FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF PROPOSED SOLAR ENERGY GENERATION FACILITIES (TEWA ISITHA SOLAR 1 AND 2) TO BE LOCATED ON THE REMAINING EXTENT OF THE FARM ALBANY 405 NEAR KAROS, NORTHERN CAPE PROVINCE

Prepared for:

Savannah Environmental (Pty) Ltd

On Behalf of:

Tewa Isitha Solar 1 (Pty) Ltd and Tewa Isitha Solar 2 (Pty) Ltd

Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

Afri-Coast Engineers SA under Special Purpose Vehicles (SPV) namely Tewa Isitha Solar 1 (Pty) Ltd and Tewa Isitha Solar 2 (Pty) Ltd are is proposing to establish a commercial 150 MW photovoltaic solar energy facility and associated infrastructure which is to be developed in two separate 75 MW phases (to be referred to as Tewa Isitha Solar 1 and 2 respectively). The project area, termed the "Developable Area" herein, which will contain the power generation infrastructure, is proposed to be located within the farm Albany 405 RE and occupies an area of approximately 1 143 ha. The project site is located approximately 9 km east of Karos and 48 km east of Upington, !Khara Hais Local Municipality, Gordonia Magisterial District, Northern Cape Province. Geographically the site lays approximately half way between the Orange River to the south and the N14 Highway to the north (Figure 1).

Afri-Coast Engineers SA under Special Purpose Vehicles (SPV) namely Tewa Isitha Solar 1 (Pty) Ltd and Tewa Isitha Solar 2 (Pty) Ltd appointed Savannah Environmental (Pty) Ltd to undertake an Environmental Impact Assessment Process and compile an Environmental Management Programme (EMP) for the proposed Albany Solar Energy Facility, Northern Cape Province. Savannah Environmental (Pty) Ltd has appointed BM Geological Services to provide a Full 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 project area is entirely underlain by Mesoproterozoic rocks of the Koras Group and Zonderhuis Formation. Over the majority of the Developable Area the bed rocks are capped by unfossiliferous calcrete, which is itself overlain by a thin veneer of potentially fossiliferous aeolian sands of the Gordonia Formation.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. It is improbable that there will be any negative impact on the palaeontological heritage of the Gordonia Formation **as no fossil materials were identified during the site visit**. However, should any undiscovered fossil materials be present they would potentially provide significant palaeoclimatic and palaeoecological information for the region. Thus, the magnitude of any negative impact upon the fossil assemblages contained within these geological units is characterised as potentially high, but the probability of any negative impact is assessed as improbable. The area of any potential negative impact caused by the project is characterised as local in extent. Similarly, the zone of permanent disruption is shallow, being restricted to the upper 1-

2m of the land surface. The rocks of the Koras Group and Zonderhuis Formation are considered to be unfossiliferous. Thus, the proposed project poses nil probability of any negative impact upon the palaeontological heritage of these units.

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 a thorough examination of all excavations within the Gordonia Formation 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. 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.

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.

The field investigation that underpins his report was conducted mainly within the eastern portions of the reporting area (due to changes in the project design after completion of the foot traverse of the area). However, sufficient observations were made of portions of the remainder of the area for an effective understanding of the superficial geology to be gained. Accordingly, it is posited that the study area is sufficiently well understood for this report to constitute a Full Palaeontological Impact Assessment Report.

In summary, this 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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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 (Appendix A).
- 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.

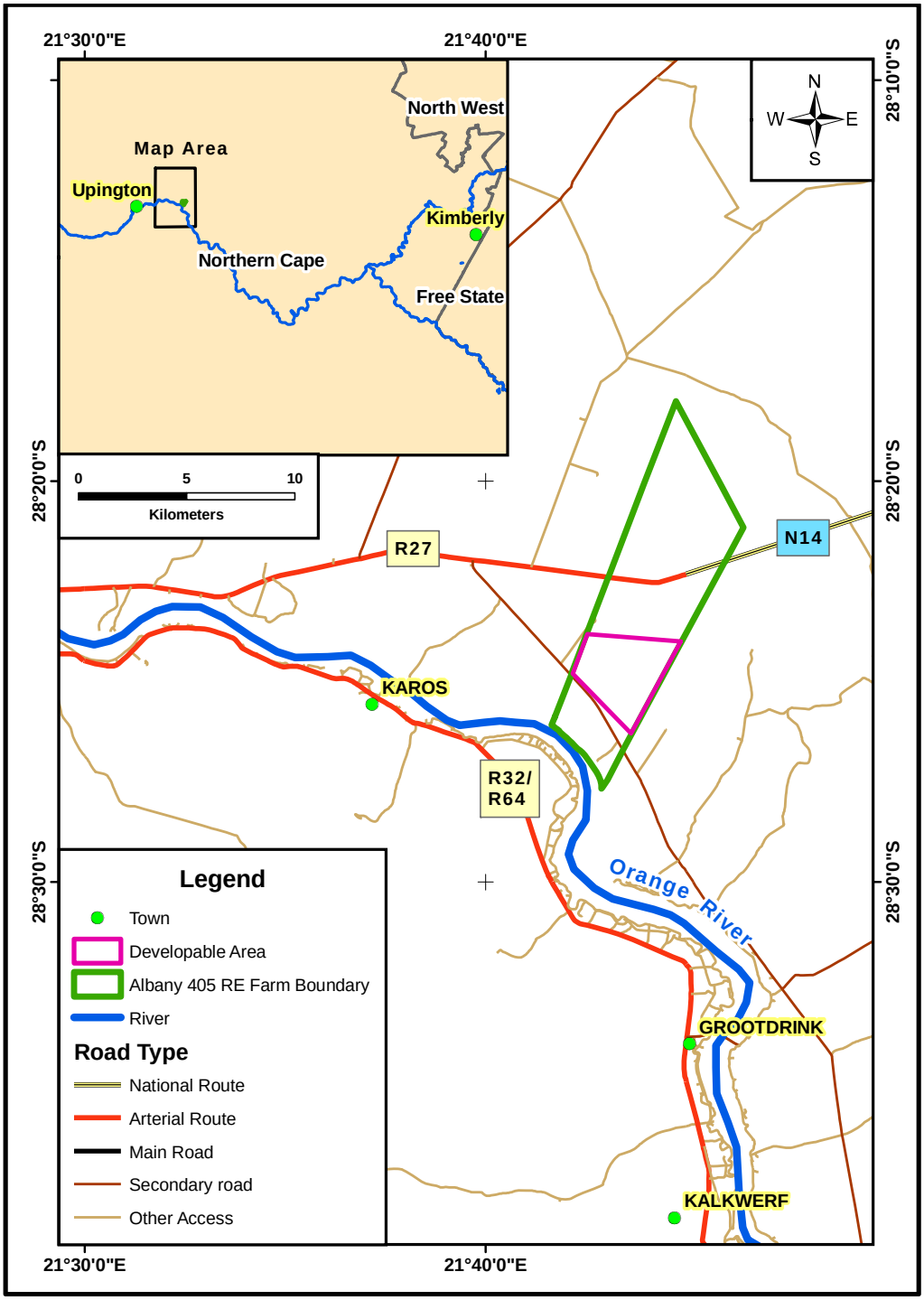


Figure 1: Location map showing the position of the proposed Tewa Isitha Solar 1 and 2 Developable Area.

