PALAEONTOLOGICAL IMPACT ASSESSEMENT REPORT ON THE SITE OF A PROPOSED SUBSTATION ON PORTION 8 OF FARM DAMFONTEIN 114, NEAR NOUPOORT, USOMBOMVU LOCAL MUNICIPALITY, NORTHERN CAPE

30 June 2013

Prepared for:
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Prepared for:
Savannah Environmental (Pty) Ltd

On Behalf of:
Geo Solar (Pty) Ltd

Prepared By:
Dr B.D. Millsteed

EXECUTIVE SUMMARY

Geo Solar (Pty) Ltd has proposed the establishment of a 132 kV to 66 kV step-down substation to connect five proposed solar energy facilities to the Eskom grid on just over 27 ha of Portion 8 of the Farm Damfontein 114, located approximately 12 km northwest of Noupoort in the Usombomvu Local Municipality, of the Northern Cape Province.

Savannah Environmental (Pty) Ltd was appointed by Geo Solar (Pty) Ltd as Independent Environmental Assessment Practitioner to produce the Environmental Management Program which is required for the project to progress. Savannah Environmental (Pty) Ltd has retained BM Geological Services to conduct a Palaeontological Heritage Impact Assessment Study for the area to be affected by the proposed project. A site investigation of the proposed project area was conducted on the 22nd of June 2013 by Dr B.D. Millsteed. The site was traversed extensively by foot to determine the palaeontological importance of the area and to quantify the impact that that proposed construction activities would have on the palaeontological heritage of the site.

Two stratigraphic units are identified as underlying the project site, these being (in descending stratigraphic order):-

1. Cenozoic regolith (covering almost the entire area)
2. Sediments of the Adelaide Subgroup (Beaufort Group) of the Karoo Super Group

The regolith and Adelaide Subgroup strata are potentially fossiliferous and are known to contain fossils elsewhere in the Karoo. However, despite a comprehensive foot-based survey of the area no fossil material was identified. Given the apparent absence of fossils that was identified within the project area, the fact that the effects of the project will be restricted to the local area and the presumed very shallow depth (> 2 m) of the disruption of the excavations proposed for the emplacement of infrastructure elements **no palaeontological reason was identified that should negatively impact on the proposed project**. This position is further strengthened by the identification of the project as being beneficial to South Africa by providing infrastructure required for the supply of renewable energy to a power generation grid that is currently under stress.

Adequate mitigation procedures can be put into place to protect, as far as possible, any fossil material that may be located during the construction of the project infrastructure. Indeed should such previously located fossil material be located it may prove to positively add to the palaeontological heritage of South Africa.

The following recommendations are made for the future conduct of the project in order to reduce the potential for any negative impact on the area to an absolute minimum:

- A careful watch be kept on the site of all excavations and construction during the development of the project to identify any fossil materials that may be uncovered.
- Should any fossil material be located during either the construction of the proposed substation and its infrastructure elements operations excavations should be halted and SAHRA informed of the discovery.
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Geo Solar (Pty) Ltd has proposed the establishment of a 132 kV to 66 kV step-down substation to connect five proposed solar energy facilities to the Eskom grid on just over 27 ha of Portion 8 of the Farm Damfontein 114, located approximately 12 km northwest of Noupoort in the Usombomvu Local Municipality, of the Northern Cape Province (Figure 1).

Geo Solar (Pty) Ltd appointed Savannah Environmental (Pty) Ltd as Independent Environmental Assessment Practitioner to produce the Environmental Management Programme necessary for the application procedure for the proposed substation facility. Savannah Environmental (Pty) Ltd has been instructed by the South African Heritage Resources Agency (SAHRA) to include a Palaeontological Heritage Impact Assessment Report as part of the Environmental Impact Assessment Report that forms part of the application process. Savannah Environmental (Pty) Ltd has retained BM Geological Services to conduct that Palaeontological Heritage Impact Assessment Study.

Dr B. Millsteed, of BM Geological Services, conducted a site investigation of the proposed project area on the 22nd of June 2013; this investigation involved a series of transects of the area by foot. The results of that investigation are presented herein.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Identify all palaeontological materials located in the area of the project area.
- Quantify the palaeontological heritage significance of any fossil materials identified.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Propose suitable mitigation measures to minimise possible negative impacts, if any are identified, on the palaeontological heritage of the site.
- Provide an overview of the applicable legislative framework.

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).

