DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF PROPOSED SOLAR AND WIND ENERGY GENERATION FACILITIES (GUNSTFONTEIN PROJECT) TO BE LOCATED ON VARIOUS FARMS NEAR SUTHERLAND, NORTHERN CAPE PROVINCE

10 June 2013

Prepared for:
Savannah Environmental (Pty) Ltd

On behalf of:
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On Behalf of:

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Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

Networx Eolos Renewables (Pty) Ltd proposes to construct a 150 MW photovoltaic solar energy facility (to be completed in two phases), a 280 MW wind power generation facility to be instituted in various phases and a 132 KV power line to connect the power generation facilities to the ESKOM power grid. The core project area, which will contain the power generation infrastructure, is proposed to be located within the farm Gunstfontein 131, the farm Boschmans Hoek 177 and the remainder of the farm Wolven Hoek 182 on a site located approximately 14 km south of Sutherland in the Karoo Hoogland Local Municipality, Sutherland Magisterial District in the Northern Cape Province. The location of the proposed 132 KV power line will be selected from four options (named option A, B, B split and C) that will connect to a proposed substation adjacent to the existing ESKOM Komsberg capacitor substation located approximately 24 km to the south of the southern boundary of the core project area (Figure 1). Each of the proposed 132 KV power line options will have a 300 m buffer zone for the purposes of examining their potential impact on the palaeontological heritage of the area; option A extends for approximately 38 km in length outside of the core project area, option B for approximately 55 km, option B split for approximately 55 km and option C for approximately 34 km.

Networx Eolos Renewables (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd, as independent consultants, to undertake a Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme ("EMP"). Savannah Environmental (Pty) Ltd 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 final Heritage Impact assessment Report. The final location and extent of the project infrastructural elements is unknown at the time of compilation of this report and will only be finalised after the completion of the Scoping Study Phase of the Environmental Impact Assessment Program.

The core project area and power line options A, B split and C are entirely underlain by rocks of the Abrahamskraal Formation. Power line option B is also predominantly underlain by the Abrahamskraal Formation, but is also underlain by the Waterford Formation in its north-western extent. It is known that elsewhere in the Main Karoo Basin these two rock units are fossiliferous and, as such, it can be anticipated that they unit contains fossils within the project area.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. The probability of a negative impact on the palaeontological heritage of the Waterford and Abrahamskraal Formations is low due to the general scarcity and sporadic nature of fossils within the geological record. However, the vertebrate faunas contained within the Abrahamskraal Formation are potentially

significant, amongst other reasons, for documenting the evolutionary transition from reptiles to mammals. The plant macrofossil assemblages contained within both the Waterford and Abrahamskraal Formations potentially provide a window into the botanical record of the Late Permian which is otherwise rare in southern Africa. Thus, any negative impact upon the fossil assemblages contained within these geological units is characterised as potentially highly significant. However, the probability of any negative impact being caused upon the fossil assemblages occurring within the project area is assessed as low. It is pertinent to note that the area of any potential negative impact caused by the project is characterised as local in extent. Similarly, the zone of permanent disruption is vertically restricted to the maximum depth of any excavations associated with the proposed constructions.

The project has been assessed as being socially beneficial, herein, as it would provide renewable energy to a stressed South African power grid. The possibility of any negative impact on the palaeontological heritage of the project area could be minimised by the conduct of a thorough site investigation by a palaeontologist prior to commencement of the project. This site investigation would make it possible that scientifically and/or culturally significant fossils may be discovered that would be otherwise damaged, destroyed or inadvertently moved. Similarly, a thorough examination should be made of all excavations as they are being performed. Should any fossil materials be identified during the construction phase, the excavations should be halted and SAHRA informed of the discovery. A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

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

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1. INTRODUCTION

Networx Eolos Renewables (Pty) Ltd has identified a site for the establishment of their Stormberg Renewable Energy Project, a development comprising of separate wind and solar energy facility components. In addition, Networx Eolos Renewables (Pty) Ltd is also applying for environmental authorisation for the grid connection infrastructure which includes 132 KV power lines allowing connection of the proposed power generation facilities to the ESKOM power grid. The site identified for the proposed development is located approximately 14 km south of Sutherland in the Karoo Hoogland Local Municipality, Sutherland Magisterial District in the Northern Cape Province (Figure 1).

The core of the project site, where the energy generation facilities will be developed, occupies an area of approximately 12 432 Ha and is located wholly within the farm Gunstfontein 131, the farm Boschmans Hoek 177 and the remainder of the farm Wolven Hoek 182. Based on the extent of the development envelope, both the wind and solar energy facilities can be appropriately placed within the larger site taking environmental and any other identified constraints into consideration. The location of the proposed 132 KV power line will be selected from four options (named option A, B, B split and C) that will connect to a proposed substation adjacent to the existing ESKOM Komsberg capacitor substation located approximately 24 km to the south of the southern boundary of the core project area (Figure 1). Each of the proposed 132 KV power line options will have a 300 m buffer zone for the purposes of examining their potential impact on the palaeontological heritage of the area; option A extends for approximately 38 km in length outside of the core project area, option B for approximately 55 km, option B split for approximately 55 km and option C for approximately 34 km.

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2. TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.