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 [AS Amended]

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 disturbance 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 METHODOLOGY

4.1 General Discussion

It was considered that the most effective methodology for determining the fossiliferous potential of the project area was to traverse the area by foot. The study area was visited on the 9th of November 2013 by Dr B.D. Millsteed.

The path of the foot traverse was recorded as a trackway on a hand-held GPS and is indicated in Figure 2. 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.

4.2 Incomplete Foot Traverse of the Developable Area

It is apparent from Figure 2 that the Developable Area was not completely investigated during the conduct of the foot traverse and site investigation. It was originally intended that both Phase 1 (Tewa Isitha Solar 1) and Phase 2 (Tewa Isitha Solar 2) of the project would be confined to the area of the foot traverse. Subsequent to the conduct of the field work Tewa Isitha Solar 1 (Pty) Ltd took the commercial decision to expand the aerial extent of both phase of the development resulting in an expanded Developable Area (Figure 2).

Prior to the commencement of the foot traverse of the eastern portion of the Developable Area, some additional access was made of the western portions both by foot and by car (as vehicular access was made from the west along the servitude road of an Eskom power Line (Figure 2). It was apparent these non-GPS documented travels that the surface geology most of the western portion of the Developable Area is identical to that in the east (and documented via the GPS trackway). The exception to this uniformity in surface geology occurs in the south-western corner of the Developable Area (Figure 3). In this region of the Developable Area and extending west to the Orange

River the superficial geological unit is composed of a layer of rounded pebbles to cobbles of fluvial origin; presumably deposited previously by the palaeo-Orange River. Upon some inspection this fluvial material appeared to be unfossiliferous.

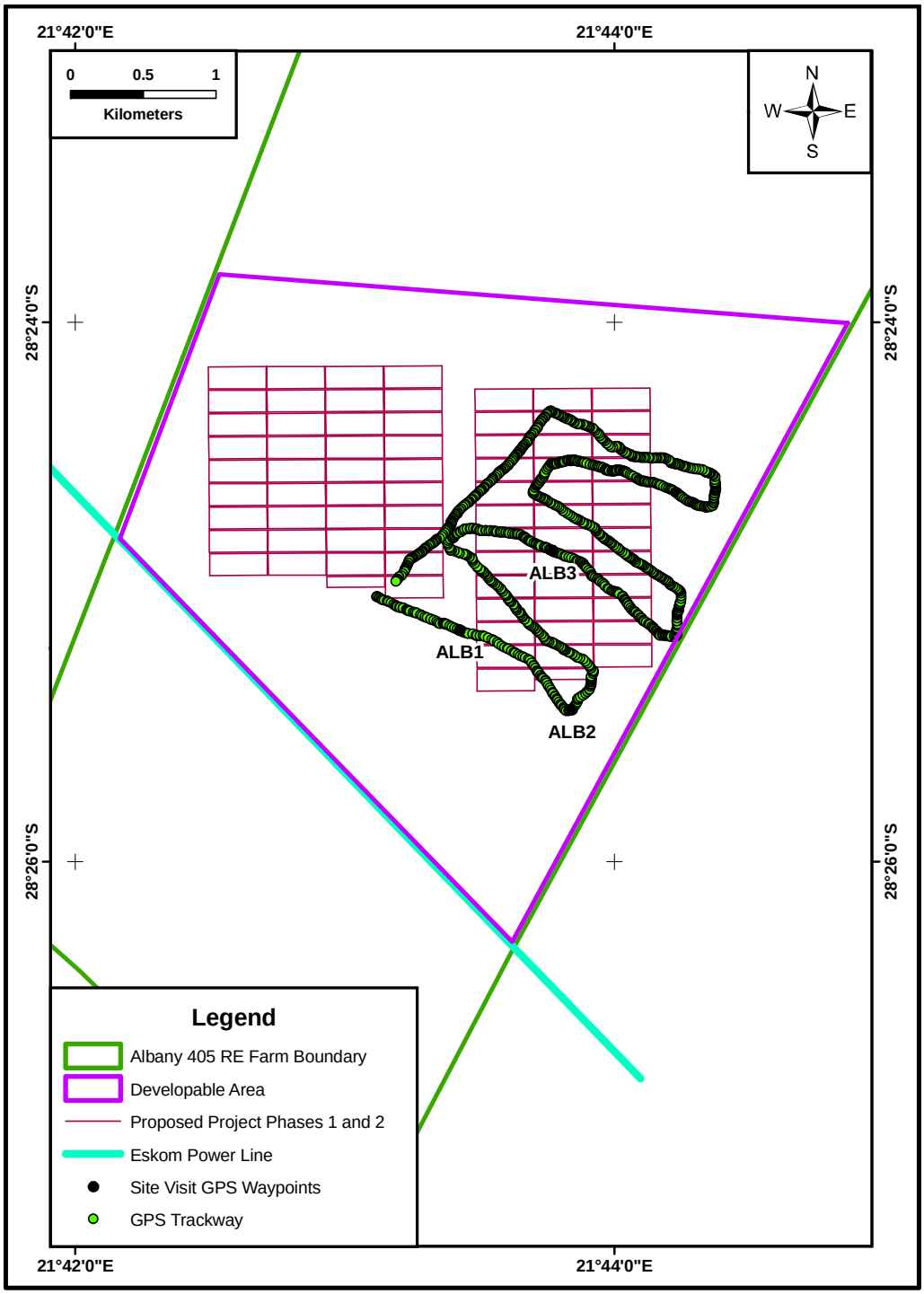


Figure 2: Map showing the location of the Developable Area, solar energy facilities, the GPS trackway representing the location of the foot traverse of the area, the location of

waypoints at which data was collected and the Eskom power line that runs along the southern margin of the area.