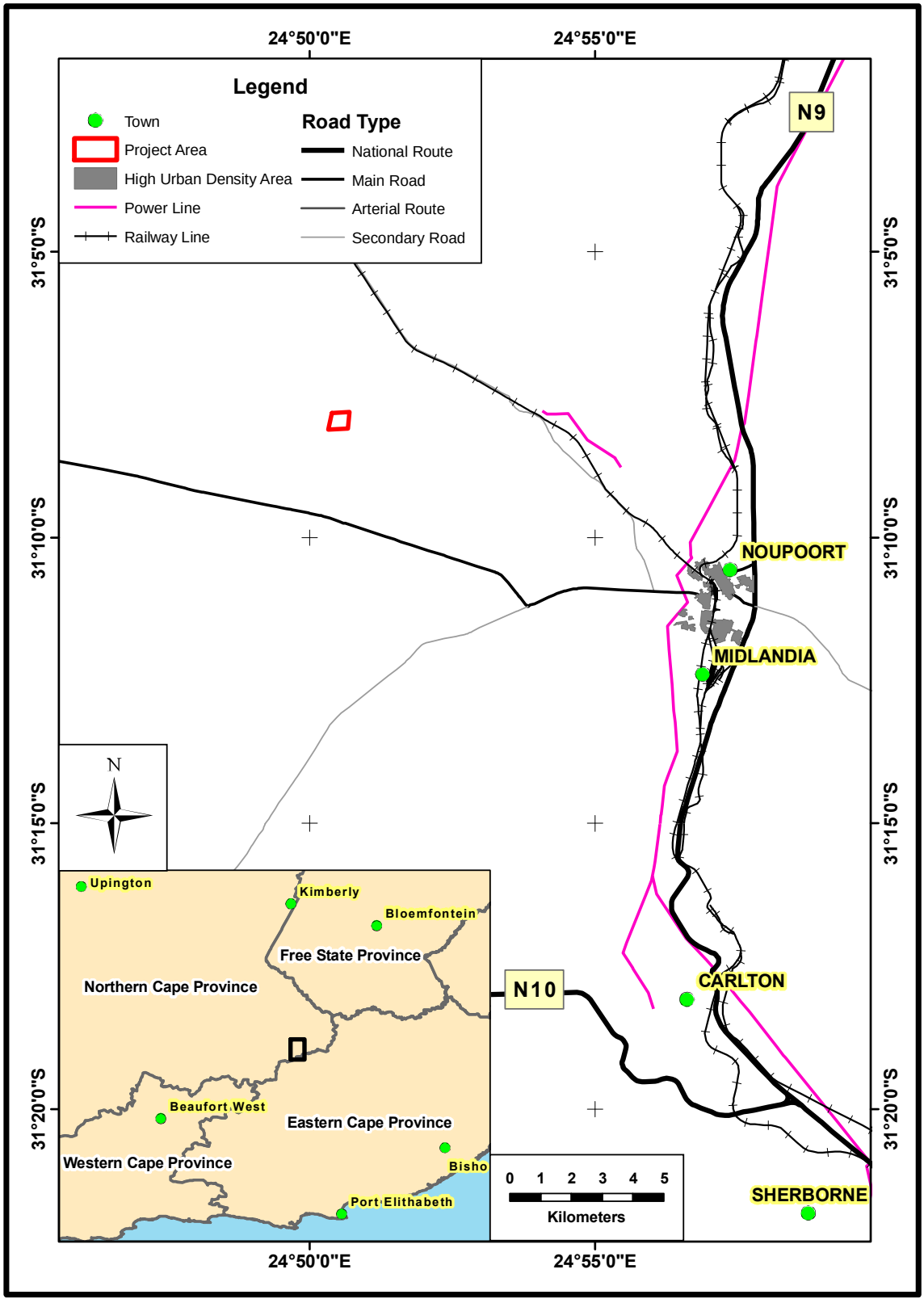

Figure 1: Location map showing the position of the proposed Geo Solar electrical substation facility.

3.1 The National Heritage Resources Act

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

- Archaeological artifacts, 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.).

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 50m in length,
- Any development or other activity that will change the character of a site and exceed 5 000m^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 METHODOLGY

It was considered that the most effective methodology for determining the fossiliferous potential of the project area was to traverse the area by foot. Given the restricted aerial extent of the proposed development it was possible to visit the entire site within an acceptable timeframe. The study area was visited on the 22nd June 2013 by Dr B.D. Millsteed.

The path of the foot traverse was recorded as a track on a hand-held GPS and is indicated in Figure 2. Where ever rock outcrops were identified they were intensely investigated to identify any fossil material present.

Photographs were taken and observations made were taken at a number of locations (see data waypoint locations in Figure 2). The location of the photographs and observation points was recorded using a hand-held GPS.

5 RELEVENT EXPERIENCE

Dr Millsteed holds a Ph.D 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.

6 ACCESS AND INDEPENDENCE

The area to be impacted by the proposed electrical substation was supplied to BM Geological Services as a .kmz file. The research was conducted completely free of any hindrance. Access was freely available to all portions of the study area and the field visit was able to be conducted wherever it was deemed necessary for the satisfactory completion of the study.

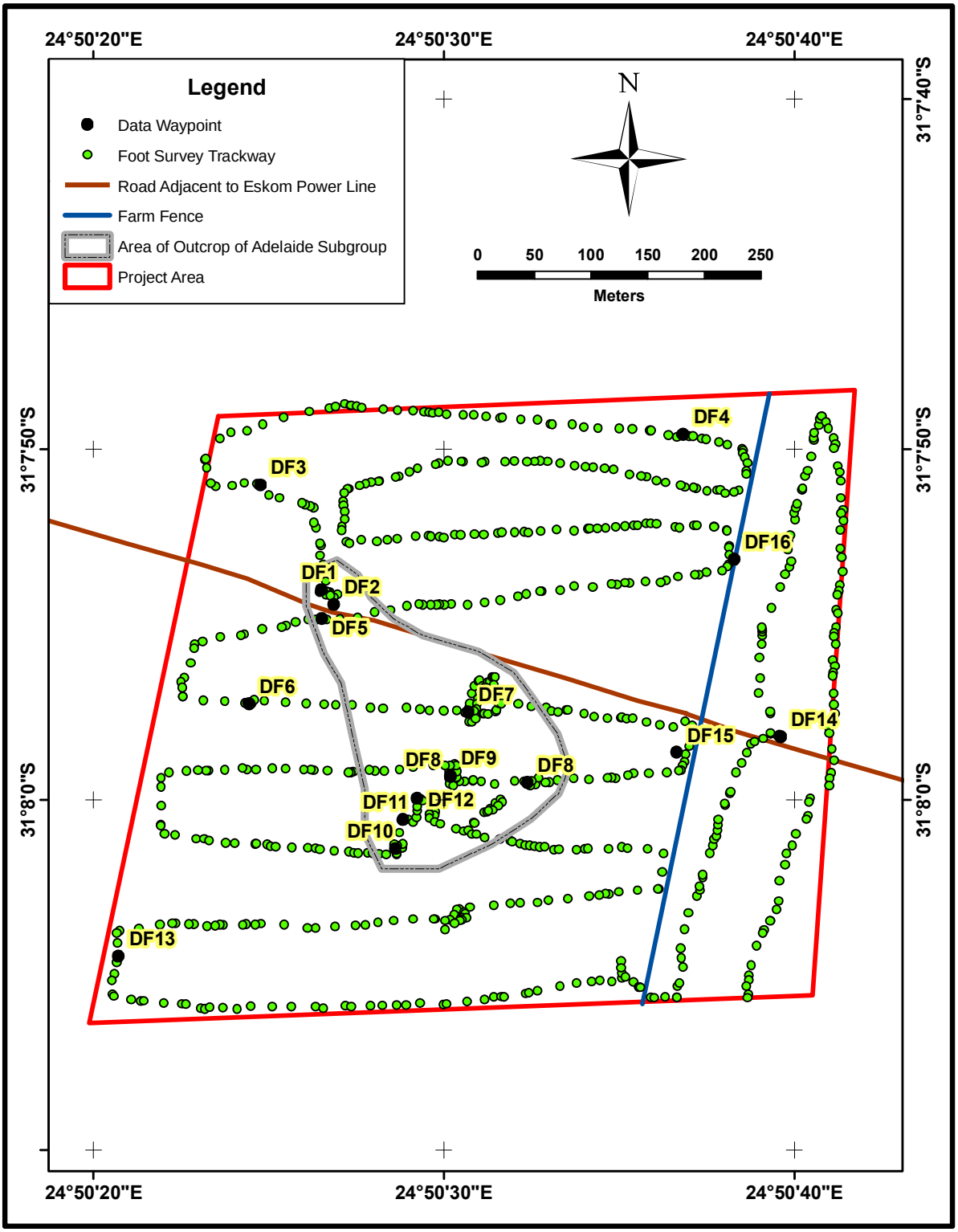

Figure 2: The location of the path taken during the site visit (GPS generated survey trackway), the location of GPS waypoints where photographs and observations were taken as well as the locations of the dirt road that passes through the area and which is located immediately adjacent to a high voltage Eskom power line. Indicated via the blue line is the location of a farm fence that passes through the eastern portion of the project area.