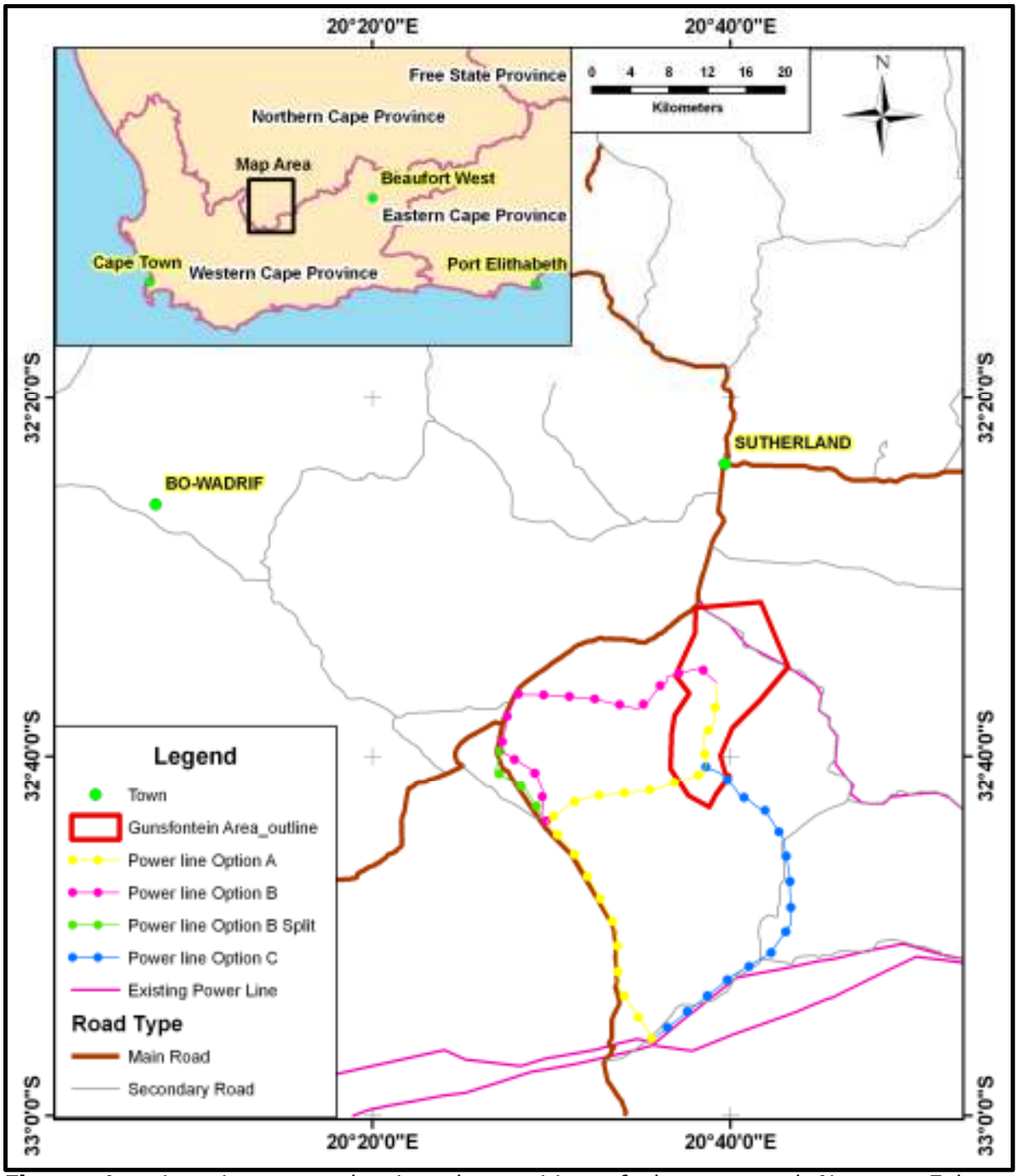

Figure 1: Location map showing the position of the proposed Networx Eolos Renewables (Pty) Ltd's energy generation facilities.

- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

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:

- 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 palaeontological resources of the proposed area 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, 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 and 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 Networx Eolos Renewables (Pty) Ltd or the proposed power generation facilities.

6. GEOLOGY AND FOSSIL POTENTIAL

Figure 2 shows that the core project area as well as the majority of the area underlying the proposed 132 KV power lines options A, B split and C is completely underlain by Late Permian sediments (the Abrahamskraal Formation) of the Adelaide Subgroup, Karoo Supergroup. The majority of the area underlying power line option B also consists of the Abrahamskraal Formation, but a small portion lying in the north-western most extent of the power line is underlain rocks of the Waterford Formation, Karoo Supergroup. The Waterford and Abrahamskraal Formations, accordingly, form part of the basin fill of the Main Karoo Basin (Figure 3). A schematic stratigraphic column showing detailing the stratigraphic relationships within the local section of the Karoo Supergroup is shown in Figure 4. A summary of the characteristics of the Waterford and Abrahamskraal Formations and their fossiliferous potentials follows.

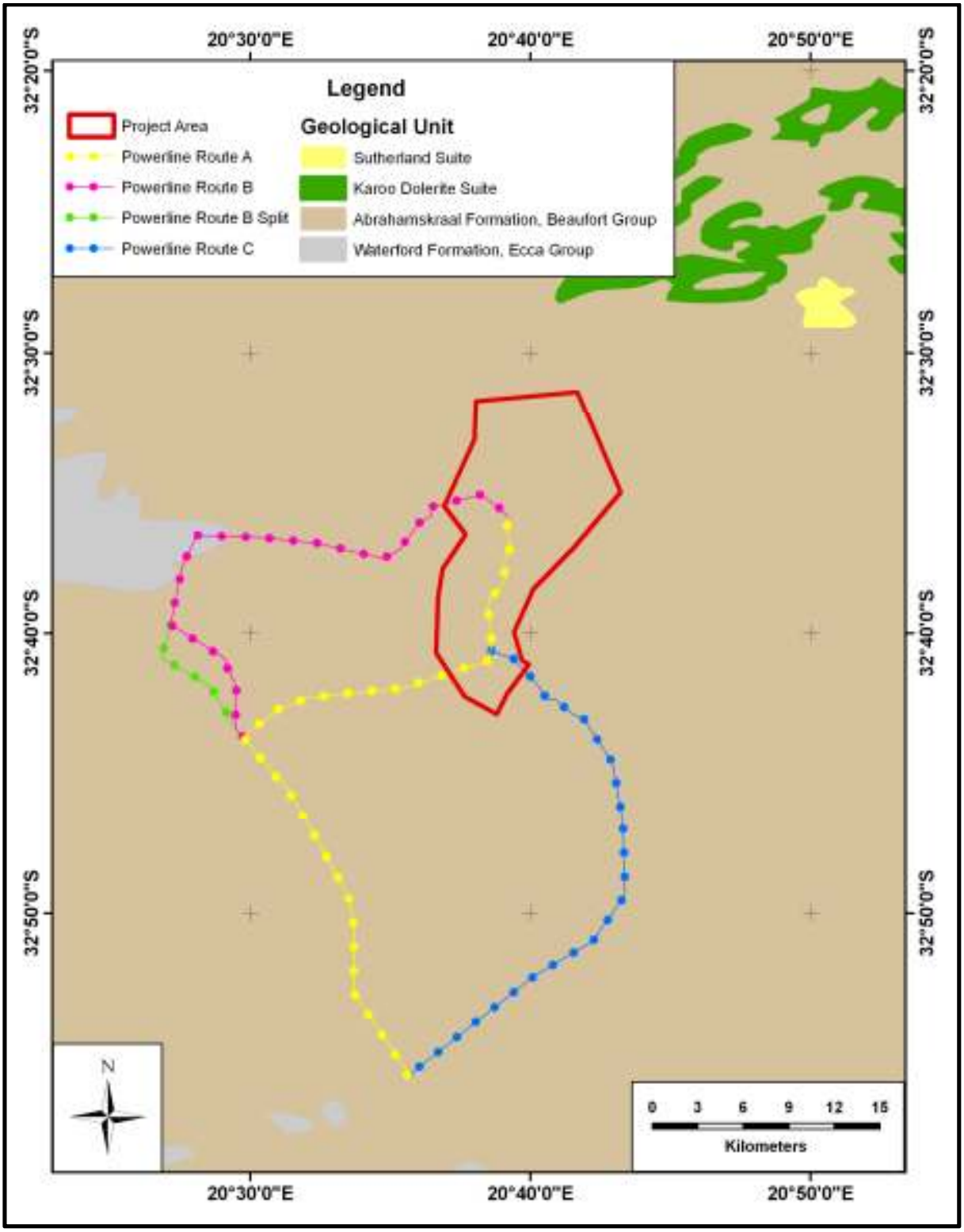

Figure 2: Map of the bedrock geology underlying the project area and its surrounding environs.