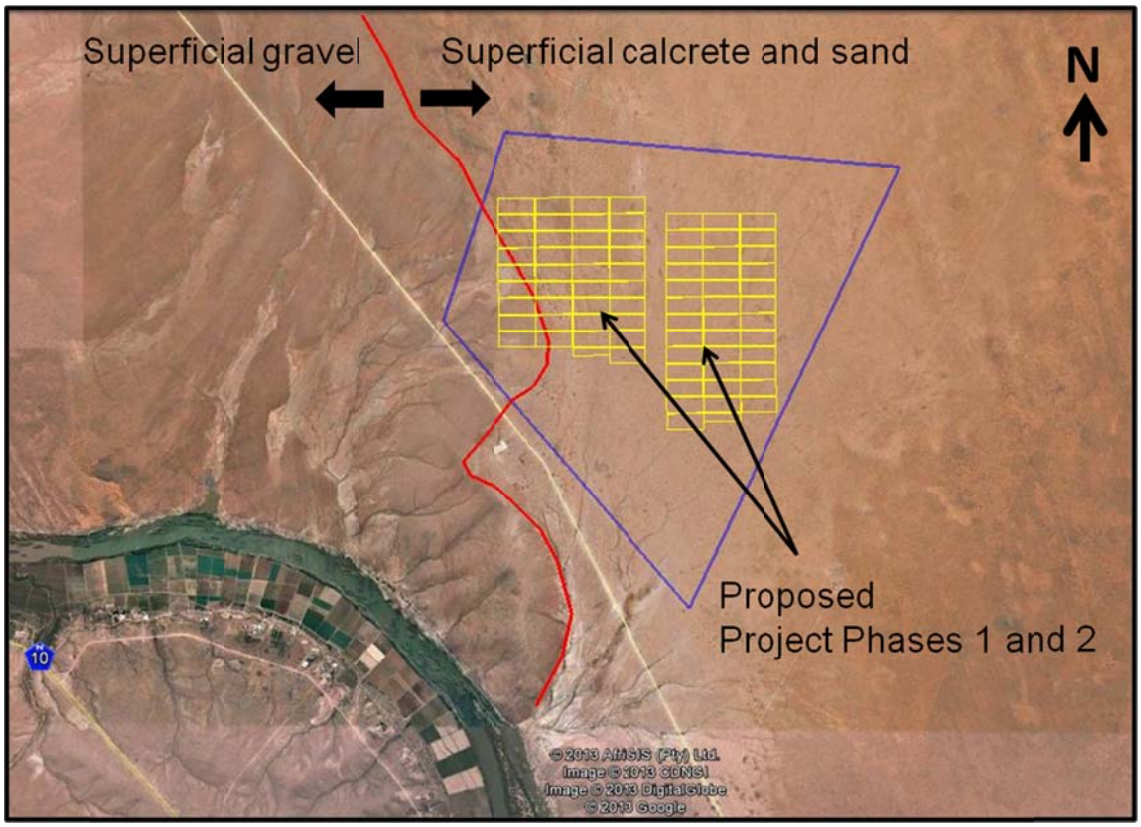


Figure 3: Google Earth image of the Developable Area (purple polygon) and proposed solar power generating facilities (yellow grids). The location of the dividing line between the superficial deposits of fluvial gravels and calcrete/aeolian sands is interpreted from colour variation within the Google Earth image and is supported by field observations.

Field observations made by Dr Millsteed indicate that the superficial geology of the western portions of the Developable Area are generally identical to that in the area extensively investigated by foot and, as such, the two areas should have the same palaeontological potential. The presumed palaeo-Orange River gravels in the south-western corner appear to be unfossiliferous and, as such, should not be negatively impacted by the proposed project.

As much of the eastern phase of the project was intensively investigated, and as field observations of portions of the remainder of the area indicate that the superficial geology is similar in both areas it is considered, here in, that this study constitutes a Full Palaeontological Impact assessment of the entire extent of the Developable Area.

5 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.

6 ACCESS AND INDEPENDENCE

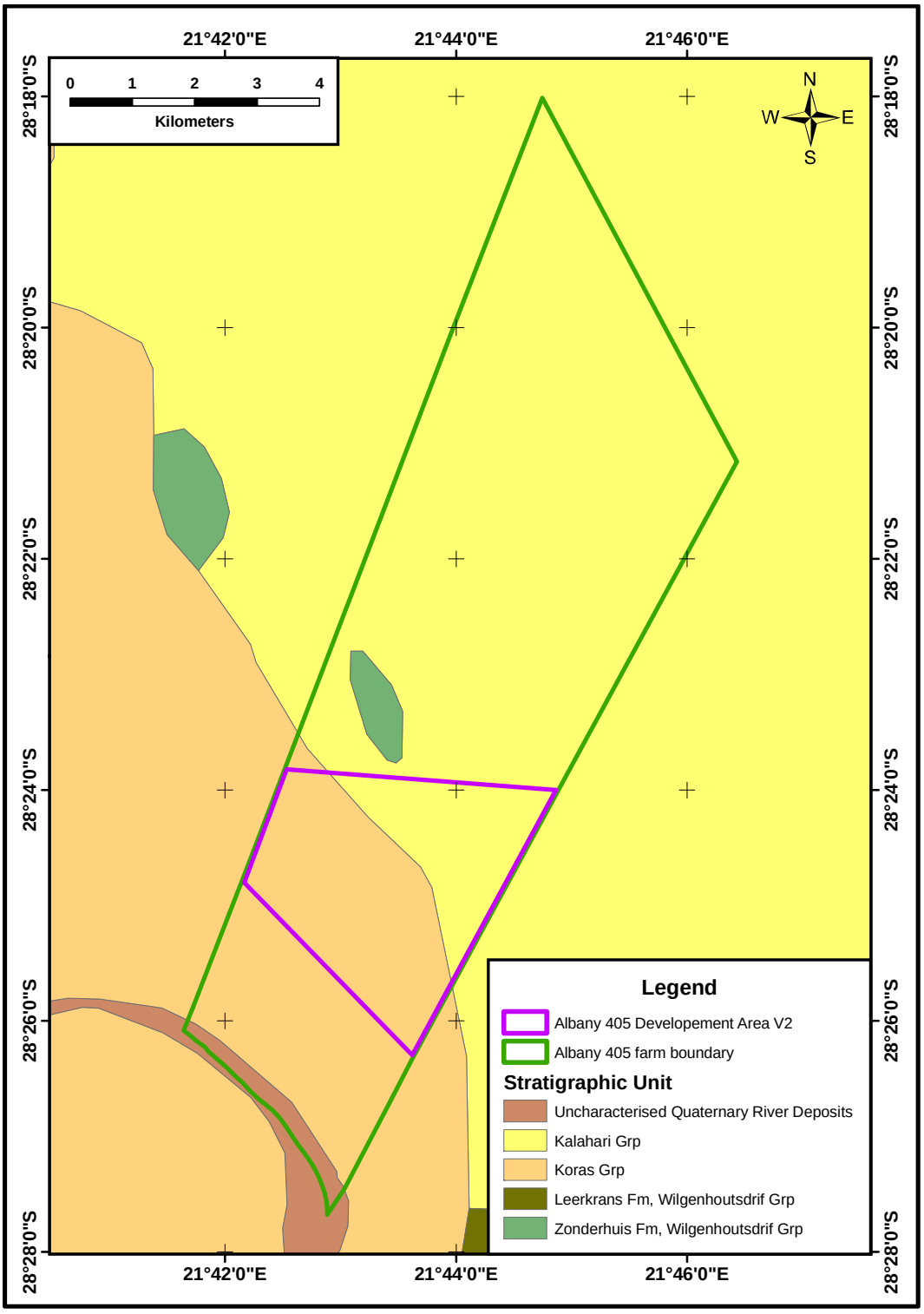
The area to be impacted by the proposed electrical substation was supplied to BM Geological Services as a .kmz file. The research was conducted completely free of any hindrance. Access was freely available to all portions of the study area and the field visit was able to be conducted wherever it was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