The land surface is relatively flat and featureless, otherwise featureless and vegetated with sparse, low bushes generally less than 50 cm high. Accordingly, as the observations were conducted on foot there were no areas that could not be easily visited and studied.

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Impact Assessment study and shall receive fair remuneration for these services. Neither Dr Millsteed nor BM Geological Services has any financial interest in Geo Solar (Pty) Ltd, the electrical substation or its associated proposed solar energy facility.

7 GEOLOGY

Figure 3 shows that the project area underlain by Late Permian sediments of the Adelaide Subgroup, Karoo Supergroup. The central portion of the area is typified by sparse outcrops of the Adelaide Subgroup rocks and a thin regolith cover (Figures 2 and 4). The western- and eastern-most extents of the project area are typified by a deeper regolith cover exhibiting termite mounds and an absence of outcrops (Figure 5). A brief description of the stratigraphic units identified during the field visit and their potential palaeontological content are provided below, in order of increasing geological age.

7.1 Adelaide Subgroup

7.1.1 Geology

The Adelaide Subgroup consists of greenish or blue grey and greyish-red mudstones and sandstones (South African Committee for Stratigraphy, 1980; pp. 538-539). 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. The project area lies proximally to, but west of the dividing line of longitude and so must form part of the western succession (Johnson *et al*., 2006). Detailed mapping and stratigraphic identification of the lithological succession within the project area did not form part of the mandate for this study. However, it is evident from Figure 2.1 of Cole and Wipplinger (2001) and the fact that the project area lies east of longitude 24° east that the Adelaide Subgroup sediments present are those of the Balfour Formation.

7.1.2 Palaeontological potential

The fluvial lacustrine sediments of the Balfour Formation underlying the project form part of the faunally diverse *Dicynodon* Assemblage Zone (Figure 6). As such the rocks underlying the project area may be expected to contain vertebrate fossils belonging to the reptiles Dicynodontia (*Aulacephalodon*, *Dicynodon*, *Diictodon*, *Dinanomodon*, *Emydops*, *Oudenodon*, *Palemydops*, *Pelanomodon* and *Pristerodon*), Biarmosuchia (*Burnettia*, *Ictidorhinus*, *Lemurosaurus* and *Rubidgina*), Gorgonopsida (*Broomicephalus*, *Cielandina*, *Cyonosaurus*, *Dinogorgon*, *Lycaenops*, *Prorubidgea*, *Rubidgea*, *Paragalerhinus* and *Leontocephalus*), Therocephalia (*Akidnognathus*, *Cerdops*, *Homodontosaurus*, *Ictidosuchoides*, *Lycideops*, *Moschorinus*, *Nanictidops*, *Promoschorhynchus*, *Scaloporhinus*, *Tetracynodon* and *Theriognathus*), Cynodontia (*Cynosaurus*, *Nanictosaurus* and *Procynosuchus*), Captorhinida (*Anthodon*, *Milleretta*, *Millerosaurus*, *Owenetta*, *Pareiasaurus* and *Spondylolestes*) and Eosuchia (*Saurosternon* and *Youngia*), amphibians (*Laccocephalus*, and *Rhinesuchus*) and fish (*Athestonia* and *Namaicthys*) (Kitching, 1995). In addition to the well documented and scientifically important vertebrate fossils the unit also contains the freshwater mollusc *Palaeomutella* (Kitching, 1995) and 34 genera of insects (Riek 1973, 1976a and b).

The plant macrofossil assemblages of the Balfour Formation are sparse and depauperate compared to the vertebrate fossil assemblages. Bamford (2004) records on the presence of the wood genera *Agathoxylon* and *Australoxylon*).

7.2 Regolith Cover

7.2.1 Geology

Almost the entire land surface of the project area is covered with a cover of Cenozoic age sheet wash and sandy regolith (Figure 7). This unconsolidated mostly consists of yellow brown coloured clay-rich sands, but in places there are clasts of sandstone and dolerite varying in size up to cobbles.

7.2.2 Palaeontological potential

Cenozoic age palaeontological sites are occasionally identified in alluvial terraces and dongas throughout the Karoo. It may expected that large mammal bones, dentition, horn cores, micromammal bones and fresh water molluscs may be identified within this part of the stratigraphic sequence.