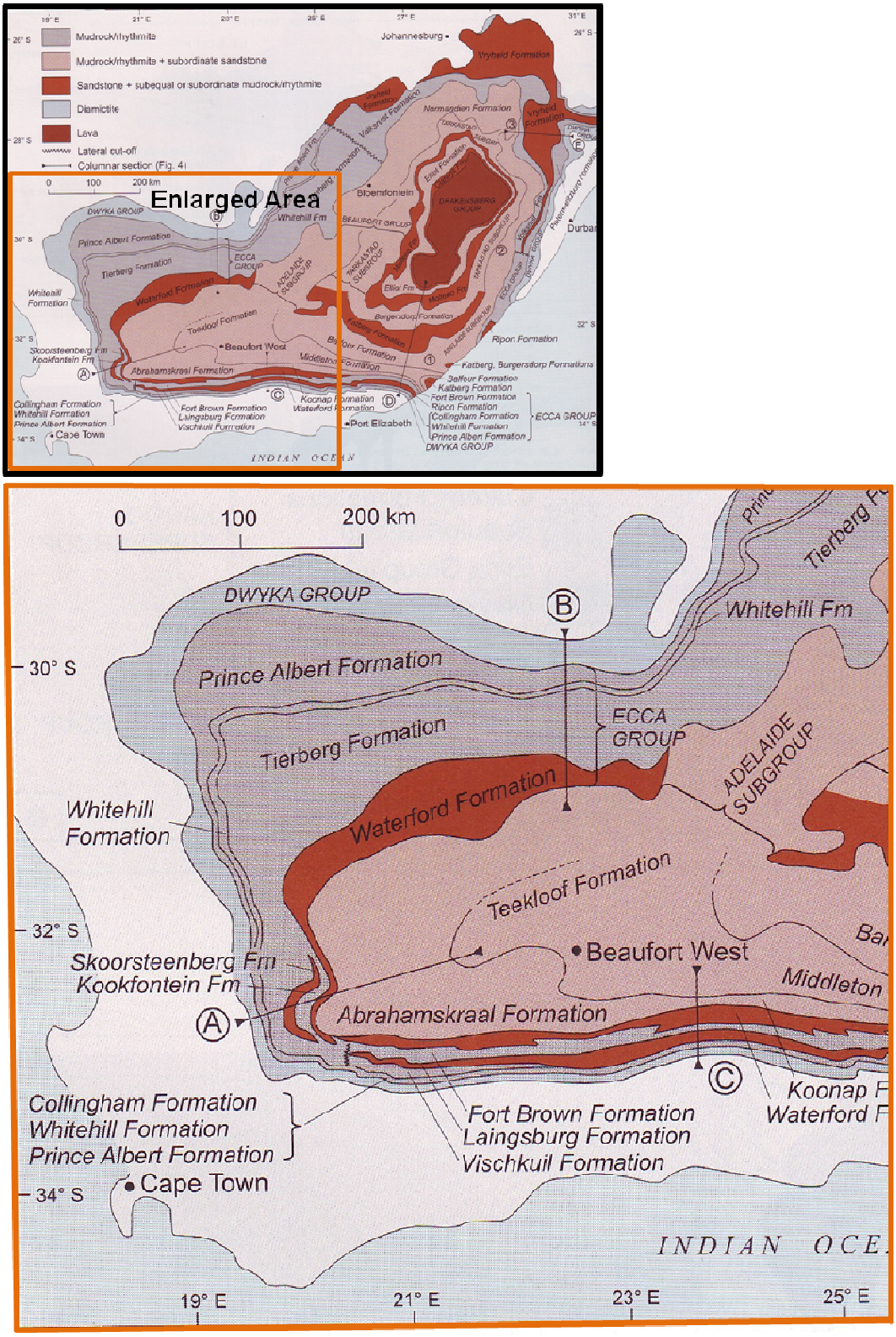

Figure 3: Map of the location of the Main Karoo Basin within South Africa; shown (in the enlarged area) are the outcrop extents of the various stratigraphic units that comprise the basin infill in the south-western portion of the basin (after Johnson *et al.*, 2006).

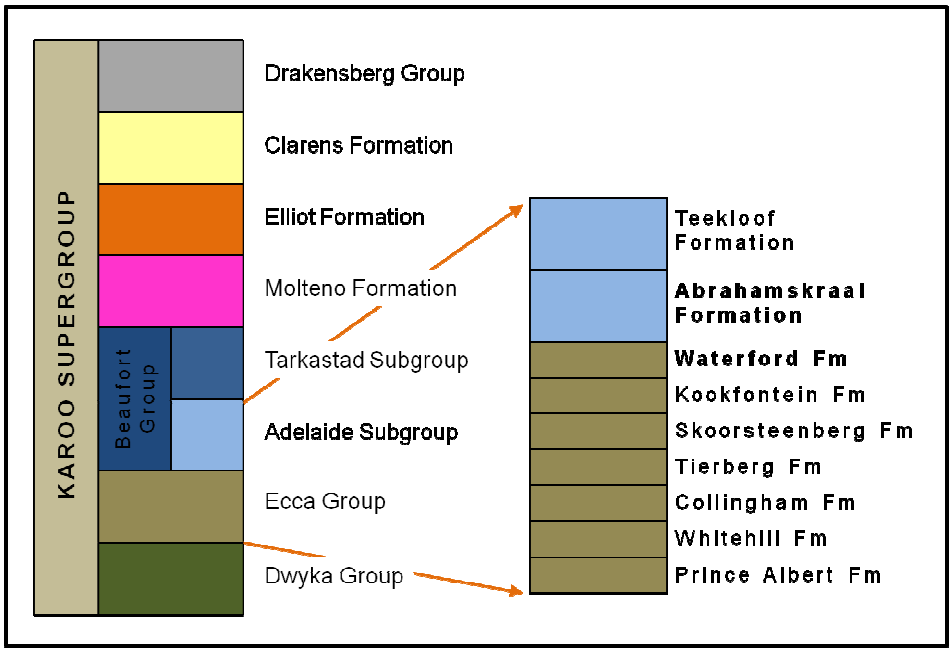

Figure 4: Stratigraphic column of geological units comprising the Karoo Supergroup. The subdivision of the Adelaide Subgroup shown is that applicable to the strata in the southwest of the Main Karoo Basin (i.e., west of 24° of longitude).

6.1 Waterford Formation

6.1.1 Geology

The Permian Waterford Formation, together with the underlying Tierberg and Kookfontein Formations, forms an upward-coarsening deltaic megadeltaic cycle (Wickens, 1996). In its western outcrop area the unit represents the terminal topset deposits of fluvially dominated deltas that prograded eastwards (Johnson *et al*., 2006). The major rock types of the Waterford Formation are fine- to medium-grained sandstone, siltstone, shale and rhythmites. The contact with the overlying Abrahamskraal Formation is relatively sharp and the break in lithology represents a change from the lower delta plain to the to a mud-rich, subaerially exposed upper delta plain environment (Wickens, 1996). The upper-most portions of the Waterford Formation, thus, represents the final stages of infill of the Karoo "sea" in the south of the Main Karoo Basin and presaged the widespread deposition of the terrestrial Beaufort Group.