The land surface is flat and featureless. The area is vegetated with sparse to dense cover of low acacia bushes and trees generally less than 4m 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 Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either Tewa Isitha Solar 1/2 (Pty) Ltd) or the proposed power generation facilities.

7 GEOLOGY AND FOSSIL POTENTIAL

Figure 4 shows that the project area is completely underlain by bedrocks of the Mesoproterozoic aged Koras Group and Zonderhuis Formation (the latter being part of Kaaien Terrane of the Namaqua-Natal Province). The majority of the project area bears a superficial cover of Cenozoic sands of the Gordonia Formation, Kalahari Group. The site visit revealed that there is an aerially extensive horizon of grey calcrete that caps the Mesoproterozoic bedrock and immediately underlies the sands of the Gordonia Formation. A summary of the characteristics of the geological units and their fossiliferous potentials follows.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Legend
Albany 405 Developement Area V2
Albany 405 farm boundary
Stratigraphic Unit
Uncharacterised Quaternary River Deposits
Kalahari Grp
Koras Grp
Leerkrans Fm, Wilgenhoutsdrif Grp
Zonderhuis Fm, Wilgenhoutsdrif Grp

Figure 4: Map of the geology underlying the project area and its surrounding environs, the calcrete is not shown, but is present over the majority of the Developable Area.

7.1 Koras Group

7.1.1 Geology

The Mesoproterozoic Koras Group is divisible into three sectors; these being the northern, central and southern sectors. The project area is located within the southern sector. The stratigraphic sequence comprising the Koras Group is, in order of decreasing age, the Christiana, Boom River, Swartkopsleegte, Ezelsfontein, Rouxville and Leeuwdraai Formations. Lithologically the sequence consists of interbedded conglomerates, sandstones, volcanic breccia and tuff as well as rhyodacitic, rhyolitic and basaltic lavas (Cornell *et al*., 2006).

The sequence was deposited into a series of grabens and half grabens that formed as a result of the regional scale collision and deformation (approx. 1 200 Ma) that occurred as part of the Namaqua Orogen (Jacobs *et al*., 1993). The strata of the Koras Group are essentially undeformed, but are invariably altered to greenshist facies (Cornell *et al*., 2006).

7.1.2 Palaeontological potential

The Mesoproterozoic age of the formation as well indicates that the unit was formed prior to the evolution of life forms capable of producing macrofossils. Stromatilites are common fossil forms in Precambrian carbonate successions throughout South Africa, but the absence of carbonate lithologies within the bedrocks of the area similarly suggest a negligible potential for the preservation of any palaeontological materials. No outcrop of this unit was observed as it appears to be ubiquitously caped by calcrete and the Gordonia Formation sands.

7.2 Zonderhuis Formation

7.2.1 Geology

The 300 m thick, light purple colored sequence of quartzites comprising the Zonderhuis Formation constitutes the basal unit of the Wilgenhoutsdrif Group. The unit also contains lenses of ferruginous or manganiferous quartzite siderite dolomite and argillaceous limestone occur in scattered localities throughout its aerial. The continuity of the formation and its mylonite texture suggests that it accompanies a thrust fault which represents a major crustal detachment zone (Cornell *et al*., 2006). No outcrops of

this formation were identified during the field visit, as they are hidden beneath both the calcrete and the sands of the Gordonia Formation.

7.2.2 Palaeontological potential

The Mesoproterozoic age of the formation, non-carbonate lithology and metamorphic grade of the formation suggest a negligible potential for the preservation of any palaeontological materials. No fossil materials were identified in any of the rock float that was inspected.

7.3 Calcrete

7.3.1 Geology

A layer of grey, occasionally laminated calcrete is present throughout most of the study area, where it caps the Mesoproterozoic bedrock units and immediately underlies the unconsolidated sands of the Gordonia Formation (Figures 5-7).

7.3.2 Palaeontological potential

Where exposures of the calcrete were encountered during the site investigation they were without exception unfossiliferous. It is believed that this stratigraphic unit has no palaeontological potential within the study area.

7.4 Gordonia Formation

7.4.1 Geology

The stratigraphic units comprising the Kalahari Group constitute the most extensive body of terrestrial sediments of Cenozoic age in southern Africa. The Kalahari Group is composed (in order of decreasing stratigraphic age) of the Wessels, Budin, Eden, Obobogorob, Gordonia and Lonely Formations (Partridge *et a*l., 2006).

The Late Pliocene/Early Pleistocene to Recent age Gordonia Formation consists of red aeolian sands covering most of the underlying stratigraphic units within the region and usually rests on a calcrete surface (Figures 5-7). The unit is up to 30 m thick and consists of rounded quartz grains colored red by a thin coating of hematite. Aeolian overprinting of sands originally deposited by streams and sheetwash is evident in some places. A considerable area of the Gordonia Formation is covered by linear dunes which are now stabilized by vegetation. These dunes may have formed as early as the Late Pleistocene or Early Pleistocene (Moore and Dingle, 1998).

Within the developable Area the sands of the Gordonia Formation are widely distributed throughout the Development Area, although Figure 4 indicates that they are mostly confined to the northern and eastern portions. Where present within the site these sands dunes consist of a thin veneer of orange-red colored, unconsolidated aeolian sand up to several centimeters thick (Figurs 5-7).

Figure 5: Scattered outcrop of grey, unfossiliferous calcrete with a thin veneer of unconsolidated orange-red coloured Gordonia Formation sand (Waypoint Alb1, Figure 2).

Figure 6: Scattered outcrop of grey, unfossiliferous calcrete partially covered by a flat veneer of reworked Gordonia Formation sands. The sand is only several centimetres thick over the majority of the area (Waypoint Alb2, Figure 2).

