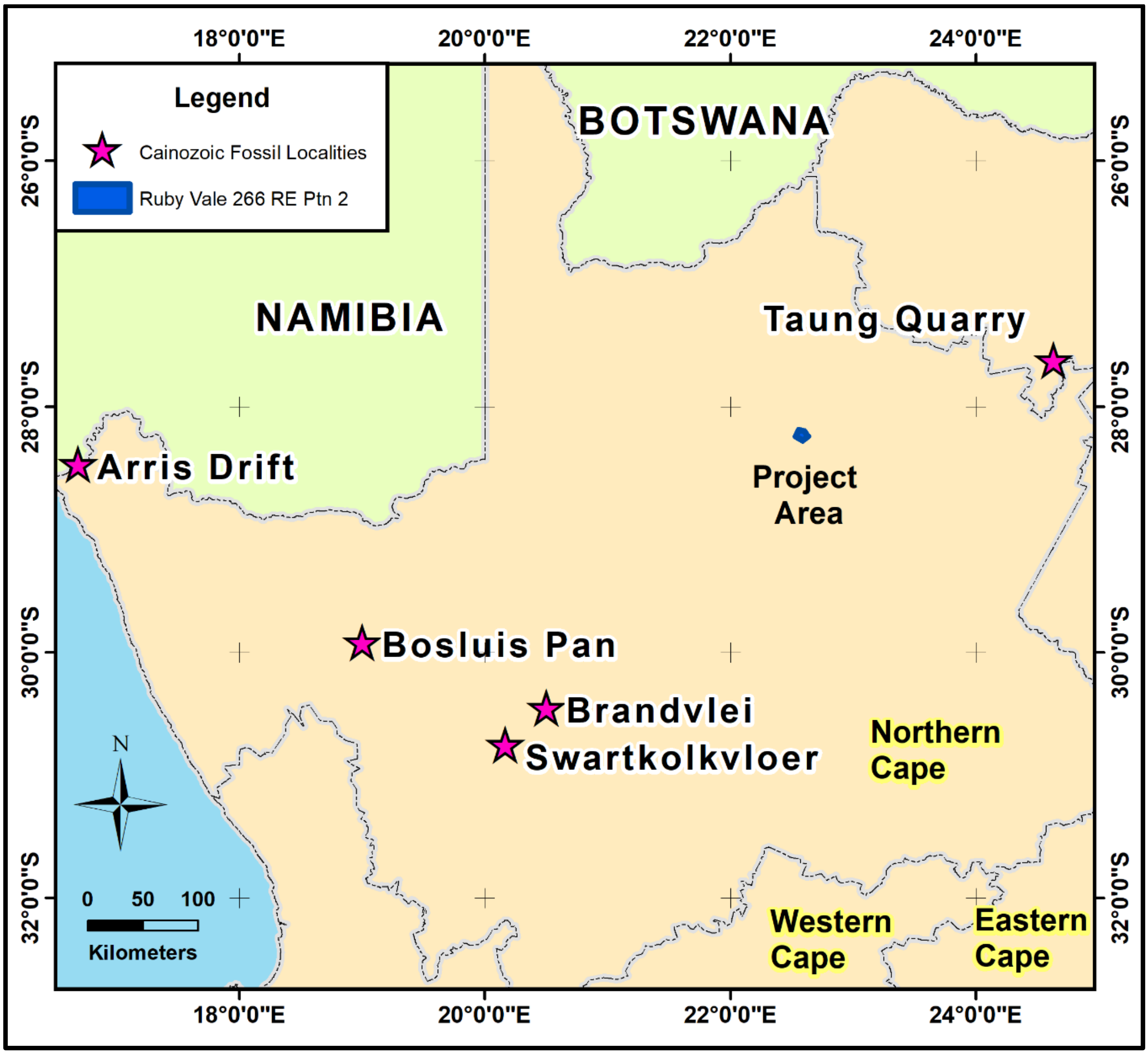

Figure 4: Map of the region surrounding the position of the proposed mine. Shown are the locations of the significant Cainozoic fossil sites discussed in Sections 6.2.2. and 9.7.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The area where the solar farm project will be located consists of two portions (named areas A and B herein). Areas A and B both have aerial extents of approximately 300 ha (i.e., cumulatively 510 ha). A ca. 3.95 km long powerline is envisaged that will connect the project are to the Lewensaar Substation. The substation will connect the electricity generation facility to the national power grid. The area that will contain the solar panels is located immediately adjacent to the western margin of the farm Ruby Vale 266 Remaining Extent of Portion 2. The area's eastern margin is defined by a railway line. The northern margin is defined by the dirt road extending between Nokanna homestead and Langberg. The connecting powerline extends from the Lewensaar Substation to the north-eastern corner of area B; thence along the margin of Area B until the north-eastern corner of area B.