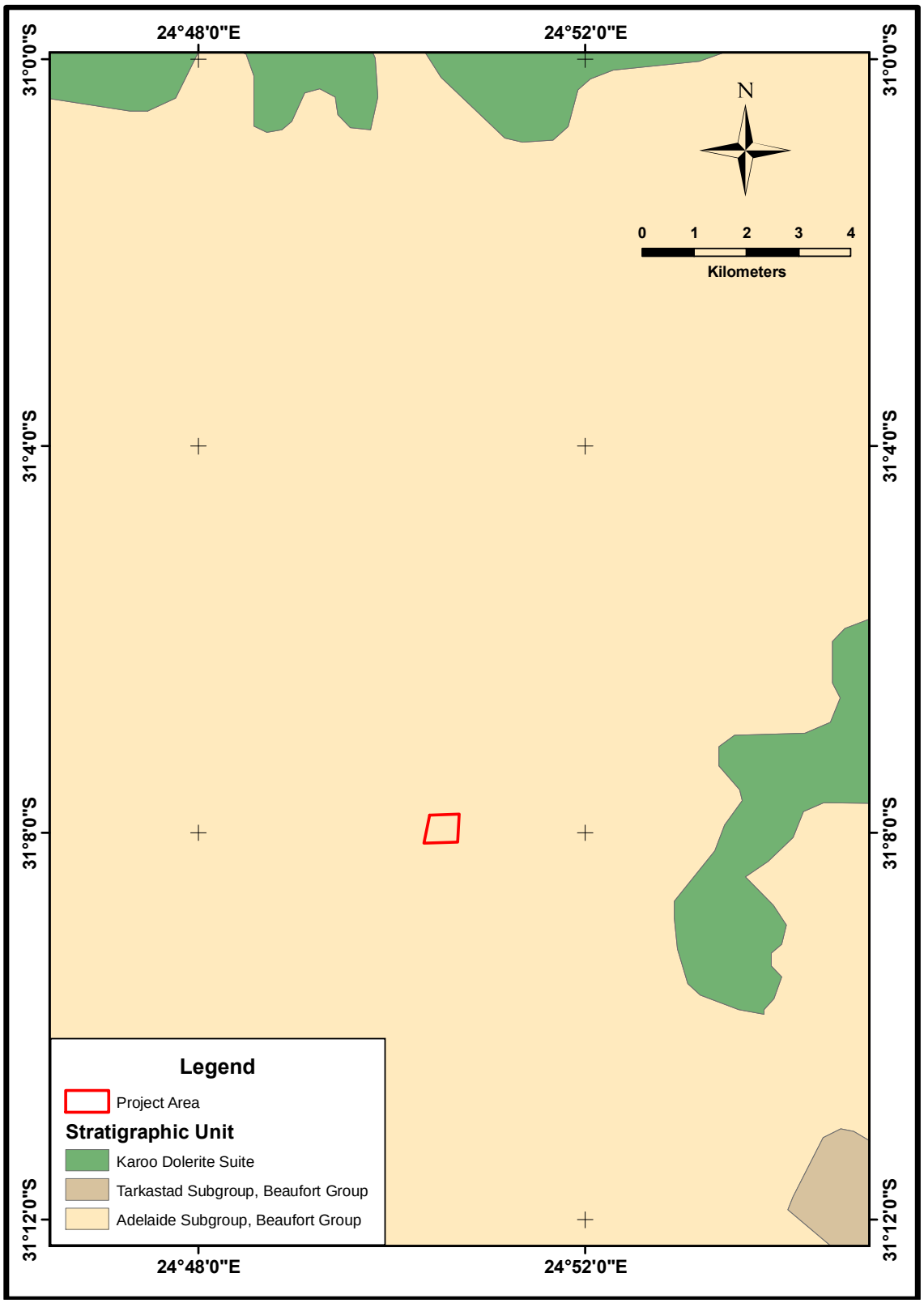

Figure 3: Geological map of the bed rock underlying the project area and its surrounding environs.

Figure 4: View of the low, flat outcrop style of the rocks of the Adelaide Subgroup within the project area (see Figure 2, waypoint DF5).

Figure 5: View of the thicker regolith succession that occurs on the eastern- and western-most portions of the project area. These areas are readily identified by the presence of rounded termite mounds (see Figure 2, waypoint DF4).

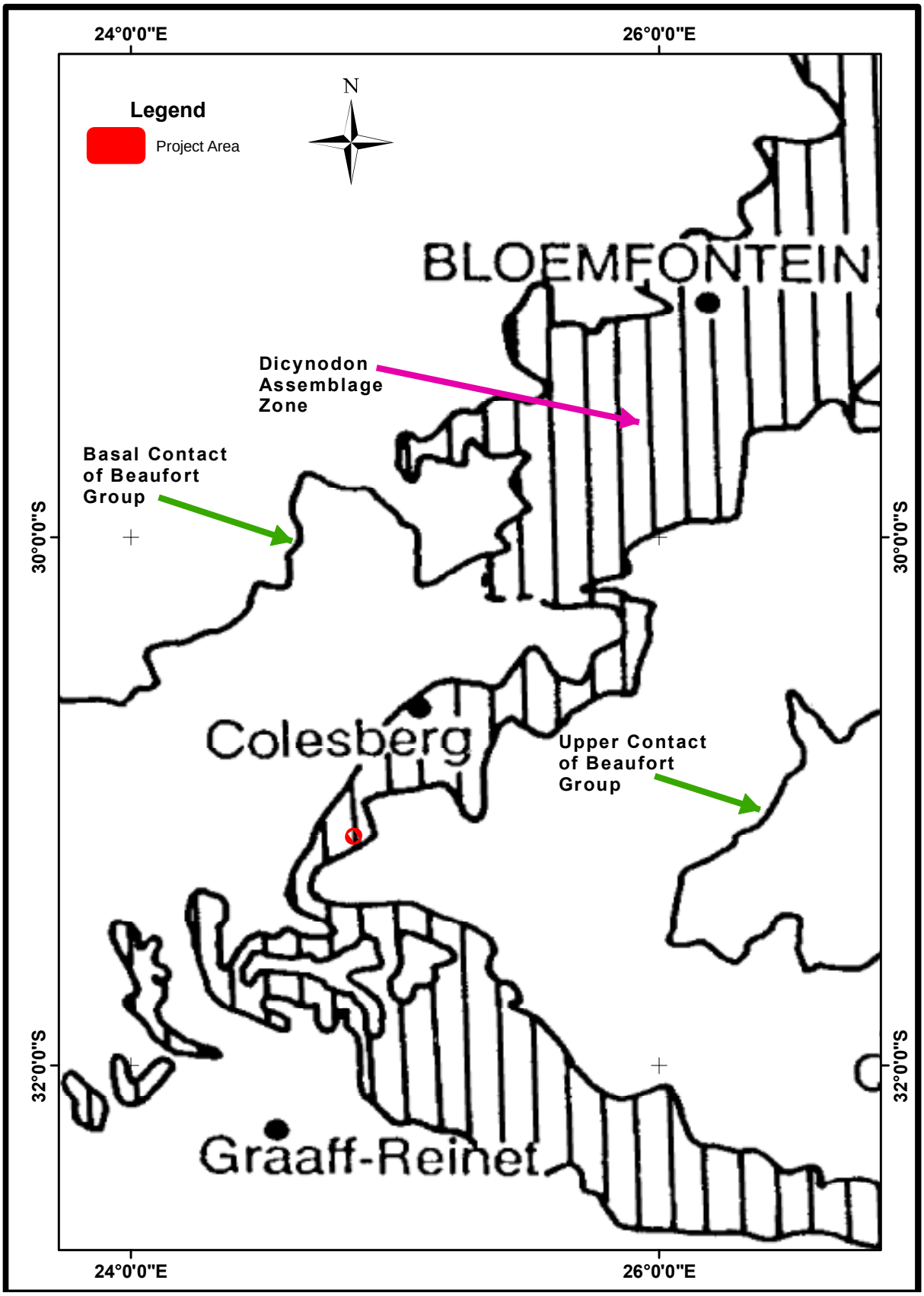

Figure 6: map of the distribution of the rocks containing the *Dicynodon* Assemblage Zone in the region containing the project area (modified from Kitching, 1995).