Figure 7: The calcrete horizon is relatively thick, as demonstrated by the size of some of the scattered blocks of the material found in the area (Waypoint Alb 4, Figure 2).

of the study area devoid of sand dunes these Gordonia Formation sands form a thin veneer of material up to several centimeters thick (Figure 5)

7.4.2 Palaeontological potential

The sediments of the Gordonia Formation are not noted for containing either an abundant or diverse palaeontological heritage. Indeed, no fossil occurrences are recorded in the general region in a recent compilation of geological data from the area (Moen, 2007). This paucity of palaeontological materials within the formation is possibly due to two causes. Firstly, the sand dunes that comprise the formation were deposited under dry conditions (Moen, 2007) and active, extensive dune fields are not noted for their abundance of either flora or fauna. Secondly, the unit is composed of unconsolidated, porous sands. The high porosity and permeability of the sands facilitates ready inflow and through-flow of oxidizing meteoric water flowing through these sands is not conducive to the preservation of most biological materials as fossils. Cumulatively there was low potential for biological materials to be incorporated into the sediments and a high probability for the subsequent destruction of any biological materials that may have been contained within the sands by oxidizing ground waters.

The presence of fossils within the sequence in the project area cannot, however, be completely discounted as they are known to be present in similar aged sediments elsewhere in the northwestern portion of South Africa; examples of such fossil occurrences are discussed below.

Occurring commonly within reddish aeolian sands of the Quaternary superficial deposits at Bosluis Pan are spherical calcretised termitarea up to 250 cm across. These termitarea resemble nests constructed by the extant harvester termite *Hodotermes* (Macey *et al*., 2011). There are also smaller nests (8 cm in diameter) resembling those of *Psammatermes* present (De Wit, 1990).

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

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

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

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

No fossil materials of any kind were located during the extensive foot traverse or other observations made within the Developable Area.

8 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The project area, which will contain both phases of the project, is large occupying an area of approximately 1 143 ha. Topographically the area predominantly consists of a flat, featureless land surface (Figures 8, 9 and 10). A number of small ephemeral stream systems drain the extreme southern portion of the developable area (Figure 10) and eventually flow into the Orange River which is located immediately to the adjacent southern margin of the study area.

Mucina and Rutherford (2006) indicate that the vegetation cover of the northern portion of the Developable Area is vegetated with a cover of the Kalahari Karroid Shrubland vegetation type, while the southern area is vegetated with Bushmanland Arid Grassland (Figure 11). The conservation status of both veld types is listed as least threatened by Mucina and Rutherford (2006). It was apparent during the field investigation that the entire Developable Area is utilised for grazing.

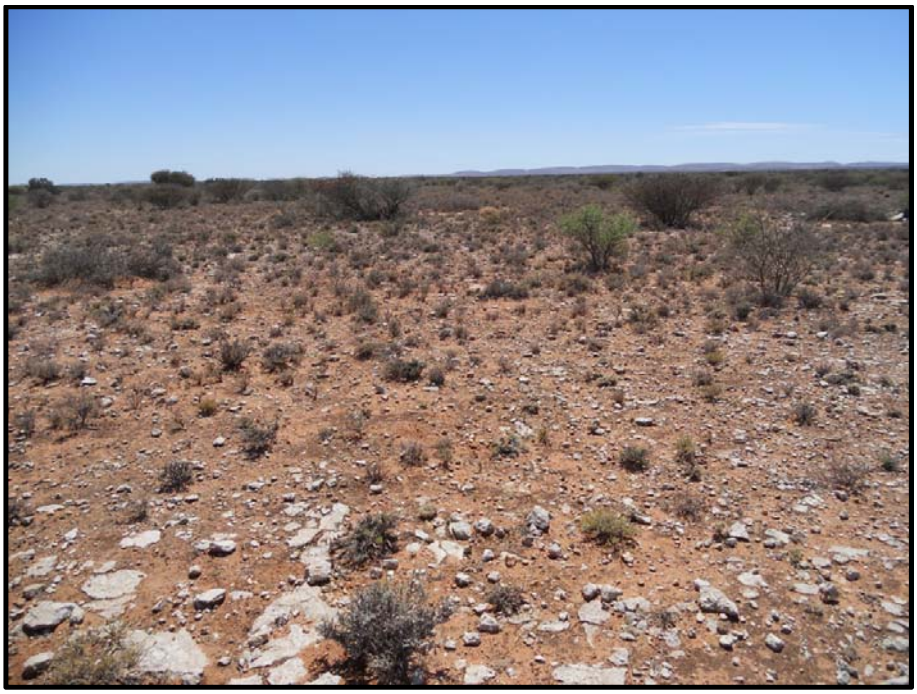

Figure 8: Photograph of the Developable Area from Waypoint Alb2 (see Figure 2). View is to the east.

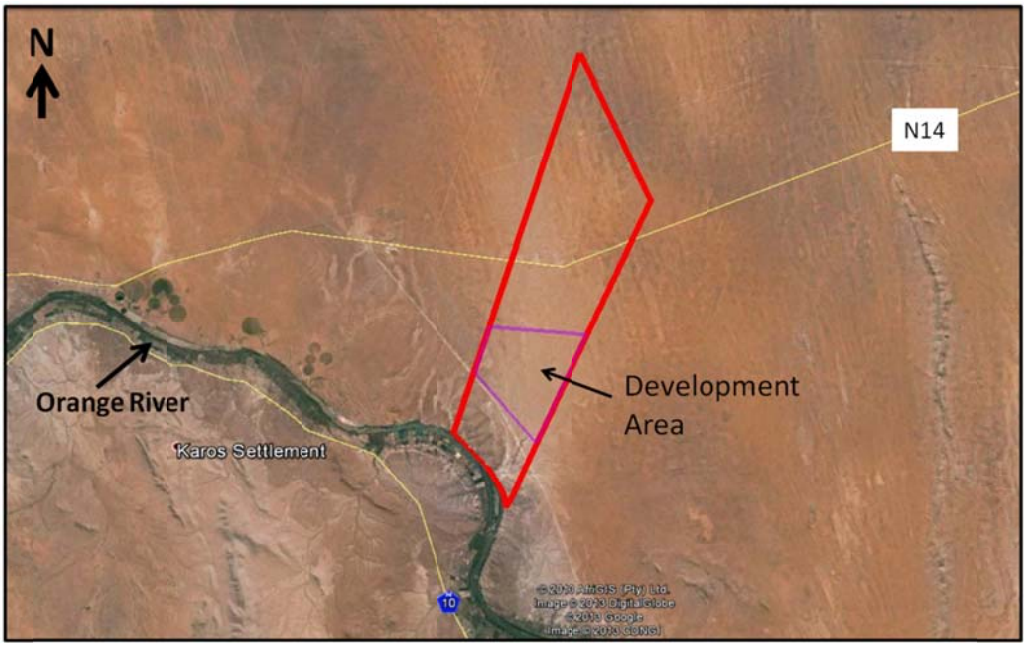

Figure 9: Google Earth image of the Developable Area (the purple polygon) within the farm boundary (red polygon). Evident from the image is that that the general evirons of the project area are extremely flat and featureless, except for the Orange River to the south

