DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF A PROPOSED 75 MW SOLAR ENERGY FACILITY TO BE LOCATED ON THE FARMS BEYERS 186 NEAR HENNEMAN, FREE STATE PROVINCE

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On Behalf of:

FRV Energy South Africa (Pty) Ltd

Prepared By:

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EXECUTIVE SUMMARY

FRV Energy South Africa (Pty) Ltd proposes to construct an 75 MW photovoltaic solar energy facility on a site located approximately 4 Km to the west of Hennenman, within the Magisterial District of Lejweleputswa in the Free State Province of South Africa. The site occupies an area of approximately 393 Ha and is located wholly within the farm Beyers 186.

FRV Energy South Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd, as independent consultants, to undertake a Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme ("EMP"). Savannah Environmental (Pty) Ltd appointed Heritage Contracts and Archaeological Consulting CC to conduct the Heritage Impact Assessment component of the Scoping Study. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact assessment Report.

The project is anticipated to consist of the following technology and infrastructural elements:

» Mounting structures for the solar panels to be either rammed steel piles or piles with pre-manufactured concrete footings to support the PV panels.
» Cabling between project components, to be lain underground where practical.
» A new on-site substation to evacuate the power from the facility into the Eskom grid.
» A loop in loop out power line connection to the 132kV power line on the farm, which connects to the Theseus 132/44/11 kV substation.
» Internal access roads and fencing.
» Workshop area for maintenance, storage, and offices.

The final location and extent of the project 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.

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

1. Cainozoic regolith
2. Adelaide Subgroup

The Cainozoic regolith and the Adelaide Subgroup are both potentially fossiliferous and their stratigraphic equivalents are known to contain scientifically important fossil

assemblages elsewhere in South Africa. Accordingly, it may be reasonably expected that significant fossils may be present within the project area. Any disruption to those fossils by the proposed construction process would potentially result in permanent and irreversible damage or destruction of the fossil heritage of the area.

The entire project area is underlain by Permian sedimentary rocks of the Adelaide Subgroup, but they only crop out in the central portion of the project. The majority of the eastern- and western-most parts of the project area appear to be covered by regolith that has been extensively cultivated (ploughed). Thus, the historical farming processes have probably destroyed any fossil materials that may have been present at surface in these areas. Similarly, where present the regolith cover would hide any fossils contained within the underlying Adelaide Subgroup from discovery. The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. Any fossil materials that may have been present at/or near the surface in the cultivated regolith will have been historically destroyed and the likelihood of any negative impact is categorised as negligible. The possibility of a negative impact on the depth interval between the maximum depth of ploughing and the maximum depth of excavations within the regolith is categorised as low (due to the scarcity of fossils in general). Below the maximum depth of excavation any potential negative impact on the palaeontological heritage is restricted to the loss of opportunity for scientific study of any fossils for the life of the project. Within outcrops of the Adelaide Subgroup the possibility of negative disruption is categorised as low. It is important to recognise that while the probability that a negative impact may be assessed as low for any area; this assessment is based on the normally uncommon nature of fossils. Despite their normal scarcity any fossil material is potentially highly scientifically and/or culturally significant. Thus, while the chance of a negative impact may be low any potential negative impact that results may be high. The potential for a significant negative impact within potentially fossiliferous strata cannot be adequately accessed via a desktop study.

The project has been assessed as being socially beneficial herein. Other aspects in favour of the continuation of the project are that fossils are generally rare and sporadic in their occurrence and the chances of a fossil being negatively impacted upon in any particular area are small so there is a minor probability of a negative impact. Similarly, the area of potential negative impact that may be caused by the project is characterised as local. Similarly, the zone of permanent disruption is vertically restricted to the maximum depth of any excavations associated with the proposed constructions, and this is likely to be restricted to the upper 1-2 meters of the land surface.

The possibility of any negative impact on the palaeontological heritage of the project area could be minimised by the conduct of a thorough site investigation by a palaeontologist prior to commencement of the project. This site investigation would make it possible that scientifically and/or culturally significant fossils may be discovered that would be otherwise damaged, destroyed or inadvertently moved. Similarly, a thorough examination should be made of all excavations as they are being performed.

Should any fossil materials be identified during the construction phase, the excavations should be halted and SAHRA informed of the discovery. A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

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

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FRV Energy South Africa (Pty) Ltd proposes to construct an 75 MW photovoltaic solar energy facility on a site located approximately 4 Km to the west of Hennenman, within the Magisterial District of Lejweleputswa in the Free State Province of South Africa. The site occupies an area of approximately 393 Ha and is located wholly within the farms Beyers 186(Figure 1).