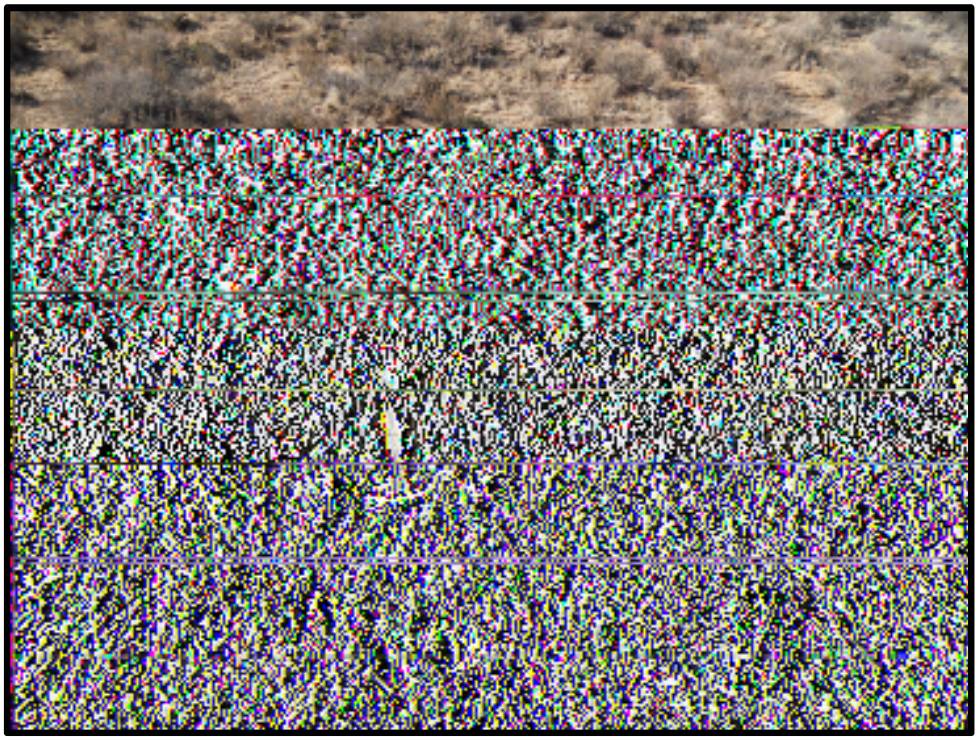

Figure 7: Photograph of the sandy regolith covering much of the project area. Evident is the sparse cover of low (< 50 cm high) Karoo bushes (see Figure 2, waypoint DF3).

8 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The project area consists of just over 27 ha of land vegetated with low Karoo bushes and grass. The land is currently utilised for stock grazing. A high voltage Eskom power line and associated road runs east-west through the centre of the area (Figure 8) and there is a farm fence that runs approximately north-south through the eastern-most potions of the project area (Figure 2).

Topographically the area consists of a featureless low, flat hill located upon the southern slopes of a very prominent dolerite ridge (Figures 9, 10 and 11). There is no significant drainage features developed within the area. The entire site is covered with vegetation of the Eastern Upper Karoo veld type which has a conservation status of least threatened (Mucina and Rutherford, 2006; Figure 12).

Figure 8: Photograph of the Eskom high voltage power line that runs east-west through approximately the centre of the project area. The view is from waypoint DF2 (see Figure 2) looking east.

Figure 9: Photograph looking north from waypoint DF1 (see Figure 2) towards a prominent dolerite ridge located outside of the northern margin of the project area. The land surface slopes gently upwards from the location of the photograph towards the ridge.