6.1.2 Palaeontological potential

Bamford (2004) included a discussion of the indicates that the plant macrofossil assemblages of the Waterford Formation with those of the Fort Brown and Collingham Formations as those in rocks of the upper Ecca Group, which outcrop in the south-western portions of the Main Karoo Basin (i.e., south of the outcrops of the Vryheid and Volksrust Formations). The plant fossil assemblages documented by Bamford include lycopods (*Lepidodendron*), Sphenophytes (*Phyllotheca*, *Raniganjia*, *Schizoneura* and *Equisetum*), ferns (Astrotheca), *Glossopteris* (1 leaf type) and fossil wood (*Australoxylon* and *Prototaxoxylon*). The fossil wood is abundant in the sandstones within the Waterford Formation (Johnson *et al*., 2006).

A variety of trace fossils, mainly vertical to subvertical burrows of the *Cruziana-Skolithos* ichnofacies, are present within the formation (Johnson *et al*., 2006). A large proportion of the formation has been bioturbated with *Planolites* (*Cruziana* ichnofacies) and *Scoyenia* ichnofacies are the most common trace fossils, while *Skolithus* occurs sporadically (Siebrits, 1987 Unpubl.).

6.2 Abrahamskraal Formation

6.2.1 Geology

The Adelaide Subgroup consists of greenish or blue grey and greyish-red mudstones and sandstones (South African Committee for Stratigraphy (SACS), 1980; pp. 538-539). Palaeocurrent data suggests that the bulk of the sediment comprising the Adelaide Subgroup was derived from a source area lying to the south and southeast of the main Karoo Basin (i.e., the uplifted strata of the Cape Fold Belt). The ubiquitous presence of fining-upward cycles within the sediments, a terrestrial biota (see Section 7.1.2 below), red coloured mud rocks and distinctive sedimentary structures indicate that the unit was deposited under fluvial conditions. The high mud/sand ratios and fine-grained character of the sandstones suggests meandering rather than braided rivers (Johnson *et al*., 2006).

The Adelaide Subgroup is differentiated into two distinct stratigraphic sequences which are located either side of the line of longitude of 24° east. To the east of that dividing line the Adelaide Subgroup consists of (in order of decreasing stratigraphic age) the Koonap, Middelton and Balfour Formations. To the west of 24° east the Adelaide subgroup is subdivided into a lower Abrahamskraal and an upper Teekloof Formations [South African Committee for Stratigraphy (SACS), 1980)]. The project area lies west of the dividing line of longitude and so must form part of the western succession. The Gunstfontein Project area is completely underlain by sediments of the Abrahamskraal Formation (Figure 2).

The Abrahamskraal Formation is distinguished from the overlying Teekloof Formation by the presence of a number of distinctive chert bands (a few centimetres to 2 m in thickness) as well as a higher abundance of red mudstones [South African Committee for Stratigraphy (SACS), 1980]. In practice the boundary between the two units is drawn at the base of the Poortjie Sandstone (a sandstone-rich stratigraphic succession).

6.2.2 Palaeontological potential

The Abrahamskraal Formation sediments of the project area lie within the *Tapinocephalus* Assemblage Zone (Figure 5). The fauna of the *Tapinocephalus* Assemblage Zone include the synapsid reptiles such as Dinocephians (*Anteosaurus*, *Paranteosaurus*, *Titanosuchus*, *Jonkaria*, *Struthiocephalus*, *Struthiocephaloides*, *Struthionops*, *Taurocephalus*, *Avenantia*, *Criocephalus*, *Delphinognathus*, *Moshops*, *Riebeeckosaurus*, *Keratocephalus*, *Mormosaurus*, *Phocosaurus*, *Styracocephalus* and *Tapinocephalus*), dicynodonts (*Galeops*, *Robertia*, *Pristerodon* and *Diictodon*), Biarmosuchia (*Hipposaurus*), theracephalians (*Gianosuchus*, *Alopecodon*, *Scylacosaurus*, *Lyosuchus*, *Blattoidealestes*, *Icticephalus* and *Pristerognathus*), captorhinid reptiles (*Eunotosaurus*, *Bradysaurus*, *Embrithosaurus* and *Broomia*), the pelycosaur reptile *Elliotsmithia*, the amphibian Rhinesuchus and fish (*Namaichthys*, *Atherstonia* and *Elonichthys*) (Smith and Keyser, 1995).

Plant macrofossil assemblages associated with the Abrahamskraal Formation are not well documented, but appear to be relatively restricted in terms of taxonomic diversity. Bamford (2004) has reported that the palaeobotanical record of the lower Beaufort Group is dominated by glossopterids, but they diminish in both diversity and abundance upwards through the Beaufort Group strata. Bamford combined discussion of the stratigraphic section extending from the Volksrust Formation (Ecca Group) up to the top of the Teekloof Formation (top of the Adelaide Subgroup in the southwest of the Main Karoo Basin) as one assemblage. Bamford's compilation of the plant macrofossils present within that combined unit includes mosses (*Buthelezia*), sphenophytes (*Sphenophyllum*, *Raniganjia*, Phyllotheca and *Schizoneura*), a fern (*Sphenopteris*), glossopterids (11 different leaf types and 6 fructifications), a cordaitalean (*Noeggerathiopsis*), wood (*Australoxylon* and *Prototaxoxylon*) and three general of uncertain botanical affinity (*Taeniopsis*, *Pagiophyllum* and *Benlightfootia*). The depositional environments indicated above for the lower Beaufort Group are usually considered to have good potential for growth and fossilization of plant materials; the relatively low taxonomic diversity exhibited by the unit may well be an artefact of under representative sampling (Bamford, 2004).