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2. TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

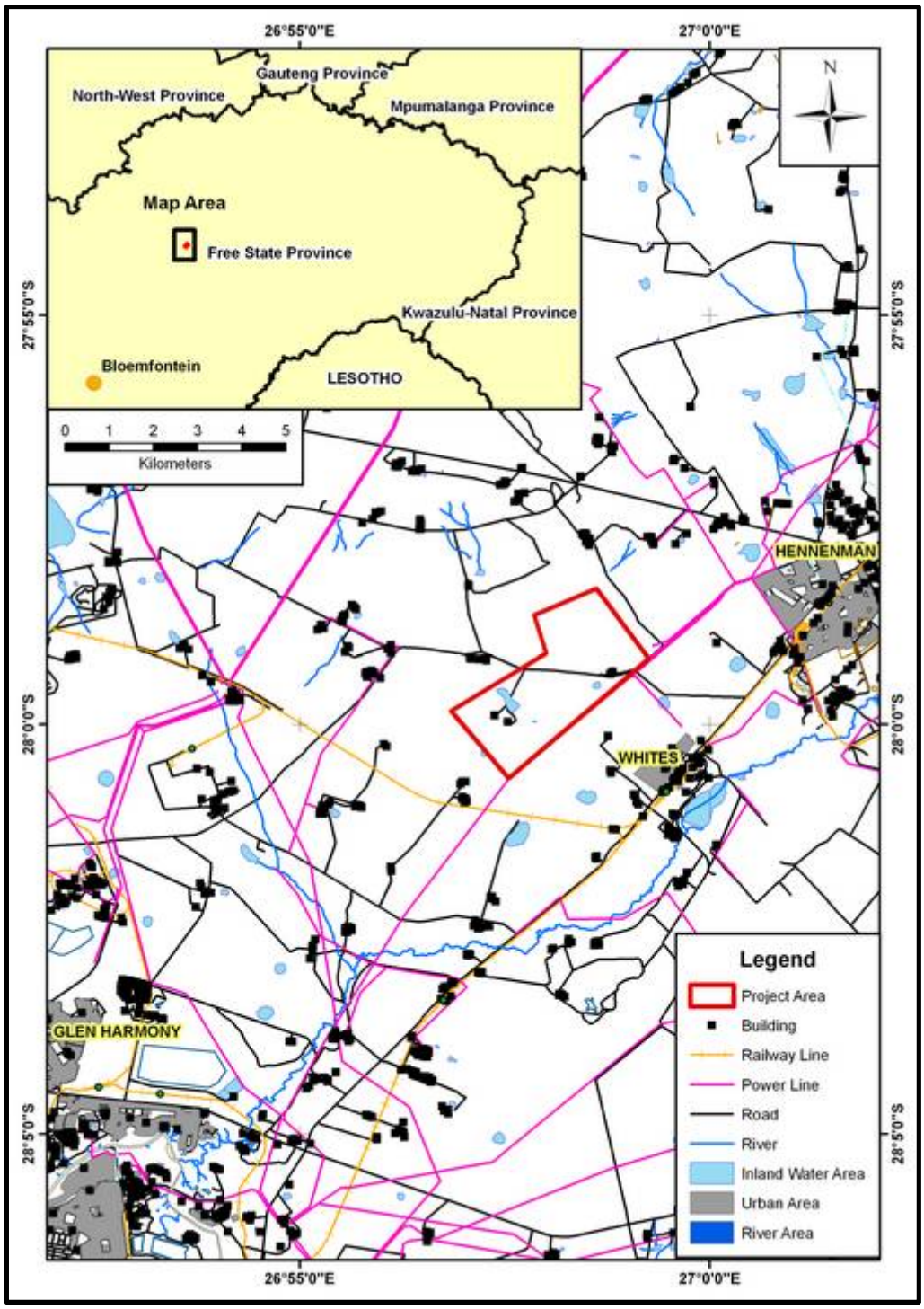

Figure 1: Location map showing the position of the proposed FRV Energy South Africa (Pty) Ltd's solar energy generation facility.

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 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.).

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 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. RELEVENT EXPERIENCE

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

5. INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact assessment study and shall receive remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either FRV Energy South Africa (Pty) Ltd or the proposed power generation facility.

6. GEOLOGY AND FOSSIL POTENTIAL

Figure 2 shows that the project area underlain by Late Permian sedimentary rocks of the Adelaide Subgroup. It is also evident from Figure 3 that much of the geology of the eastern- and western-most portions of the area lies beneath an extensive cover of Cainozoic regolith consisting of aeolian sands.