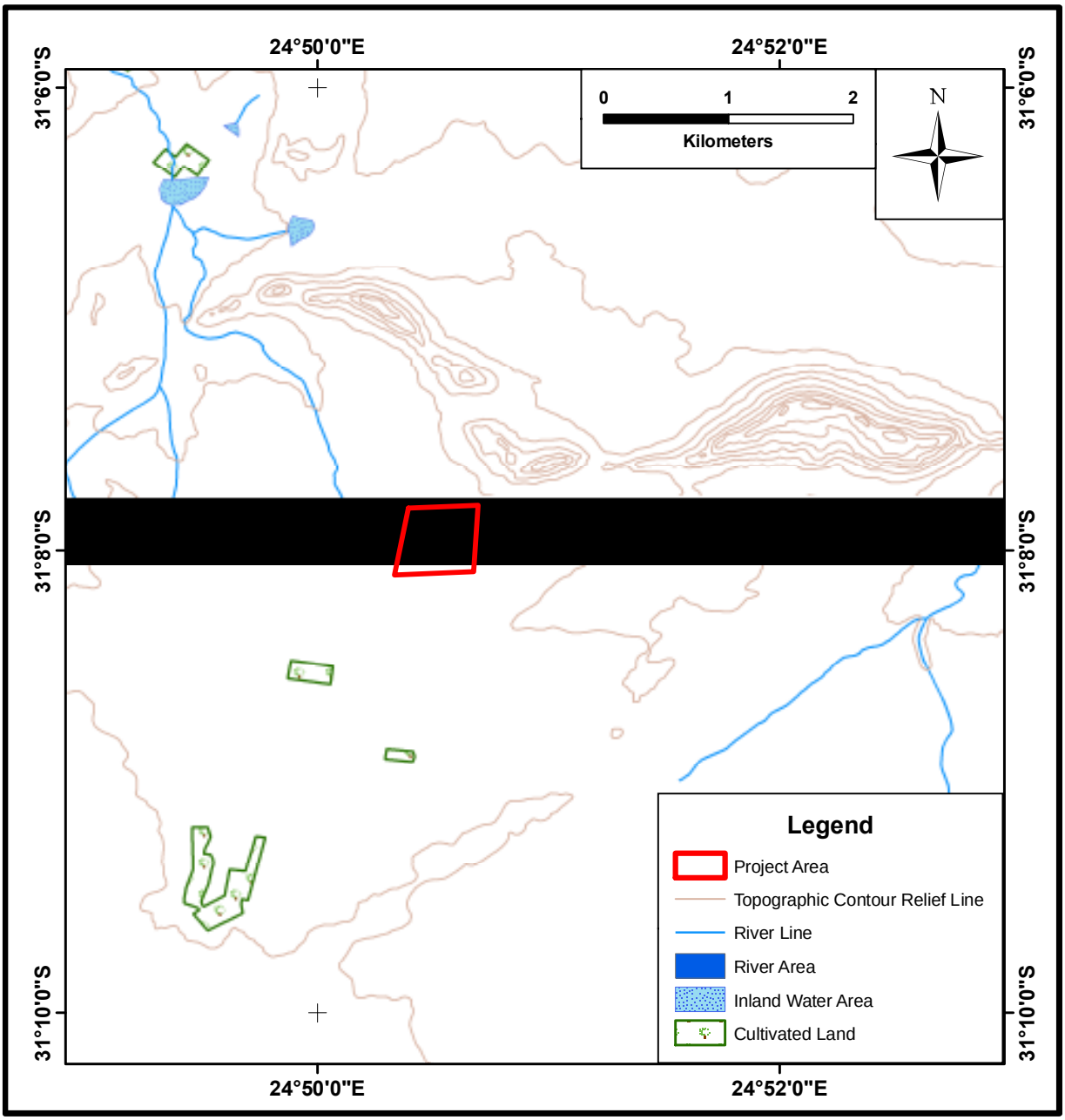

Figure 10: Map of the project area and its immediate environs. It is evident that the land surface is relatively flat (note: the topographic contour interval is 20 m) and that there are no drainage feature flowing through the project area.

Figure 11: Google Earth image of the project area and its immediate environs. The dolerite ridge lying to the north of the project area is evident as is the flat, featureless topography within the project area. The prominent, straight white line running northwest-southeast through the project area is a high voltage Eskom power line and its associated dirt track.

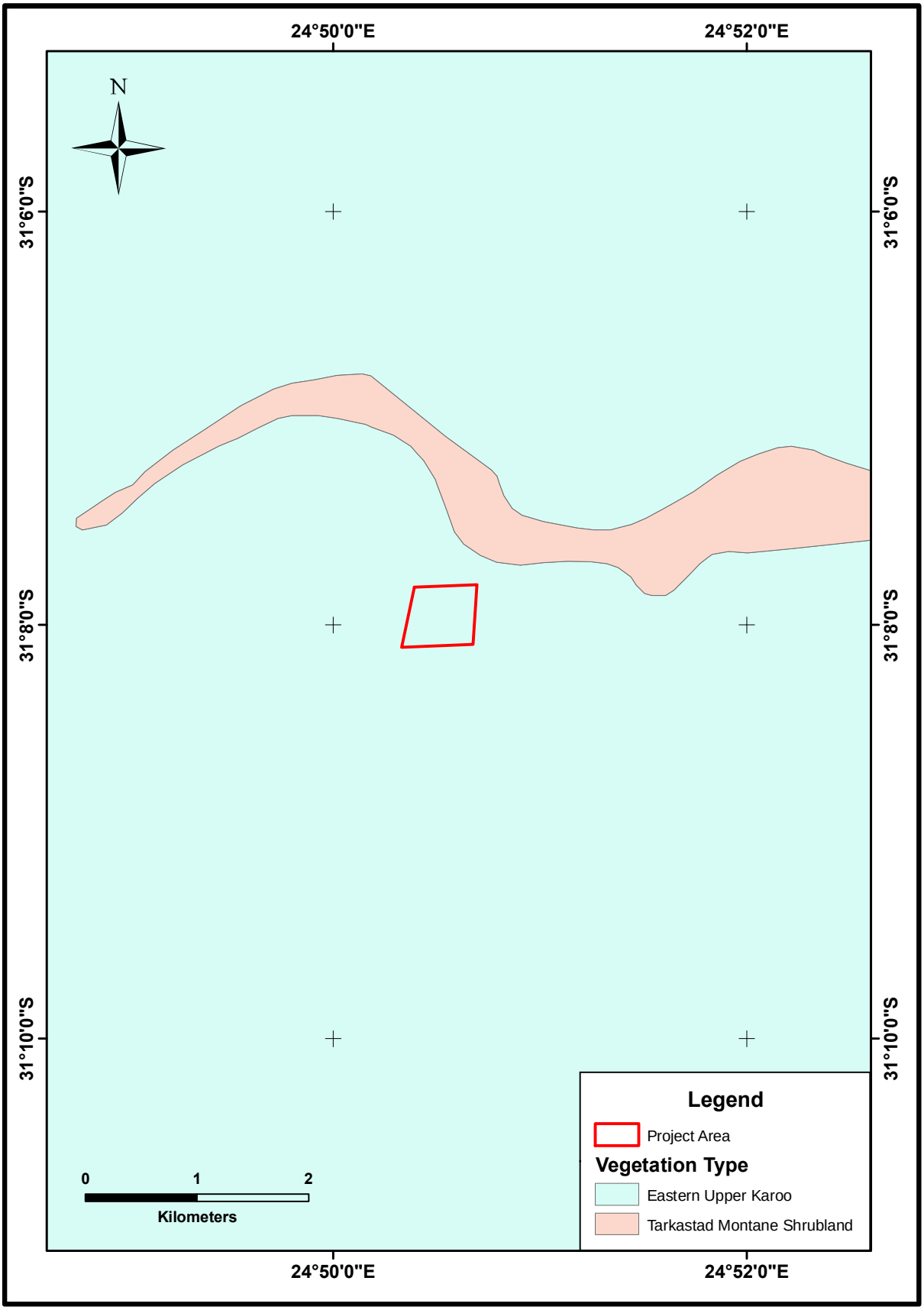

Figure 12: Map showing the distribution of the veld types present within the project area and its immediate environs (after Mucina and Rutherford, 2006).

9 OVERVIEW OF SCOPE OF THE PROJECT AND POTENTIAL NEGATIVE EFFECTS

The development is proposed to consist of a 132 kV to 66 kV step-down substation. The specifications for the proposed project are uncertain at the time of preparation of this report. However, comparison to similar structures located elsewhere in South Africa, suggests that any negative effects on the palaeontological heritage of the area will be restricted to the upper-most few meters of the land surface. There is a pre-existing network of farm roads available to provide vehicular access to the site and there is a well developed dirt road that runs east-west through the centre of the project area parallel to, and immediately adjacent to, a high voltage Eskom power line.