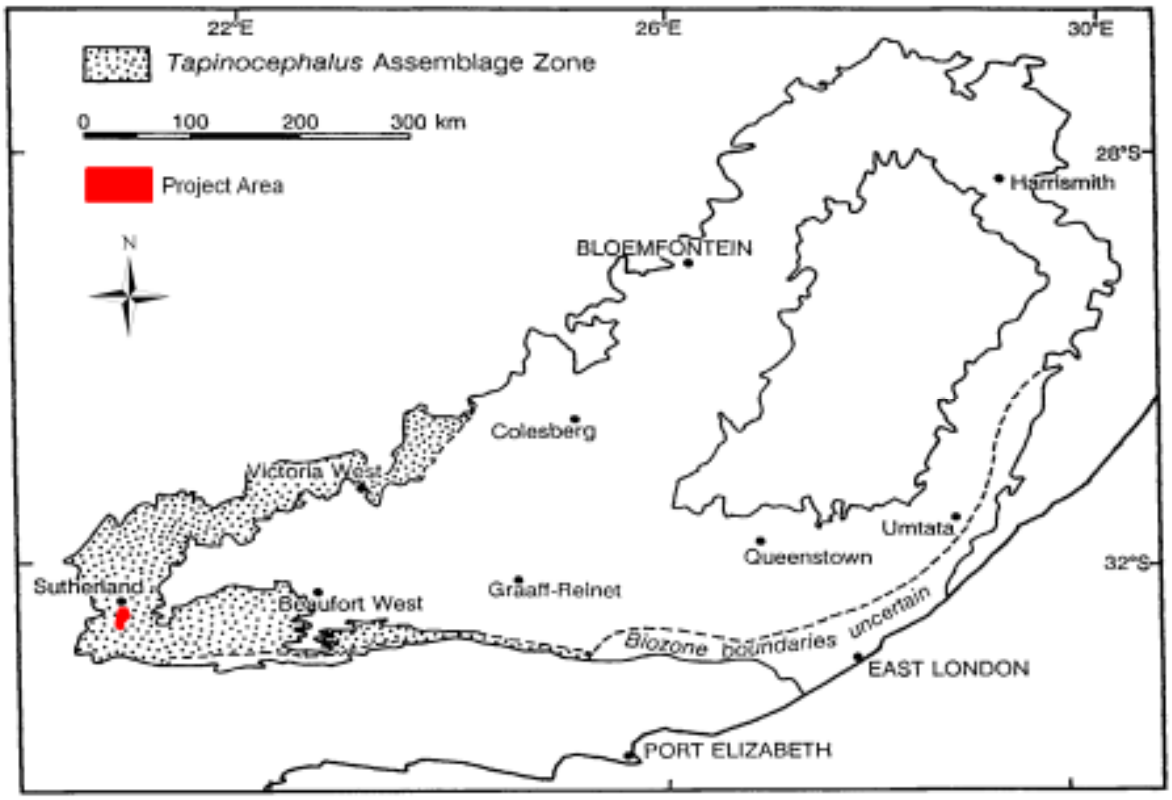

Figure 5: Map of the upper and lower stratigraphic boundaries of the Beaufort Group, Main Karoo Basin. Shown on the map is the aerial extent of the *Tapinocephalus* Assemblage Zone and the location of the project area (after from Smith and Keyser, 1995).

Abundant fossil insect faunas have been recovered from localities within the Estcourt Formation (now included within the Normandien Formation) in the north-eastern extent of the Main Karoo Basin (Riek, 1973, 1976a, 1976b). The Normandien Formation is the sole formation comprising the Adelaide Subgroup in the north of the basin, but the nature of the stratigraphic relationship with these faunas and the Abrahamskraal Formation is unclear.

7. ENVIRONMENT OF THE PROPOSED PROJECT SITE

The core project area, where the energy generation infrastructure will be located, is approximately 12 432 Ha in extent. Each of the proposed 132 KV power line options will have a 300 m buffer zone for the purposes of examining their potential impact on the palaeontological heritage of the area; option A extends for approximately 38 km in length outside of the core project area, option B for approximately 55 km, option B split for approximately 55 km and option C for approximately 34 km. Examination of Google Earth imagery of the project area (Figure 6) and topographic contours (Figure 7) suggests that the land surface of the project area predominantly consists of a number of topographic elements. The northern half of the core project area consists of an elevated

plateau lying between approximately 1 560 m and 1 600 m a.m.s.l. The southern half of the project area consists of a large, approximately northeast-southwest oriented valley. The slopes of the valley are extremely prominent and steep, with the northern slope occupying much of the southern half of the project area and forming part of the Great Escarpment. The majority of the southern slopes of the valley lie outside of the project area this southern slope form part of a prominent northeast-southwest oriented spur protruding to the south-west from the Great Escarpment. There is a well developed ephemeral, dendritic drainage system that drains the slopes of the valley and these drainage lines coalesce along the axis of the valley to form a single, prominent trunk channel predominantly lying below 1 000 m a.m.s.l. This ephemeral trunk channel eventually flows to the north-west where it coalesces with the Tankwa River. The four power line options extend from the western and southern extents of the core project area and cross the hill, steep sided valleys and extensively developed dendritic fluvial systems of the Moordenaars Karoo.

Mucina and Rutherford (2006) indicate that the vegetation cover of the project area and the various alternative power line corridors consists of six veld types (Figure 8). Within the project area the northern plateau carries a vegetation cover of the Roggenveld Shale Rhenosterveld veld type. The slopes of the southern valley (i.e., the Great Escarpment) are covered by the Tanqua Escarpment Shrubland veld type and the base of the valley consists of Tanqua Wash Riviere veld type (Figure 8). Outside of the project area power line option A additionally crosses the Tanqua Wash Riviere, Koedoesberge_Moordenaars Karoo, Tanqua Escarpment Shrubland and Central Mountain Shale Rhenosterveld veld types; option B crosses Tanqua Escarpment Shrubland, Tanqua Karoo and Tanqua Wash Riviere veld types; option B split crosses Tanqua Karoo, Tanqua Escarpment Shrubland and Tanqua Wash Riviere veld types and option C crosses Tanqua Escarpment Shrubland, Central Mountain Shale Rhenosterveld and the Koedoesberge_Moordenaars Karoo veld types. The conservation status of all six veld types is listed as least threatened by Mucina and Rutherford (2006).

The general absence of signs of cultivation within the boundaries of the project area (Figure 6) suggests that the majority of the site is predominantly utilised for grazing and/or game farming. There is a small area of cultivation west of power line option C on the banks of the Meinjiesplaas River as well as in an area proximal to the homestead of the farm Saaiplaas (along the banks of an ephemeral river that flows to the east where it becomes a tributary of the Meinjiesplaas River).