Examination of Google earth imagery of the project area and the connecting powerline (Figure 5) suggests that the land surface is topographically flat and featureless. However, Figure 6 indicates that the land surface slopes gently from east to west across the project's extent. No significant fluvial waterways traverse the area and there are no pans present within the affected area (Figure 6).

Mucina and Rutherford (2006) indicate that the vegetation cover of project areas A and B consists of the Gordonia Plains Shrubland (Figure 7). The land underlying the Lewensaar Substation and the connecting powerline (up until it joins with Area B) is vegetated with the Oliphantshoek Plains Thornveld vegetation biome. Mucina and Rutherford (*op. cit*.) indicate that the conservation status of the Gordonia Plains Shrubland as being moderately protected, while that of the Oliphantshoek Plains Thornveld is described as hardly protected. The absence of signs of cultivation/development within the boundaries of the project area (Figure 5) suggests that the majority of the site is predominantly utilised for grazing and/or game farming.

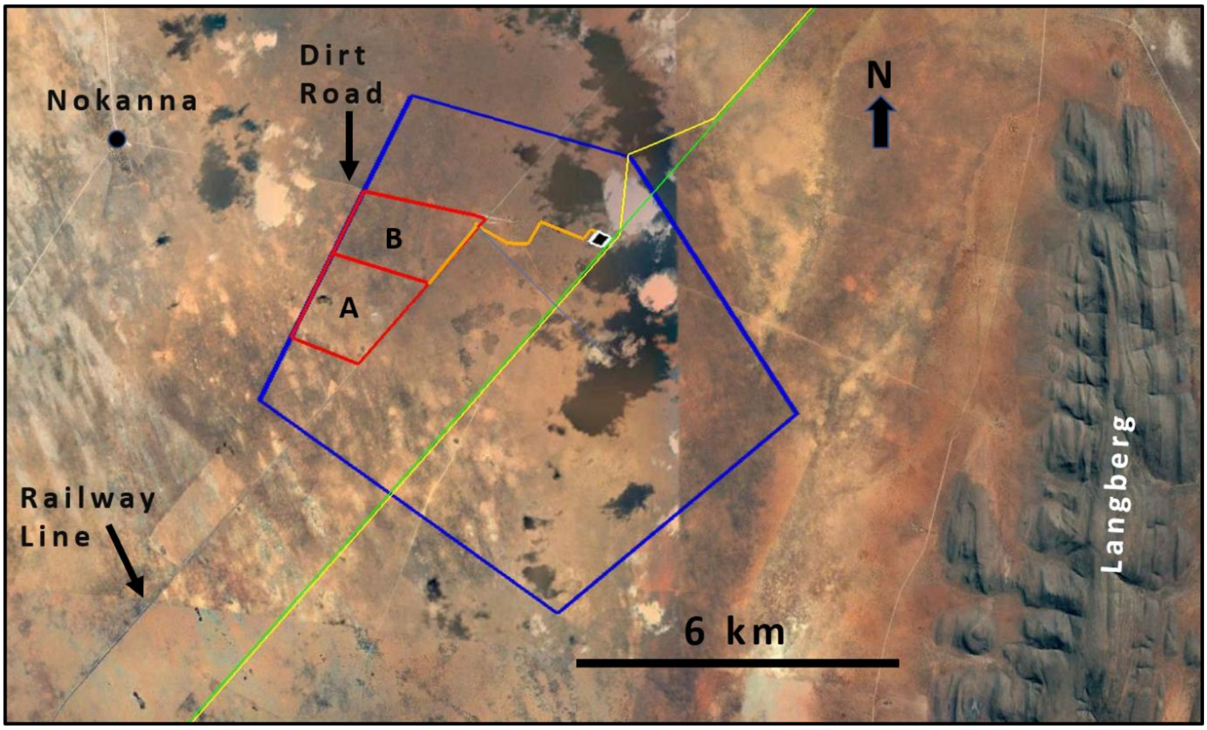

Figure 5: Google earth image of the boundary of the farm Ruby Vale 266 Remaining Extent of Portion 2 (blue polygon), the project areas (the red polygons), the proposed connecting powerline (orange line) and the Lewensaar Substation (black polygon with white edge) and Nokanna farmstead. It is evident from the land surface underlying areas A and B and the remaining infrastructure is flat, featureless, and undeveloped.