The construction of the planned infrastructural elements comprising the project would potentially risk causing damage or the destruction of any fossil materials occurring at or near surface or at depths of up to approximately 2 m. Should any fossil material occur within the area directly affected by any excavations or earth moving procedures, and in the absence of any mitigating activities, the effect on the palaeontological heritage of the area would be permanent and irrevocable. The negative effects on any fossil materials that will occur beneath the infrastructural elements, but sufficiently deep not to be disturbed by the earth moving operations will be restricted to the life span of the existence of the infrastructural elements and will consist of the loss of access to the fossils for scientific investigation.

10 FIELD OBSERVATIONS

10.1 Geological Outcrop

Outcrops of the potentially fossiliferous Adelaide Subgroup strata are concentrated within the central portion of the project area (Figure 2). Where present, the outcrops are very low and flat (Figure 4) and vary up to several 10's of square meters in size. On the eastern- and western-most portions of the project area the land surface consists of unconsolidated Cenozoic regolith typified by the presence of low, rounded termite mounds.

10.2 Fossil occurrences and significance

No fossil material was identified in any portion of the project area.

11 IMPACT ASSESSMENT

The potential impact of the proposed expansion of the Geo Solar (Pty) Ltd's proposed electrical substation is categorised below according to the following criteria:-

11.1 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.

11.2 Extent of impact

The potential effects on the palaeontological heritage of South Africa is restricted to the damage, destruction or covering of fossil material caused by the construction of the necessary infrastructure elements anticipated as forming part of the project. The aerial footprint of the project is small (just in excess of 27 ha), thus, the **extent of the area of impact is categorised as local** (i.e., restricted to the project site).

11.3 Duration of impact

The anticipated duration of any negative impact that may be caused by the proposed project is assessed as potentially **long term to permanent**. 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 (i.e. **long term**).

11.4 Probability of impact

No fossil material was identified during the field visit. Thus, the probability of the proposed project resulting in any negative effect on the palaeontological heritage of the area is small, but the potential remains for fossils to exist below the land surface that could not be located during the survey. In accordance with these observations **the probability of any negative impact on the palaeontological heritage of the area occurring is improbable** (low likelihood).

11.5 Significance of impact

The rocks of the Karoo Supergroup are known as possibly the most significant stratigraphic section in the world for documenting the evolutionary transition from reptiles to mammals. Thus, the fossils of the Karoo-age sequence are an important component of the world's palaeontological and scientific heritage. The Balfour Formation (as part of the Adelaide Subgroup) in part documents the early stages of the evolutionary transition and it is evident from Section 7.1.2 above that the unit potentially contains an extremely rich and diverse vertebrate fauna.

The scientific and cultural significance of individual fossils 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 position 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.

11.6 Severity / Benefit scale

The proposed project is categorised, herein, as being **beneficial**. This classification implies that the project will provide a long term benefit to the community in terms of the provision of 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 have been categorised as very low. It is accepted that scientifically significant fossils may be present within the bedrock and regolith cover of the area and that these may only be identified during the construction phase of the project. However, any potential negative impact on the areas palaeontological heritage can be mitigated to an absolute minimum should careful attention be paid to the site during the construction phase. Should any palaeontological materials be uncovered during the construction phase construction should be halted in that area, the finds reported to SAHRA and a professional palaeontologist contracted to assess the scientific significance of the fossil(s) and to arrange their excavation and transport to an institution licensed to house fossils. In the event of these suggested mitigation procedures being properly implemented the potential benefit of the project will greatly outweigh the threat of a negative impact.

A second significant potential benefit 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.

11.7 Status

Given the combination of factors discussed above, it is evident that little to no negative effect on the palaeontological heritage of the area is anticipated as a result of the proposed project. 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.

12 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the 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.

12.1 Mitigation

It may be anticipated that fossil material may be discovered during the construction phase of the project. As the majority of the excavations required for the construction is

likely to be conducted by heavy machinery damage to the fossils during the initial excavation and discovery will be unavoidable and cannot be mitigated. However, should fossil material be identified construction on that site should be halted immediately, the finds reported to SAHRA and a professional palaeontologist contracted to assess the scientific significance of the fossil(s) and to arrange their excavation and transport to an institution licensed to house fossils.

12.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials is **irreversible**.

12.3 Degree of irreversible loss

Once a fossil is damaged or destroyed the **damage is irreversible**. However, by their nature fossils are usually rare and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material may be of the greatest scientific importance. This is particularly true of vertebrate fossils in which many taxa are known from only one fossil. Thus, the potential always exists during construction and excavation of potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete 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. However, the judgement on the significance of the fossil must be made by a suitable experienced palaeontologist.

13 DISCUSSION OF PROJECT ALTERNATIVES

The various infrastructural requirements to provide for the successful implementation the proposed substation presumably include close proximity to a power generation facility and a high voltage power line system. Accordingly, alternative options for the location of this facility are restricted. The purpose for this substation is to connect to a solar power generation facility and it can be assumed that the high number of cloud free days provided by the Karoo compared to many other areas of South Africa mark the positioning of the project within this region as a major component in the success of the proposed project. Given that the Karoo is predominantly underlain by potentially fossil-bearing strata of the Karoo Supergroup the same potential for negative impact on the palaeontological heritage of South Africa exists almost everywhere. However, one possible alternative concerning the location of the solar energy facility would be to locate the entire project upon outcropping rocks of the Karoo Dolerite Suite (as these are not fossiliferous). However, the outcrops of the Karoo dolerites elsewhere in the immediate region produce extremely steep sided ridges that are not easily built upon. Similarly,

the existing Eskom power lines tend to be located some distance from these dolerite ridges. Such a proposal would obviously only be a viable alternative if a flat region of dolerite is identified that is located such that all the other criteria necessary for the successful development of a solar energy facility can be met.

14 RECOMMENDATIONS FOR MITIGATION OF NEGATIVE EFFECTS

Should SAHRA indicate that the project may proceed, on the basis of the lack of a significant negative impact on the palaeontological heritage of the area and any fossil material be subsequently located during the construction of the proposed operations then SAHRA must be notified of the finding of the fossil material. Additionally, an appropriately experienced palaeontologist should be contacted to evaluate the material and advise on its scientific importance. Should the fossil material prove to be of scientific or cultural heritage significance the palaeontologist should make recommendations for mitigation of negative effects on the fossil material. Such recommendations may include excavation of the fossils (under a permit issued by SAHRA).