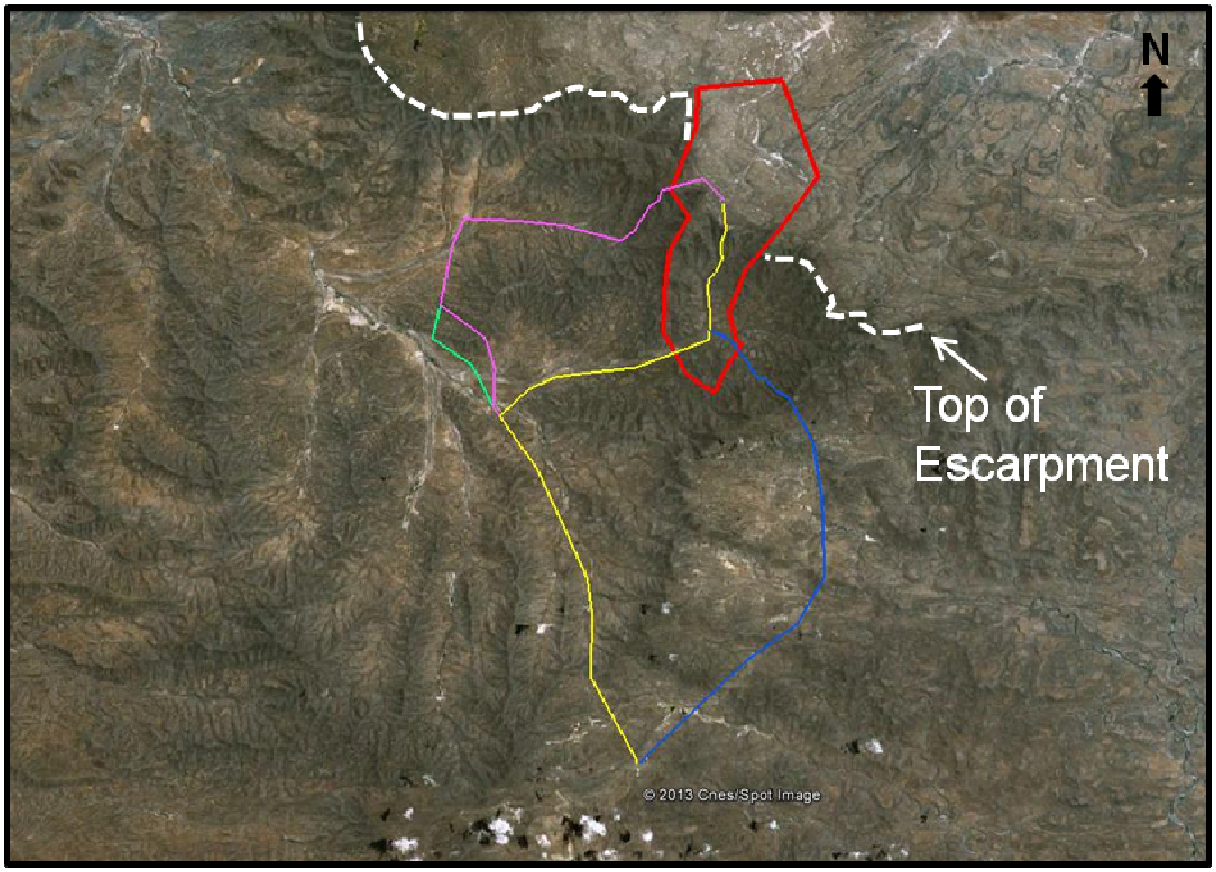

Figure 6: Google Earth image of the project area (the red polygon) and the power line options A, B, B split and C. It is evident from the image that the northern portion of the project area consists of an elevated plateau. The southern edge of the plateau is defined by the upper edge of the Great Escarpment (white stippled line). The southern portion of the project area consists of a steep sided, valley. The majority of the power line options locations are located within the intensively incised landscape of the Moordenaars Karoo. There are no signs of cultivation evident in the core project area or in the majority of the area associated with the power line options; as such it is probable that the area is utilised for grazing and/or game farming. There are two small areas of cultivation evident along the banks of two river areas. However, these lie to the west, and upstream, of power line option C and should not be directly affected by the construction of the power line.

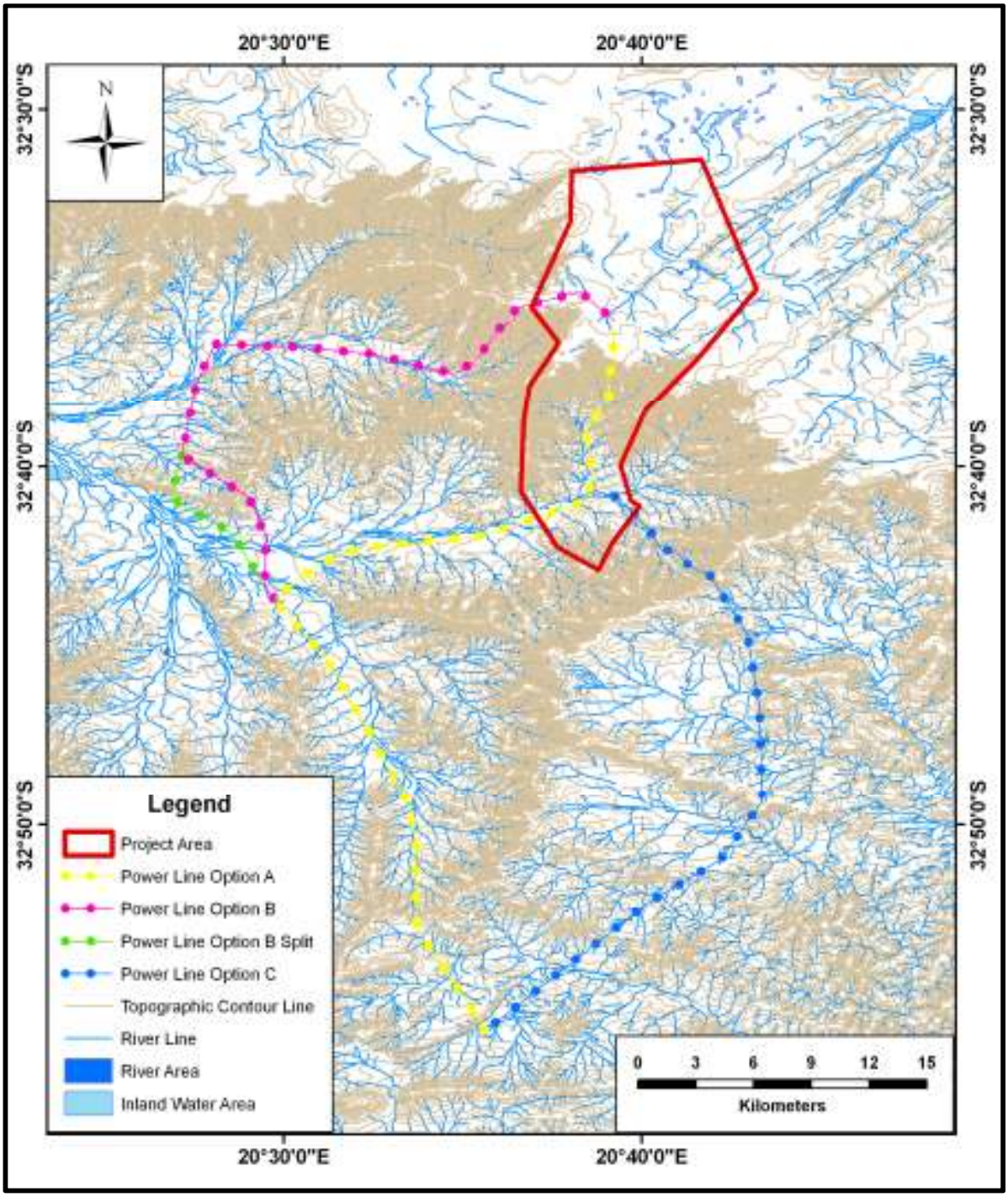

Figure 7: Map of the project area with topographic contours superimposed. It is evident that the project area consists of a northern plateau and a northeast-southwest oriented valley in the south. The boundary between these two topographic features is defined by the top of the Great Escarpment. Located within the southern valley is a distinct dendritic drainage system. The drainage system flows to the west where it eventually becomes a tributary of the Tankwa River. The majority of the area underlying the power line location options consists of the heavily fluvially dissected Moordenaars Karoo. The contour interval of the topographic contours is 20 m.