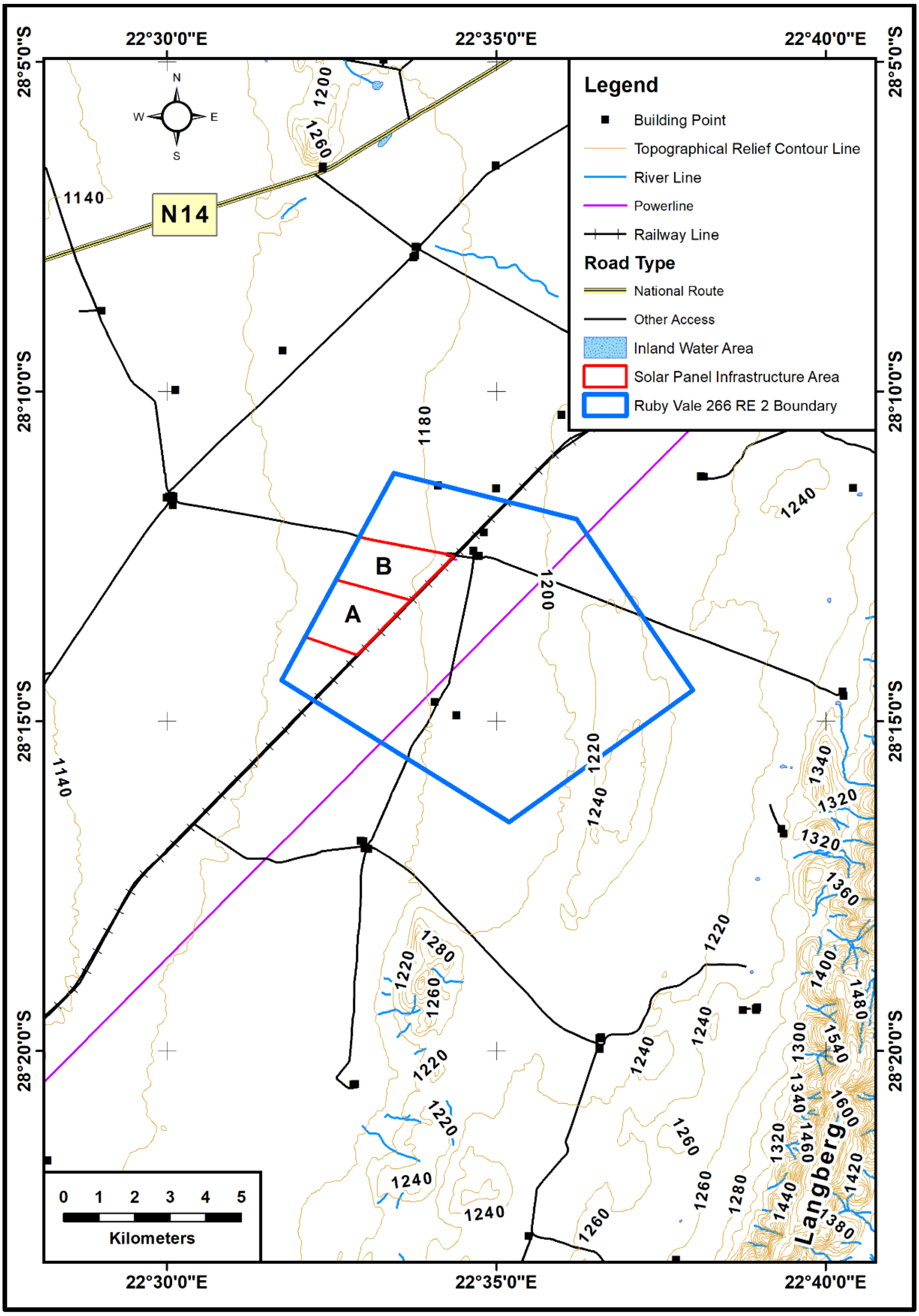

Figure 6: Map of the project area and its immediate environs. It is evident that the region is generally topographically flat and featureless, but slopes gently to the west. It is also evident that there are no significant fluvial drainage channels that traverse the project area or the route of any planned infrastructure. The topographic contour interval is 20 m.