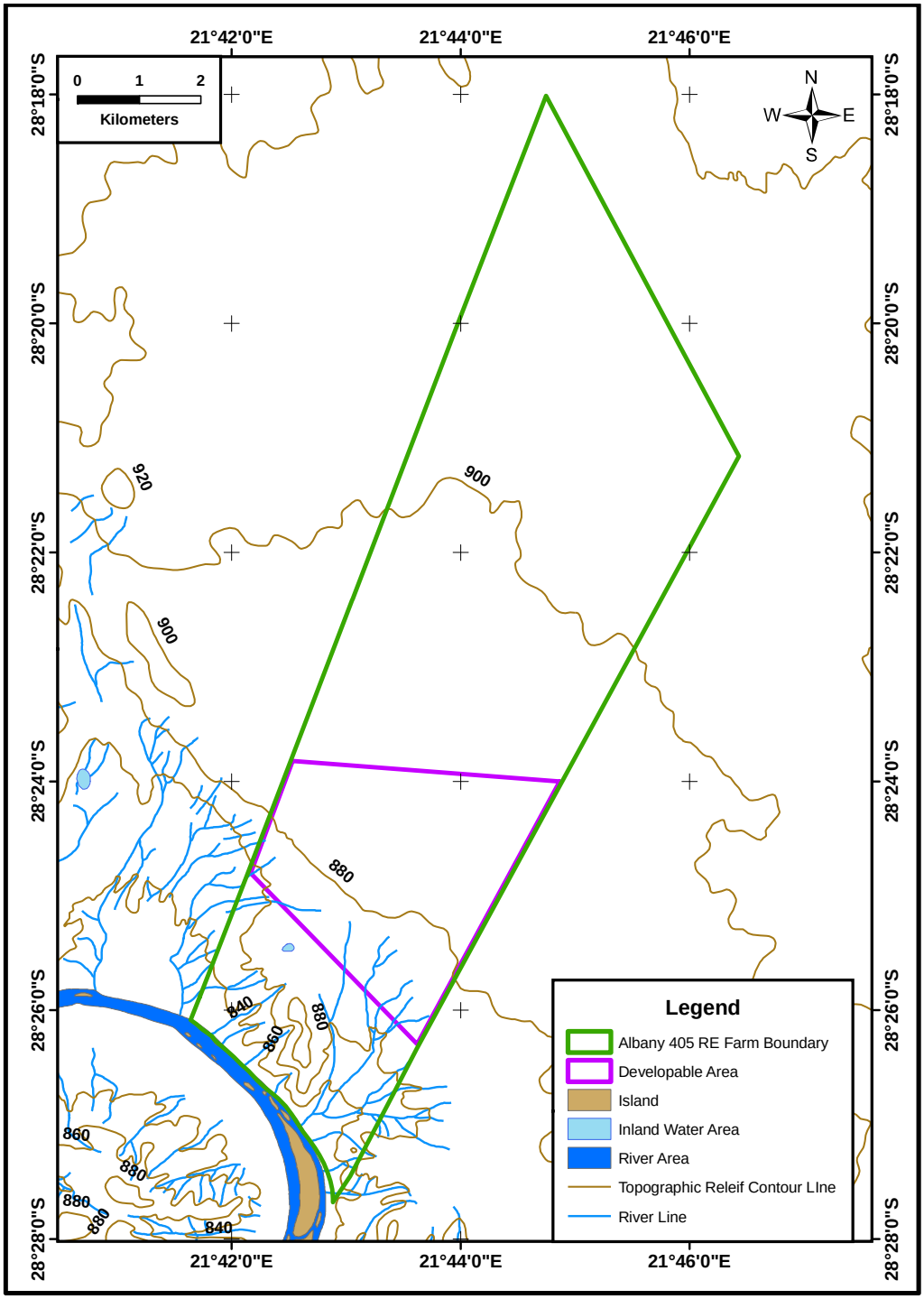

Figure 10: Map of the project area with topographic contours superimposed. It is evident that the project area consists of a flat, featureless landscape. Located within the southern-most portion of the Developable Area are a number of small ephemeral

drainage lines that drain into the Orange River. The contour interval of the topographic contours is 20 m.