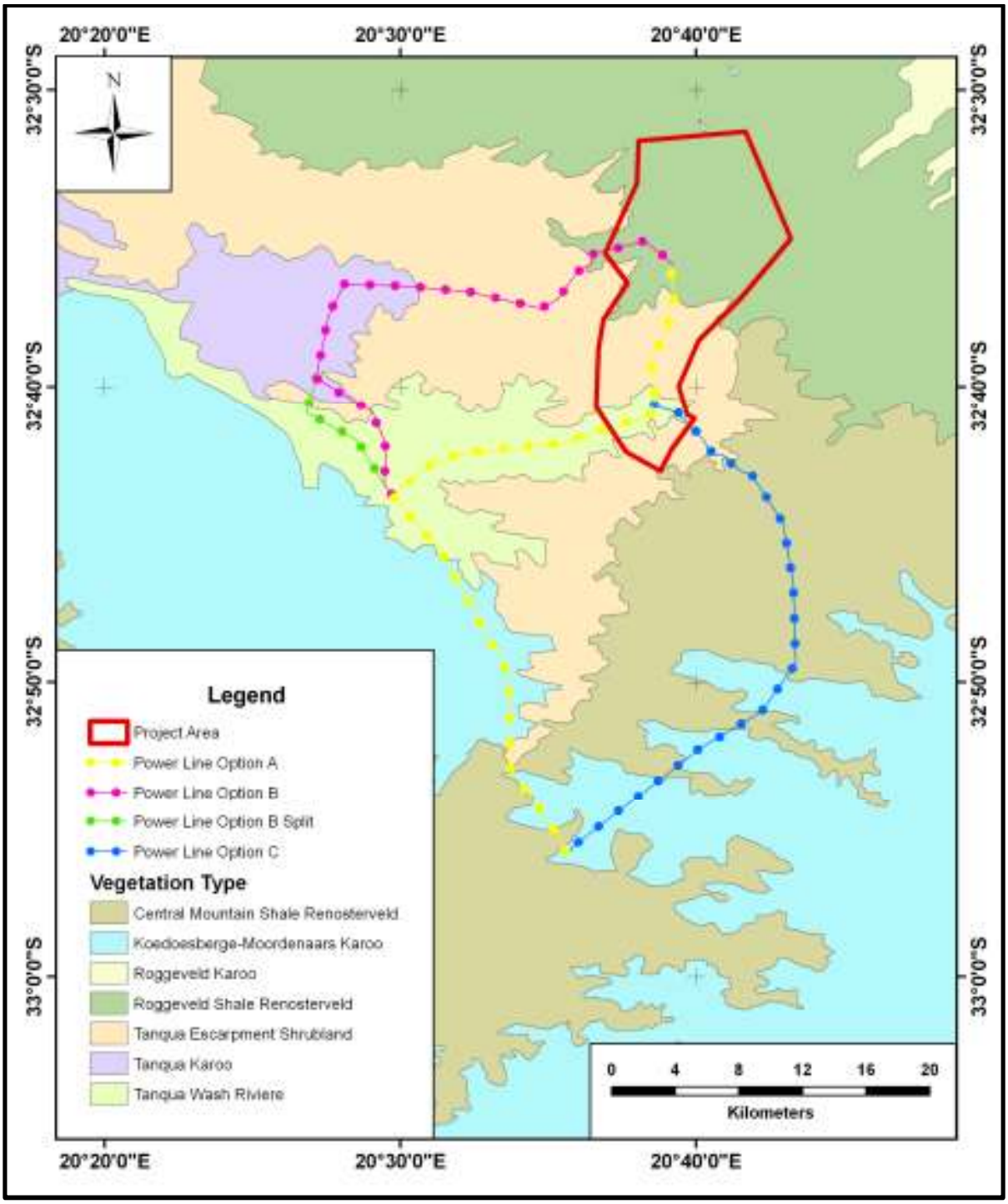

Figure 8: Map of the distribution of the vegetation veld types located within the core project area, the four power line option locations and their surrounding environs (after Mucina and Rutherford, 2006).

8. OVERVIEW OF SCOPE OF THE PROJECT

The proposed power generation project will consists of a separate wind and solar energy generation facilities as well as corridors for the construction of a 132 KV power line to connect to ESKOM's grid facility.

A general overview of the infrastructure required for each facility is as follows:

8.1 Solar Energy Facility

The Photovoltaic facility is proposed to have a total generating capacity of up to 150 MW and is to be developed in two phases.

Infrastructure associated with the solar energy facility is proposed to include:

- Photovoltaic (PV) panels on a mounting structure, with a capacity of up to 150 MW and respective inverter stations;
- A new on-site substation to facilitate the connection between the solar energy facility and the electricity grid, including a building for control and storage;
- Cabling between the above mentioned infrastructures, to be laid underground where practical;
- Internal access roads and fencing.

8.2 Wind energy Facility

The facility will comprise of up to 100 turbines with a generating capacity of up to 3.5 MW each, with a hub height of up to 120 m and a rotor diameter of up to 130 m. The wind energy facility would have a capacity of up to 280 MW and is to be developed in two phases. Infrastructure associated with the wind energy facility is proposed to include:

- Wind turbines up to 3.5 MW in capacity;
- Concrete foundations to support the turbines;
- Cabling between the turbines, to be laid underground where practical, will connect to an on-site substation;
- An on-site substation to facilitate the connection between the wind energy facility and the electricity grid, including a building for control and storage;
- Internal access roads to each turbine linking the wind turbines and other infrastructure on the site.

8.3 Proposed Power lines

Three alternative corridors (options A-C below) are being investigated for the construction of a 132 KV power line to connect to ESKOM's national grid:

- Option A is 49 Km in length and runs through from Farm Gunstfontein 131, Boschmans Hoek 177, Zwanepoelshoek 184, Leeuwe Koek 183, Brand Hoek 176, Wagen Drift 175, Lange Huis 174, Roode Wal 187, Karreebosch 200, Appels Fontein 201, and Standvastigheid 210 where it would connect to the proposed substation adjacent to the existing ESKOM Komsberg Capacitor Substation.

- Option B is 60 Km in length and runs through Farm Gunstfontein 131, De Kruis 153, Knoofloks Hoek 154, Klip Drift 156, Kraai Rivier 173, Alkant 220, and Lange Huis 174, Roode Wal 187, Karreebosch 200, Appels Fontein 201, and Standvastigheid 210 where it would connect to the proposed substation adjacent to the existing ESKOM Komsberg Capacitor Substation.

- Option C is 45 Km in length and runs through Farm Gunstfontein 131, Farm Boschmans Hoek 177, Wolven Hoek 182, Annex Drie Roode Heuvels 181, Drie Roode Heuvels 180, Orange Fontein 203, Kentucky 206, Wolvenkop 207, Rheebokke Fontein 209 and Standvastigheid 210 where it would connect to the proposed substation adjacent to the existing ESKOM Komsberg Capacitor Substation.

A corridor of up to 300 m in width will be considered for each power line alternative. The most environmentally and technically feasible alternative for connection will be identified through the EIA process.

9. IMPACT ASSESSMENT

The potential impact of Networx Eolos Renewables (Pty) Ltd's solar and wind power generation facilities as well as the power line option that will be selected is categorised below according to the following criteria:-

9.1 Nature of Impact

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 material is 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 completely 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.

9.2 Extent of impact

The possible extent of the permanent impact 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 is, accordingly, categorised as local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term**. This is assessment is based on the fact that, 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 power generation facility will be unavailable for scientific study for the life of the existence of those features.