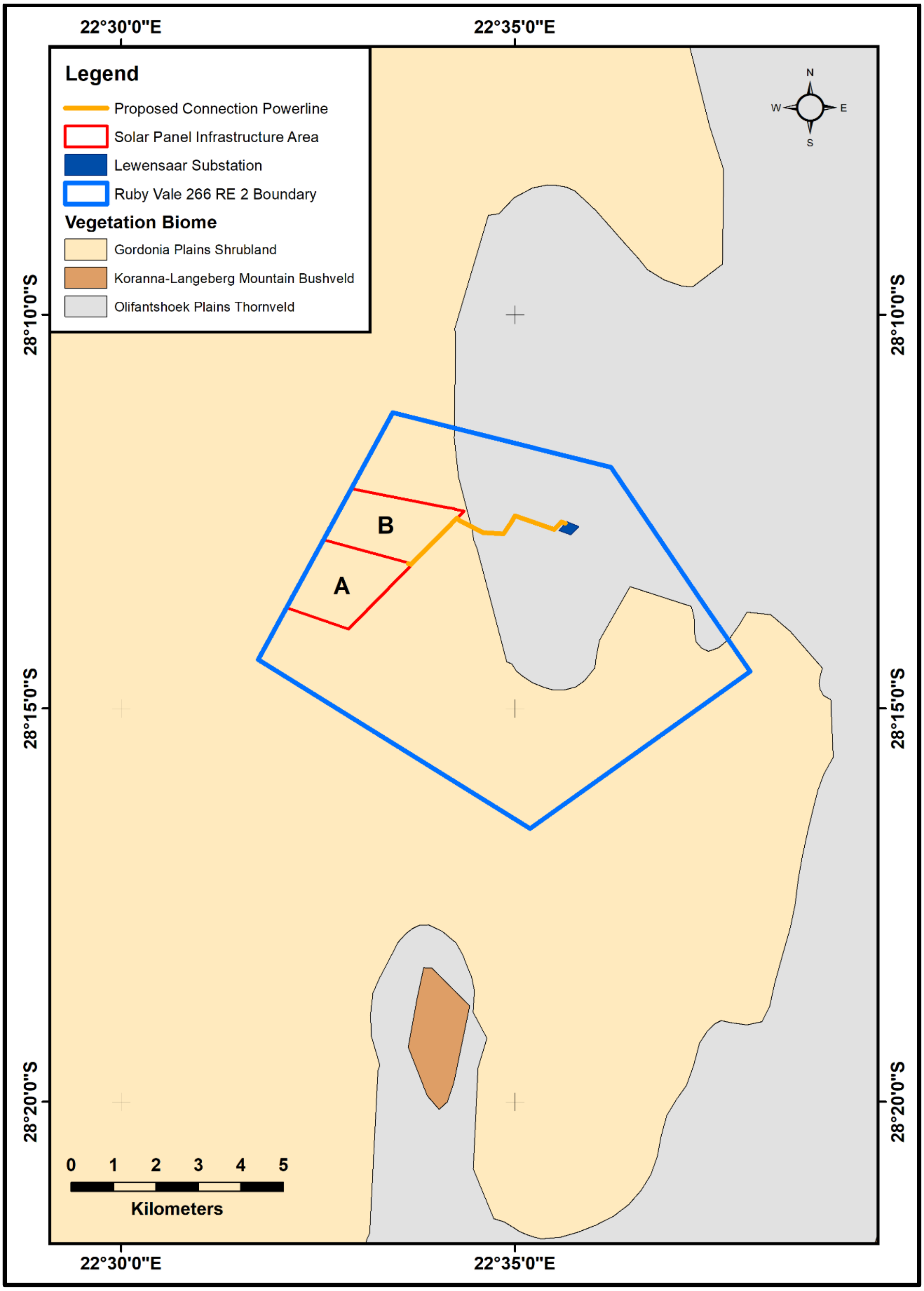

Figure 7: Map of the distribution of the vegetation veld types located within the project area and the immediate environs (after Mucina and Rutherford, 2006).

8 OVERVIEW OF SCOPE OF THE PROJECT

The aerial extents of the regions identified, herein, as areas A and B will be almost completely populated with solar power panels. The individual solar panels will be connected to the power grid via a network of buried powerlines. These powerlines will be emplaced and buried in shallow excavations. The power generation infrastructure of the project will be connected to the national power grid via a connecting powerline. The connecting powerline extends from the Lewensaar Substation to the north-eastern corner of Area B; thence along the margin of area B until the north-eastern corner of area B.