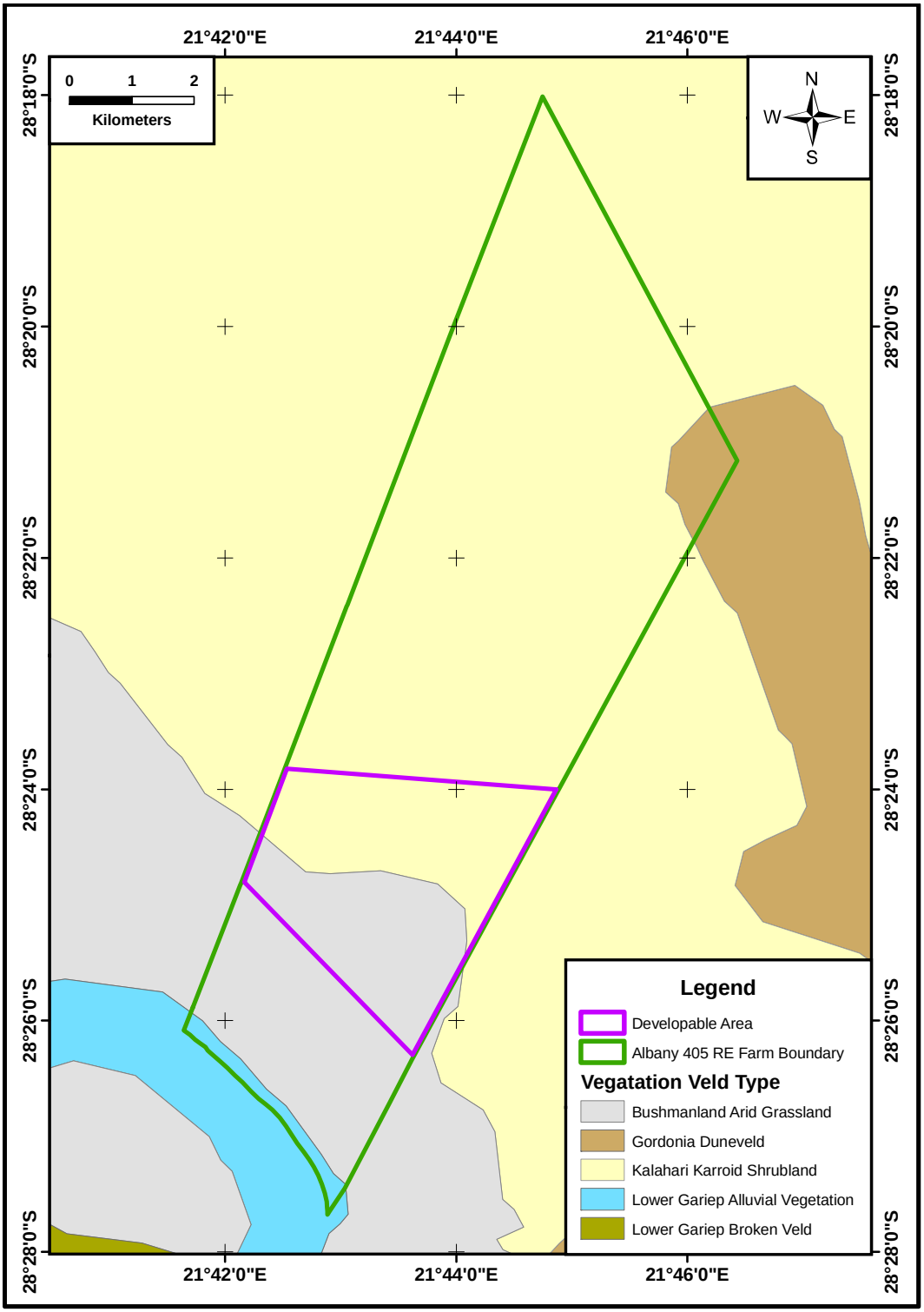

Figure 11: Map of the distribution of the vegetation veld types located within the project area and surrounding environs (after Mucina and Rutherford, 2006).

9 OVERVIEW OF SCOPE OF THE PROJECT

9.1 Project Infrastructure

The proposed power generation project will consists of a 150 MW solar energy generation facility to be constructed in two separate phases of 75 MW each to connect to ESKOM's grid facility.

Each facility will include the following infrastructures:

- Arrays of photovoltaic (PV) panels
- Appropriate mounting structures
- Cabling between the project components, to be lain underground where practical.
- New on-site substation and power line to evacuate the power from the facility into the Eskom grid via the existing Garona-Gordonia 132kV power line that traverses the site.
- Internal access roads and fencing.
- Workshop area for maintenance, storage, and offices.

9.2 Impact of Infrastructure

Construction of the infrastructure will predominantly be limited to the land surface. The underlying geology (and any contained fossils) will be disrupted to a maximum depth of 1-2m.

10 IMPACT ASSESSMENT

The potential impact of Tewa Isitha Solar 1 and 2 power generation facilities is categorised below according to the following criteria:-

10.1 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.

10.2 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 comprising 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). As the Developable area is relatively large a scoring **value of 2** is applied, herein, to the extent of the impact.

10.3 Duration of Impact

The anticipated duration of the identified impacts is assessed as potentially **permanent to long term**. This is assessment is based on the fact that, in the absence of mitigation procedures (should undiscovered fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be **permanent**. Similarly, any fossil undiscovered materials exist in the subsurface 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** > 15 years). Using the worst case scenario for the duration of the impact (i.e., permanent) a **scoring value of 5** is assigned for the duration of the impact.

10.4 Magnitude of Impact

No fossil materials were located during the conduct of the field investigation. All stratigraphic units appear to be unfossiliferous within the Development Area, but there

remains a small possibility of undiscovered fossil materials occurring within the subsurface portions of the Gordonia Formation. Should such fossils exist they would potentially be of significant scientific importance. Accordingly, the magnitude of the impact of the two proposed solar production areas upon the palaeontological heritage of the area is assessed as **high** (**= a scoring value of 8**). Should the mitigation procedures suggested, herein, be performed no fossil materials of any significance will be negatively impacted. Accordingly, the magnitude of the resultant impacts will be **small (= a scoring value of 0)**.

10.5 Probability of Impact

The Koras Group and Zonderhuis Formations are considered to be unfossiliferous, herein, due to the combination of their Mesoproterozoic age (preceding the advent of macrofossils) and the absence of carbonate lithologies within the sequence. As such the probability of the proposed project causing any negative impact on the palaeontological heritage is **nil**.

The sands of the Gordonia Formation are not noted for possessing either an abundant or diverse palaeontological heritage. However, similarly aged strata within the Northern Cape Province do contain scattered fossil assemblages. However, no fossil material of any description was located during within the study area during the field visit and it appears that the Gordonia Formation is unfossiliferous within the developable area. There remains a small possibility that there may be fossil material within the subsurface and this geological unit is ubiquitous within the development Area, but the probability of any development negatively impacting a fossil within the unit is assessed as **improbable (= a scoring value of 1)**.

10.6 Significance of the Impact

The fossils potentially contained within the Gordonia Formation are geologically young and as such, are most significant in terms of information that they may provide concerning insights they may provide into the historical climatic and ecological status of the immediate region. Due to the young age of the unit many of the taxa present may be expected to be extant, but a number of extinct taxa are also known to be present within similarly aged sediments elsewhere in South Africa; their significance is potentially **high**. As no fossil materials are expected to be present within the rocks of either the Koras Group or Zonderhuis Formations the severity of any negative effects on the palaeontological heritage of these formations is categorised as being **nil**.

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.

The significance of the impacts resulting from the proposed project is calculated as follows:

S = (E+D+M)P

Where

S = Significance
E = Extent
D = Duration
M = Magnitude
P = Probability

Accordingly, the significance of any impacts posed by the project upon the palaeontological heritage of the area is calculated as being;

Unmitigated
S = (2+5+8)1
S = 15

The calculated significance value of 15 equates to a Significance Weighting of **Low** (i.e., <30 points) if no mitigation processes are performed.

Mitigated
S = (2+5+0)1

S = 7

The calculated significance value of 7 equates to a Significance Weighting of **Low** (i.e., <30 points) if mitigation processes are performed.

10.7 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 for the Gordonia Formation (if appropriate mitigation procedures are put into place) and nil for the rocks of the Koras Group, Zonderhuis Formation and the calcrete.

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 sediments of the Gordonia Formation may contain important or unique fossils. Thus, it is possible that there are fossils of 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 improbable, the severity of any impact is potentially 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.

10.8 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.