9.4 Probability of impact

The Waterford and Abrahamskraal Formations are fossiliferous elsewhere in the Main Karoo Basin and the area under consideration is large (approximately 12 432 Ha for the core project area plus the 300 m wide corridor that run the length of one of the four power line options); as such there is a reasonable chance of fossil materials occurring within the rocks underlying the project area. It is pertinent to realise that fossils (particularly vertebrate fossils) are generally scarce and sporadic in their occurrence.

Similarly, locations containing plant macrofossil assemblages are also uncommon, but differ from vertebrate fossils in that large numbers of fossils tend to be present within the fossil sites. In the case of both vertebrate and plant macrofossils the probability of any development affecting a fossil at any particular point on the land surface consisting of either the Waterford or Abrahamskraal Formations is assessed as **low**.

9.5 Significance of the impact

The scientific and heritage importance of the fossil assemblages known to occur within the Waterford and Abrahamskraal Formations can be defined as follows. The rocks of the lower Beaufort Group form the lower portion of a stratigraphic succession which is known as the most complete and possibly important stratigraphic sequence in the world which contains fossil assemblages that document the evolutionary transition from reptiles to mammals. The documented plant macrofossil assemblages of the Waterford Formation and lower Beaufort Group are neither common nor taxonomically diverse. However, there is reason to believe that this situation may to some extent be the result of under sampling of the unit resulting from a lack of research. If the later is true then any plant macrofossil assemblages present within the project area may considerably extend the current understanding of the evolution of plant types and communities within the later Permian of South Africa. Any new fossil materials may considerably extend the current state of knowledge of the palaeofloras of this part of South Africa's stratigraphic succession. Thus, the fossils of the Karoo-age sequence are an important component of the world's palaeontological and scientific heritage.

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 potentially 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.

Thus, while **the probability of a negative impact on the palaeontological heritage contained within the sedimentary strata underlying the project area is categorised as low, the significance of any negative impact posed by the project**

on the palaeontological heritage is categorised as potentially high if appropriate mitigation procedures are put into place.

9.6 Severity / Benefit scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide a long term benefit to the community in terms of the provision of renewable electricity to an increasingly stressed national power grid. This positive benefit will continue throughout the life of the project. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as low if appropriate mitigation procedures are put into place.

The low likelihood of fossils being directly affected by the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa (particularly vertebrate forms) are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that the sedimentary rocks of the Abrahamskraal Formation may contain important or unique examples of vertebrate fossils. Similarly, the plant macrofossil assemblages contained within the Waterford and Abrahamskraal Formations may potentially provide an important window into botanical evolution during a geological period in southern Africa where such information is otherwise uncommon. Thus, it is possible that there are fossils of the highest scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South. Thus, **although the likely hood of any disturbance of palaeontological materials is low, the severity of any impact is potentially extremely high**. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project may uncover fossils materials that were hidden beneath the surface exposures and, as such, would have remained unknown to science. If the planned excavations are inspected, while they are occurring, with a view to identifying any possible palaeontological materials present the possibility would be generated of being able to study and excavate fossil materials that would otherwise be hidden to scientific study.

9.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced prior to commencement of the construction

phase little to no negative effect on the palaeontological heritage of the area is anticipated. As the proposed project would supply electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

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

A thorough field investigation by a palaeontologist prior to the commencement of construction, of the site identified for final development of the solar and wind power generation facilities as well as the proposed power line, would allow a meaningful evaluation of the presence of potentially fossil-bearing strata within the project area. If fossil materials prove to be present the process would allow the identification of any such fossils that should either be protected completely or could have damage mitigation procedures emplaced to minimise negative impacts.

It is also recommended that a close examination of all excavations be made while they are occurring. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery. 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.

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 an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

10.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials or reduction of scientific value due to a loss of the original location is **irreversible**.

10.3 Degree of irreversible loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible**.

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material that may be contained within the strata underlying the project area is potentially of the greatest scientific and cultural importance. Thus, the potential always exists during construction and excavation within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

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 1:250 000 geological map 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.

The geological map 1: 250 000 geological map series 3220 Sutherland (Geological Survey of South Africa, 1983) does not indicate the presence of any Cainozoic regolith cover within the project area. Cainozoic palaeontological sites are occasionally identified within alluvial terraces and dongas throughout South Africa and it may be expected that large mammal bones, dentition, horn cores, micromammal bones and fresh water molluscs may be identified within Cainozoic strata. The absence of regolith indicated on the geological sheet does is not definitive of its absence in the area and it is possible that such deposits may be present.

Many details concerning the aerial extent and location of the infrastructural elements that will comprise this development will only be finalised after the completion of the

Scoping and Environmental Impact Assessment phase. The assumption made in this study is that the final project area will occupy a much reduced surface area than that reported on herein. This assumption is based on comparison to the size of other similar projects being proposed within South Africa.

12. ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of the proposed construction of a solar and a wind power generation facility. This desktop study forms part of a Heritage Impact Assessment Report that is a component of a larger Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme.

The core project are, where the power generation infrastructure will be located, is relatively large (approximately 12 432 Ha) in size and in addition there will be the 300 m wide corridor that runs the length of one of the four power line options (34 -55 km outside of the core project area) . It is probable that the area that will be affected by the proposed project is considerably smaller within the core project area; although the final extent of the project area is yet to be finalised. Additionally, any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the construction of the projects infrastructural elements that are constructed within the project area. The extent of any impact is accordingly characterised as local. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth, although the maximum depth of the constructions is unknown at the time of compilation of this report. Any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

This study has identified that the geological units that underlies the core project area and the location of the four power line options are fossiliferous elsewhere in the Main Karoo Basin and, as such, fossils are potentially present and may be negatively impacted. The fossil assemblages contained within the Abrahamskraal Formation are of high scientific and cultural significance because of their importance in documenting the evolutionary transition between retiles and mammals. In addition, the rocks of the Waterford and lower Beaufort Group are known to contain plant macrofossil assemblages and the lower Beaufort group contains insect faunas elsewhere in the Main Karoo Basin.

There is a potential for negative impact on the palaeontological heritage of the project area throughout it's the majority of its extent, but the potential risk is categorised as low

due to the generally scarcity of fossils in the geological record. However, the fossils that may be anticipated to be present within these units are potentially highly significant to the cultural and scientific heritage of South Africa and the world. As such, the risk of a negative impact is low, but the significance of any negative impact on the fossil assemblages could potentially be very high. Any damage that occurs to such fossil material during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. A thorough site investigation of the outcrops of the area prior to commencement of the project by a palaeontologist would make it possible that scientifically and/or culturally significant fossils, present within the area may be discovered that would be otherwise damaged, destroyed or inadvertently moved. A secondary advantage of such an investigation would be that any fossil materials located could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country. Similarly, a thorough and ongoing examination should be made of all excavations as they are being performed. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery.

The social benefits of the project have been classified as beneficial, herein, as the project aims to provide a renewable source of energy to the South Africa power grid. The power generation capacity of South Africa is presently under significant pressure. As such **this desktop study has not identified any palaeontological reason to prejudice the progression of this project, subject to adequate mitigation programs being put in place**.

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