8.1 Required infrastructure

The activities within the two project areas (areas A and B) will entail the generation of approximately 115 MW of electrical power each, through photovoltaic (PV) panels. The total footprint of each project will be approximately 300 ha. The key components of the individual proposed projects are described below:

- PV Panel Array - To produce 115 MW, each facility (area A and B) will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. Since these projects only require ca. 300 ha of land, there is scope to avoid major environmental constraints through the final design of the facilities. The PV panels will be tilted at a northern angle in order to capture the most sun.
- Wiring to Central Inverters - Sections of the PV array will be wired to central inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- Connection to the grid - Connecting the array to the electrical grid requires transformation of the low voltage from 480 V to a medium voltage of for example 11 kV, 22 kV or 33 kV to 132 kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is expected to be 480 V and this is fed into step up transformers to a maximum voltage of 132 kV. Onsite substations will be required to step the voltage up to 132 kV, after which the power will be evacuated into the national grid. The exact scope of the grid connection is not finalized at the time of compilation of this report.
- Supporting Infrastructure - A control facility with basic services such as water and electricity will be constructed on each site and will have an approximate footprint 400 m². Other supporting infrastructure include voltage and current regulators, and protection circuitry.
- Roads – Ready access already exists from the D 3300 and an internal site road network will be constructed to provide access to the solar field and associated

infrastructure will be required. A corridor of 25 m will be assessed for the location of site roads.

- Fencing - For health, safety and security reasons, the facilities will need to be fenced off from the surrounding farms.

8.2 Effect of project on the geology

Most of each solar power panel will be constructed above ground level. It is expected that the impact of the construction of the solar panels upon the underlying geology will be the excavation of a small, shallow excavation (<1 m deep and < 2 m^2) that will accommodate the concrete foundation for the panel. The individual solar panels will be connected to the power grid via a network of buried powerlines. These powerlines will be emplaced in shallow excavations < 1 m deep. It is evident that the proposed project infrastructure will only negatively impact upon the upper-most 1 m of the land surface.

9 IMPACT ASSESSMENT

The potential impact of the proposed solar farm project is categorised below according to the assessment criteria, supplied by Environamics CC, outlined in Appendix 1. The findings of this section are summarised below in Table 1.

9.1 Nature

The potential negative impacts of the proposed project on the palaeontological heritage of the area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil materials are present, and will be directly affected by the building or construction of the projects infrastructural elements, the result will potentially be the irreversible damage or destruction of the fossil(s).
- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

In summary, the following negative impacts can be expected during the various phases of the project: -

1. *Construction:* The movement/damage/destruction of fossils as a direct result of the construction activities,
2. *Operation:* Loss of scientific access to the areas underlying project infrastructure,
3. *Decommissioning:* No negative impacts are anticipated.

9.2 Geographical Extent

The possible extent of the permanent impacts of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The extent of the area of potential impact caused by the project is, accordingly, categorised as being restricted to the **site.**

9.3 Duration

The anticipated duration of the identified impact is assessed as potentially long-term to permanent. This is assessment is determined because, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below the structures and infrastructural elements that will constitute the solar power project infrastructure will be unavailable for scientific study for the life of the existence of those features (i.e., permanent). The duration of any negative effects upon the palaeontological heritage of the geological units underlying the project infrastructure will be **permanent**.

9.4 Probability

The red aeolian sands of the Gordonia Formation are fossiliferous in specific areas of the region. However, the unit is not usually known to be fossiliferous and no fossil deposits are known to occur in it within the project area. The probability of the project negatively impacting upon the palaeontological heritage of the Gordonia Formation is assessed as being **unlikely**.

The bedrock underlying the project area is the Brulsand Subgroup are unfossiliferous. Similarly, should calcrete be present cropping out in the interdune regions of the Gordonia Formation this unit is also unfossiliferous. Accordingly, the probability of the project negatively impacting upon the palaeontological heritage of these geological units is assessed as being **unlikely**.

9.5 Intensity/ Magnitude

The rocks of the Brulsand Subgroup are unfossiliferous; should diagenetic calcrete be present beneath the Gordonia Formation sands or crop out in the interdune areas it is also unfossiliferous. The significance of any negative impacts upon the palaeontological heritage of these stratigraphic units will be **low**.