This mitigation process will not avoid the possibility of some damage to the fossil material. Unfortunately, this will be an inescapable component of the discovery process. However, a potentially positive outcome of the mitigation process is that it may make presently unknown fossil materials available for scientific study that would otherwise remain unknown. The advantage to the proposer of the project is that any scientifically significant fossil material can be excavated allowing the completion of the project.

15 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The foot-based transect that constituted the site investigation of the proposed project area allowed only observation of the presence or absence of fossils occurring at the Earth's surface. The conclusions drawn within this report are derived from those surface derived observations. It is accepted that there is a reasonable possibility that fossil material may well exist either within the regolith, or within the Adelaide Subgroup sediments presently lying beneath the regolith cover. However, the determination of the existence of said fossils cannot be confidently determined without a thorough excavation of the nearly the entire area.

16 ENVIRONMENTAL IMPACT STATEMENT

A thorough investigation of the site of the proposed 132 kV to 66 kV step-down substation was conducted on foot on the 22nd of June 2013. It was identified that the project site is aerially restricted (slightly in excess of 27 ha in size). As such any negative effects emanating from the project will be restricted to the local environment.

All proposed infrastructural elements that comprise the proposed project are restricted to the project area. Most infrastructural elements will directly affect the surface of the site to a very shallow depth, with the deepest being presumed to be less than 2m in depth.

This study has identified that there are two geological units that underlie the project area. These geological units, in order of increasing stratigraphic age, are unconsolidated regolith cover and sediments of the Balfour Formation, Adelaide Subgroup. Both the sandy regolith and the Balfour Formation are potentially fossiliferous and are known to be fossil-bearing elsewhere in the Karoo. However, the site visit was detailed and did not identify any fossil material within the boundaries of project area. However, the site visit was only able to identify the presence or absence of fossil material at the Earth's surface. It is possible that fossil material may exist in the subsurface, but this cannot be determined without extensive excavation being undertaken. However, in general fossils are rare and sporadic in their occurrence and, as such, the chances of a fossil being disturbed by the relatively shallow excavations contemplated for the emplacement of the projects infrastructural elements is not high.

The rocks of the Balfour Formation that underlie the project area form part of the *Dicynodon* Assemblage Zone. This biostratigraphic zone contains a rich and diverse vertebrate fauna of extremely high cultural heritage and scientific significance due to their part in documenting the evolutionary transition from reptiles to mammals. Despite the sparse and sporadic occurrence of fossils in general a single fossil can have immense scientific importance (e.g., many vertebrate fossil taxa are known from a single fossil) so the potential for significant loss to the palaeontological heritage remains. Any damage to fossil material that occurs during the excavation and construction phase of the project is permanent and irreversible. Thus, the probability of a negative impact on the fossil heritage of the area is low, but the significance of any negative impact is potentially very high. However, the potential negative impact to the palaeontological heritage can be minimised by the implementation of appropriate mitigation processes. The suggested mitigation procedure is that a careful watch be kept on the site of all excavations and construction during the development of the project. Should any fossil material be uncovered the excavation must be immediately stopped. At this juncture SAHRA must be informed of the fossil find and an appropriately experience palaeontologist contacted to ascertain the scientific value of the fossil material. Should the fossil material be of cultural heritage significance the palaeontologist should make recommendations for mitigation of negative effects on the fossil material. Such recommendations may include excavation of the fossils (under a permit issued by SAHRA). Should such new palaeontological material be located as a result of this project 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.

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.

In summary, no fossil material of scientific or cultural importance was identified on the site of the proposed project. In addition the potentially fossiliferous strata present in the area appear to be essentially unfossiliferous. Accordingly, **no palaeontological reason was identified that would negatively affect approval for the commencement of the project**. Should an alternative solution be sought to the present proposed location of the project it is suggested that the project could be located wholly upon outcrops of the Karoo Dolerite Suite.

17 RECOMMENDATIONS

The following recommendations are made for the future conduct of the project in order to reduce the potential for any negative impact on the area to an absolute minimum:

- A careful watch be kept on the site of all excavations and construction during the development of the project to identify any fossil materials that may be uncovered.
- Should any fossil material be located during either the construction of the proposed substation and its infrastructure elements operations excavations should be halted and SAHRA informed of the discovery.
- Should any fossil materials be identified a palaeontologist should be contacted to evaluate the material and advise on its scientific importance and, if necessary, excavation or preservation.

18 REFERENCES

Bamford, M.K. (2004). Diversity of woody vegetation of Gondwanan southern Africa. *Gondwana Research*, 7: 153-164.

Cole, D.I. and Wipplinger, P.E. (2001). *Sedimentology and Molybdenum Potential of the Beaufort Group in the Main Karoo Basin, South Africa*, Council for Geoscience Memoir 80, 225 pp.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., de V. Wickens, H., Christie, A.D.M., Roberts, D.I., and Brandl, G. (2006). *Sedimentary Rocks of the Karoo Supergroup*, in Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 461 – 499.

Kitching, J.W. (1995). Biostratigraphy of the *Dicynodon* Assemblage Zone, In Rubidge, B.S. (ed) *Biostratigraphy of the Beaufort Group (Karoo Supergroup),* South African Committee for Stratigraphy Biostratigraphic Series No. 1, pp. 29-34.

Mucina, L. and Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelizia* 19. South African National Biodiversity Institute, Pretoria. 807 pp.

Republic of South Africa. 1998. National Environmental Management Act (No 107 of 1998). Pretoria: The Government Printer.

Republic of South Africa. 1999. National Heritage Resources Act (No 25 of 1999). Pretoria: the Government Printer.

Riek, E.F., (1973). Fossil insects from the Upper Permian of Natal, South Africa. *Annals of the Natal Museum*, 21. pp. 513-532.

Riek, E.F., (1976a). An immature fossil insect from the Upper Permian of Natal, South Africa. *Annals of the Natal Museum*, 22, pp. 271-274.

Riek, E.F., (1976b). New Upper Permian insects from Natal, South Africa. *Annals of the Natal Museum*, 22, pp. 755-790.

South African Committee for Stratigraphy (SACS) (1980) Stratigraphy of South Africa. Part 1 (Comp. L.E. Kent). Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Trankskei and Venda, Hand Book of the Geological Survey of South Africa 8.

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