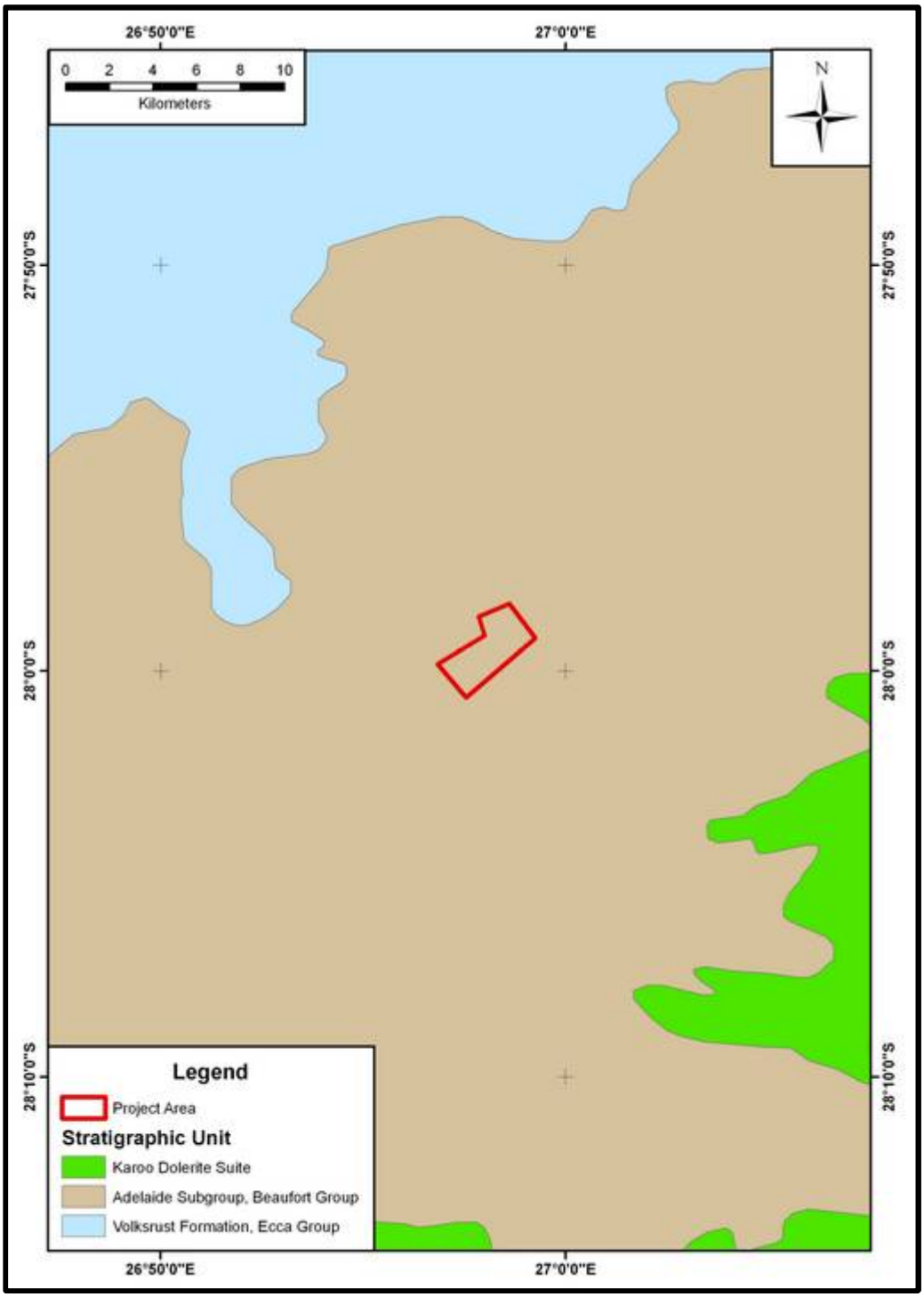

Figure 2: Map of the bed rock geology of the project area and its environs.