It was discussed above, in Section 6.2.2, that significant fossil assemblages are not common place within the Cainozoic deposits of the region. Despite this, the fossils that do occur are extremely significant for documenting the palaeoecology and palaeoclimate of this portion of the stratigraphic column. This is a portion of the stratigraphic column that is not well represented in South Africa's fossil heritage. Thus, the rarity of fossils within the sequence makes each fossil that is present potentially scientifically significant. Accordingly, the intensity/ magnitude of any negative impacts upon fossils within the Gordonia Formation would be **very high**. As the Kalahari Group (probably Gordonia Formation) mantles the land surface throughout the project area, and will be directly impacted upon by the majority of the construction activities the intensity/magnitude of the project overall is assessed as being **very high**.

The scientific and cultural significance of fossil materials is underscored by the fact that many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of project infrastructural elements the result will be the irreversible damage or destruction of the fossil(s).

The certainty of the exact *in situ* location of fossils and their precise location within the stratigraphic sequence is essential to the scientific value of fossils. The movement of any fossil material during the construction of the facility that results in the exact original location of the fossil becoming unknown will either greatly diminish or destroy the scientific value of the fossil.

9.6 Reversibility

Should any fossil materials be present within geological strata underlying the project area any negative impacts (i.e., destruction or movement from in situ location with resultant loss of stratigraphic/location context) upon them will be **irreversible**.

9.7 Irreplaceable Loss of Resources

An assessment of the quantum of loss of resources is difficult for palaeontological heritage. As discussed below (Section 9.9) it is simply impossible to quantify with any certainty the magnitude of fossil floras/faunas that may be present within an area. A site investigation may identify those fossils occurring at surface. However, fossil accumulations may be present in the subsurface portions of the same unit that are not observable at surface. The presence and abundance of any fossils that occur in stratigraphic units that do not crop out, but which may be impacted upon by a project, can only be speculated upon. Clearly, this assessment must also be made on a formation by formation basis, and factoring in the projected impacts of the project on each of the formations. In short, if there is uncertainty over what is present, any certainty of what will be lost is problematic. If any fossil is destroyed or its scientific value is degraded by loss of its *in-situ* provenance that resource will be permanently and irreplaceably lost; a fossil or fossil deposit cannot be rehabilitated.

A second factor for consideration is that it is often the project's implementation that will make previously unknown fossil assemblages available for scientific study. An example of this factor would be fossils of the *Glossopteris* flora that may be exposed in an open-cast coal mine. The costs of making the equivalent excavation are prohibitive to a research scientist. Without the mine, the fossils would remain lost to science for possibly millions of years until they are eventually exhumed by erosion. Another example is the contribution that lime mining in area now known as the "Cradle of Humankind" in Gauteng. It was these mining operations that provided access for scientists that have underpinned the birth and growth of paleoanthropological studies in South Africa. Cleary, the crux of the issue is the effectiveness of any damage mitigation protocols. The access to the site by palaeontologist and the degree of co-operation of the project's management. Theoretically, a fossiliferous geological unit may be completely destroyed by a project (e.g., it may be removed by mining), but if all fossils it contained were collected and curated by a palaeontologist, not only will there be no loss of resource, but the resource for scientific study will have increased. Should the opposite condition prevail (i.e., a project's management do not "buy into" the process and whole-heartedly enact the mitigation protocols or if palaeontologists are not granted sufficient access to the site) the loss of the resource may be complete.

A third cause of contention is the relative importance of specific components of a resource. In a grassland field a plant of one grass species is essentially as significant as any other of the same species. Thus, if 50% of the field is cleared then 50% of the species resource is lost in the area. Similarly, if 10% of the pan habitat used by flamingos for nesting in a region is lost, then 10% of that resource is lost. However, not all fossils are of equal significance. If a fossil is one of hundreds of similar fossils (e.g., a particular taxon of a trace fossil) present in portions of a formation located external to the project then the loss of that resource may be viewed as not being numerically significant in a broader context. If this is so, then it's loss may not be viewed as significant. However, a single, fossil of a habitually rare taxa such as the skull of a new hominin or dinosaur species may be present in an assemblage of more common fossil taxa. The loss of this one specimen may constitute a 100% loss of that resource in a region. An example of this case would be that should a single block of carbonate rock in a lime quarry at Taung Quarry (Figure 4) not have been collected by interested quarry workers, but rather have proceeded through the mine's crushers the skull of the Taung child would have been lost to the heritage of South Africa and the science of the world. This eventuality would have been a loss of unimaginable tragedy. Other fossils are known from the limestone formation, but there is only one Taung child.