11 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.

11.1 Mitigation

No fossil materials were identified within the study area during the site visit, but the small possibility exists that fossils may be present within the subsurface portions of the Gordonia Formation. It is recommended that a close examination of all excavations be made while they are occurring within the Gordonia Formation sands. 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.

11.2 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**.

11.3 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 and total**.

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 highest 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.

12 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

Fossils occur sporadically within geological units and their location cannot be accurately predetermined. Despite a comprehensive investigation of the project areas by foot less than half of the Development Area was investigated intensively (see Section 4.2). The possibility remains that there may be fossil materials occurring at the surface that were not located, or within the subsurface of the Gordonia Formation that were not observed in the field.

13 ENVIRONMENTAL IMPACT STATEMENT

A comprehensive, foot-based investigation of the palaeontological potential of much of the eastern portion of the Development Area has been conducted. **No fossil materials were located during the site investigation**. Subsequent to the completion of the field investigation the proposed locations of the two phases of construction were relocated for commercial reasons. The result of the relocation (predominantly of Phase 2) is that the Developable Area become greatly enlarged and that some of the northern and southern margins as well as the entire western half of the new area have not been intensively investigated. However, as part of the field work various parts of this enlarged area were visited and it is apparent that the superficial geology and palaeontological potential of most of the Developable Area is identical to that of the area which was intensively investigated. The exception to the uniformity of the superficial geology is the presence of accumulations of fluvial pebbles and cobbles in the south-western corner of the developable area; observations in the field suggest that these

gravels are unfossiliferous. As a result of the combination of all these factors it is proposed, herein, that this report constitutes a Full Palaeontological heritage Impact assessment of the entire Developable Area.

The area reported upon herein known as the developable area is aerially extensive (approximately 1 143 ha in extent). Contained within this general area are two smaller areas that will constitute Phase 1 and 2 of the project, but the final extent and location of the infrastructure elements required for each is yet to be finalised. 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 (1-2m) depth. The Gordonia Formation is the only potentially fossiliferous unit and as it is present as a thin (several centimetres thick) veneer. As such, it is highly improbable that any fossil materials that remain undiscovered after the construction of the project will be located beneath the infrastructure elements and become unavailable for scientific study as long as the infrastructure elements exist.

This study has identified that of the geological units that underlie the project area only the Gordonia Formation is potentially fossiliferous and may be negatively impacted. No fossil materials were identified within the environs of the Development Area. However, the presence of fossil assemblages is documented within sediments coeval with the Gordonia Formation elsewhere within the Northern Cape Province and these have provided valuable insights into the paleoclimate and paleoecology of the region.

There is a potential for negative impact on the palaeontological heritage of the project area throughout the majority of its extent (due to the extensive extent of coverage of the Gordonia Formation), but the potential risk is categorised as low due to the general scarcity of fossils in the unit and as none were identified during the field investigation. The low potential is accentuated by the extreme thinness of the unit within the project area. 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. As such, the risk of a negative impact is low, but the significance of any negative impact on the fossil assemblages could potentially be 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 substantially mitigated by a thorough and ongoing examination 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. 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.

A summary of the possible impacts resulting from the proposed projects, and their relative weightings, upon the Palaeontological heritage of the two solar power production facilities is presented in Table 1.

Nature: Destruction, damage and loss of provenance of fossil materials		
	Without Mitigation	**With Mitigation**
Extent:	Low (2)	Low (2)
Duration:	Permanent (5)	Permanent (5)
Magnitude:	High (10)	Minor (2)
Probability:	Improbable (1)	Improbable (1)
Significance:	**Low (15)**	**Low (7)**
Status:	Positive	Positive
Reversibility:	Impossible	Impossible
Irreplaceable loss of resources:	Low	Low
Can impacts be mitigated:	Yes	
Mitigation: All excavations must be inspected for fossil content. Should fossils be located the relevant exaction must be halted and SAHRA informed of the find. SAHRA may instruct that a palaeontologist should evaluate the fossil material and suggest appropriate protocols to either excavate or protect the fossil material.		
Cumulative impacts: None		
Residual impacts: Permanent loss of fossil heritage		

Table 1: Summary palaeontological heritage impact assessment table for the proposed project.

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**

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

14 REFERENCES

Bamford, M.K. and De Wit, M.C.J. (1993). Taxonomic description of fossil wood from Cainozoic Sak River terraces, near Brandvlei, Bushmanland, South Africa. *Palaeontologia africana*, 30, pp. 71-80.

Cornell, D.H., Thomas, R.J., Moen, H.F.G., Reid, D.L. Moore, J.M., and Gibson, R.L. (2006). *The Namaqua-Natal Province*. 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. 325-379.

De Wit, M.C.J. (1990). Palaeoenvironmental interpretation of Tertiary sediments at Bosluispan, Namaqualand. *Palaeoecology of Africa and the Surrounding Islands*, 21, pp. 101-118.

Jacobs, J., Thomas, R.J. and Weber, K. (1993). Accretion and indentation tectonics at the southern margin of the Kaapvaal Craton during the Kibaran (Grenville) Orogeny. Geology, 21, 203-206.

Kent, L.E. and Gribnitz, K.H. (1985). Freshwater shell deposits in the northwestern Cape Province: further evidence for a widespread wet phase during the Late Pleistocene in Southern Africa. South African Journal of Science, 61, pp. 361-370.

Macey, P.H., Siegfried, H.P., Minnaar, H., Almond, J. And Botha, P.M.W. (2011). The geology of the Loerisfontein Area. Explanation of 1: 250 000 Geology Sheet 3018. Council for Geoscience, 139 pp.

Moen, H.F.G. (2007). *The geology of the Upington area*. Explanation: Sheet 2820 Scale 1: 250 000. Council for Geoscience. 160 pp.

Moore, A.E. and Dingle, R.V. (1998). Evidence of fluvial sediment transport of Kalahari sands in central Botswana. *South African Journal of Geology*, 101, pp: 143-153.

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

Partridge, T.S., Botha, G.A., and Haddin, I.G. (2006). *Cenozoic deposits of the interior*. 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. 585-604.

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.

Senut, B. and Pickford, M. (1995). Fossil eggs and Cenozoic continental biostratigraphy of Namibia. Palaeontologia africana, 32, pp. 33-37.

Senut, B., Pickford, M., Ward, J., De Wit, M., Spaggiari., R. and Morales, J. (1996). Biochronology of the Cainozoic sediments at Bosluis Pan, Northern Cape Province, South Africa. South African Journal of Science, 92, pp. 249-251.

Dr B.D. Millsteed

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Appendix A

Standard Conventions for Assessing Impacts

Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified as a result of this study have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

Where

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).