For the purpose of this report, and as a characterisation of this criteria is required by the applicable legislation, the following quantification of the irreplaceable loss of resource is made. The project is anticipated to negatively impact upon an aerially restricted percentage of the land surface of the project area, and the effects will be limited to a depth of < 1 m. Taking these factors into account, and in the belief that the damage mitigation protocols outlined in the report (Section 10.1) will be enacted it is assumed that there will be **marginal loss of resource**. This categorisation is made because, even if the mitigation protocols are completely implemented, any fossil materials in the excavated areas will be destroyed or damaged.

9.8 Cumulative Effect

The calculation of cumulative effects for palaeontological resources is problematic to calculate. The process of addressing cumulative effect is inherently different for palaeontology compared to other areas of investigation e.g.,: -

- It is possible to calculate the area originally vegetated by a plant biome in a region. The area of original plant cover lost to historical development in the region can be calculated. The area that would be lost to a proposed development can be calculated and the cumulative loss (either as a percentage) can be calculated
- The projected light and/or noise pollution from a project can be added to the current night-time light or ambient sound levels, and an assessment can be made if acceptable thresholds on the life style of surrounding communities will be surpassed
- The current cumulative amount of water being pumped from an aquifer can be calculated. The proposed rates of pumping for a proposed project can be added to that total and it can, accordingly, be assessed if the cumulative sum of extracted water will exceed the recharge rate for the aquifer leading to its depletion. Obviously, this case would not only change the operational parameters for the proposed operation, but also jeopardise the existing operations in the region that extract water from the reservoir

Unless fossils are identified in outcropping rocks their presence/abundance in unexposed bedrock is a matter of informed assumption. It is also often the case that a project (e.g., an open-cast mine) will impact upon rock strata that do not crop out and no insight into their palaeontological resources will be gained from a site visit. Thus, even if a site investigation has been conducted, an accurate assessment of the quantum of palaeontological materials in the geological strata of the area will remain open to supposition. Any assessment of the fossil content of a rock unit based on a desktop assessment is even more uncertain. Clearly, the geological strata in the surrounding region will not be assessed during that site investigation, and probably will not have been the subject of intense investigation by a palaeontologist. It is also possible to make the comparison that most areas investigated as part of a project's impact assessment process are directly observable/measurable at the Earth's surface. Plant species present, their abundances and the presence of vulnerable species can be directly observed, measured and assessed (often over a 12-month period); animal and birds can be physically counted; archaeological resources can be identified with diligent searching; the light output of a project's external light sources can be calculated during the design process; groundwater flow can be calculated using either existing or new boreholes. However, most fossil specimens that will be present in the rock strata underlying a project will not be observable at surface, but rather are enclosed in the bedrock and will be unobservable at the time of the compilation of an impact assessment report.

In the case of this proposed project it is possible to make the observation that the Gordonia Formation is not richly fossiliferous, and the rocks of the Brulsand Subgroup and diagenetic calcrete (if present) are assessed as being unfossiliferous. To the proceeding observations it should be added that it is evident there is negligible industrial of agricultural development of the surrounding region. Accordingly, there would be little in the form of regional negative impacts. The potential for the project to add significantly to negative impacts upon the palaeontological heritage of the wider region must be low and, as such, the project is assessed as having a **negligible cumulative impact**.

9.9 Significance

The rules-based impact assessment rating for the projected impacts of the solar power farm project presented in Table 1 is negative low impact. The implication of this assessment is that the project will require little to no mitigation. However, it is apparent from Section 10.1 that several mitigation protocols are recommended herein. The disparity between these outcomes is explained by the unique nature of aspects of impact assessment for palaeontology compared to other areas of study usually conducted in impact assessment studies. Discussion of these points of difference is included in the various relevant assessment criteria (Section.9).

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Table 1: Table summarising findings of the assessment and calculating the significance of the proposed project upon the palaeontological heritage of the area.

Criteria	Assessment	Score
Geographical Extent	Site	1
Probability	Unlikely	1
Duration	Permanent	4
Intensity/ Magnitude	Very high	4
Reversibility	Irreversible	4
Irreplaceable Loss of Resources	Marginal loss of resource	2
Cumulative Effect	Negligible cumulative impact	1
Significance	Negative low impact	17

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed, or will result in irreversible loss of the palaeontological heritage can be determined as discussed below.

10.1 Mitigation

The terms of reference for this report stipulate that it must propose (if necessary) mitigation measures to address impacts during the construction, operation, and decommissioning stages of the project. The following negative impacts are possible during the various phases of the project: -

1. *Construction:* The movement/damage/destruction of fossils as a direct result of the construction activities
2. *Operation:* Loss of scientific access to the areas underlying project infrastructure
3. *Decommissioning:* No negative impacts are anticipated.

It is evident that the identified possible negative impacts that exist during the operational phase will be remedied during the decommissioning phase when the project infrastructure is removed. No mitigation procedures are required during the decommissioning phase. Accordingly, mitigation protocols are only required to address impacts attendant to the development phase.

A comprehensive discussion of the geological strata underlying the project area is located above (Section 6.2.1). In that discussion it was the best estimate of the author that the geological unit forming the land surface across the project area is the Gordonia Formation. However, this is an assumption, and must be treated as such; other potentially fossiliferous Cainozoic strata may be present. To mitigate any potential negative impacts that my result from the construction phase the following mitigation procedures (numbered 1-4 below) are recommended: -

- A thorough site investigation by a palaeontologist as part of a Full Palaeontological Impact Assessment prior to the commencement of construction
- The investigation should cover the regions identified as areas A and B (where the solar collection panels will be erected) as well as the area underlying the location of the electrical cable connecting areas A and B to the Lewensaar Substation
- A Full Palaeontological Impact Assessment report should be compiled by a palaeontologist and submitted to SAHRA for its consideration and recommendations
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by:
  - Its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution
  - Should the fossils be sufficiently scientifically significant and excavation be either impossible they should be protected completely and preserved *in situ* by erecting a fence around the area containing them

Recommendations that may be forthcoming from a Full Palaeontological Assessment Report on the project area may include: -

- A close examination of all excavations be made by a palaeontologist while they are occurring
- The periodicity or planning of such investigations would depend upon the planned work program for the project. The palaeontologist's work program should be negotiated between the project developer/manager and the appointed palaeontologist, and should be approved by SAHRA
- Should any fossil materials be identified in the excavations the excavations should be halted and SAHRA informed of the discovery
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution
- In the event that excavation of any scientifically significant fossils be impossible or inappropriate the fossil or fossil locality could be protected (by being fenced off) and the site of any planned construction moved
- A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study

11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a desktop study of available maps and scientific literature; no direct observation was made of the area as result of a site visit. In particular, the discussion of the geological units present within the project area (and as such the basis of understanding the fossiliferous potential of the area) was derived from the published geological 1:250 000 maps of the area). The accuracy of 1:250 000 geological maps is often variable; some areas being compiled from air photo interpretation or remote sensing procedures. The possibility of the presence of additional geological units being present within the project area cannot be disregarded.

12 CONDITIONS FOR INCLUSION IN AUTHORISATION

Conditions for inclusion any environmental authorisation including the results of this study are:

- A thorough site investigation by a palaeontologist is to be conducted on the project area as part of a Full Palaeontological Impact Assessment prior to the commencement of construction
- The investigation should cover the regions identified as areas A and B herein (where the solar collection panels will be erected) as well as the area underlying the location of the electrical cable connecting areas A and B to the Lewensaar Substation
- A Full Palaeontological Impact Assessment report should be compiled by a palaeontologist and submitted to SAHRA for its consideration and recommendations
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by:
  - Its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution
  - Should the fossils be sufficiently scientifically significant and excavation be either impossible they should be protected completely and preserved *in situ* by erecting a fence around the area containing them

13 ALTERNATIVE PROJECT SITE

A comprehensive review of the suitability of identified alternative locations for each of the preferred areas for this project has been undertaken by BM Geological Services. That review and assessment of any potential negative impacts upon the palaeontological heritage of the two alternative project areas and any required damage mitigation protocols is presented in a separate report. That report was compiled using the same format, discussion points and impact rating system utilised in this report.

The study of potential negative impacts upon the identified alternative project areas identified similar bedrock geology to that underlying the preferred project areas. As such, the identified risks and their geographical extent, duration, probability, intensity/magnitude, reversibility, cumulative effects, significance and required damage mitigation protocols are similar to those in the preferred project areas. That study found no palaeontological reason for the project not to proceed in either of the alternative project areas.

14 CONSIDERED OPINION

This desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to the suggested mitigation protocols being put in place.

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16th December 2019

16 APPENDIX 1 - [IMPACT RATING SYSTEM]

16.1 Method of environmental assessment

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 2 below.

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. The total number of points scored for each impact indicates the level of significance of the impact Impact Rating System.

Impact assessment must take account of the nature, scale and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the project phases:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact the following criteria is used: -

Table 2: The rating system

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 experienced.		
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).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		

1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact 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 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 – 30 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 indefinite.
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. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact 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.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative 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
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. 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.