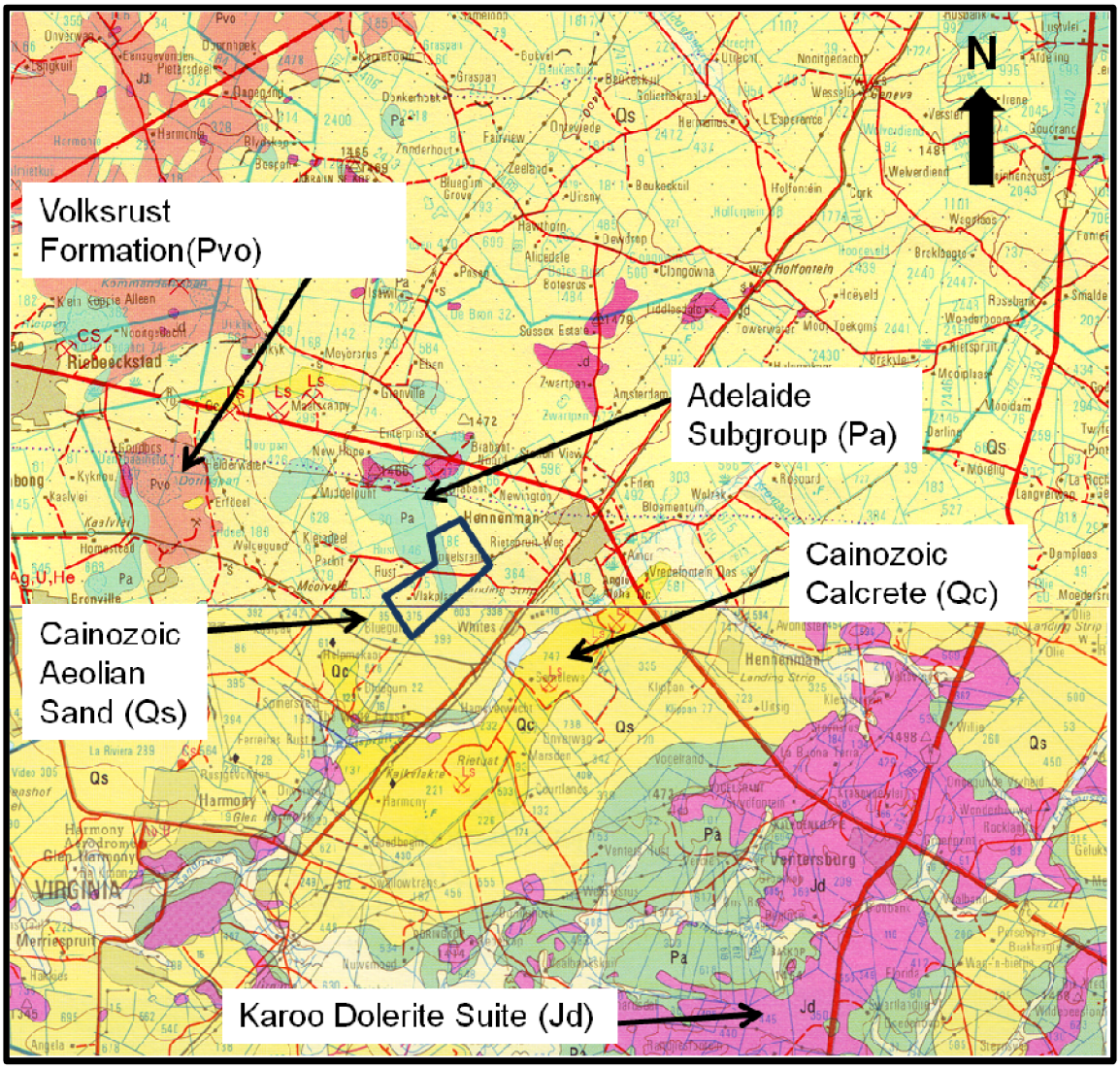

Figure 3: Map of the surface geology of the project area (blue polygon) and its immediate environs. It is evident that the western and eastern of the extents of the project area are covered by Cainozoic aeolian sands while in the central portion the rocks of the Adelaide Subgroup crop out (modified from Geological Survey of South Africa 1: 250 000 geological map series 2826 Winburg and Geological Survey of South Africa 1: 250 000 geological map series 2726 Kroonstad).

Approximately 8 Km to the north-west of the project area are exposures of the Early Permian strata of the Volksrust Formation (Figure 2). The Volksrust Formation stratigraphically older than the Adelaide Subgroup strata and it is probable that the Volksrust Formation underlies the Adelaide Subgroup at depth within the project area. Figure 2 shows that there are substantial exposures of rocks of the Karoo Dolerite Suite located approximately 11 Km to the south-east of the project area. Figure 3 indicates that there are small exposures of dolerites of the Karoo-age dolerite located

approximately 1 Km to the north of the project area, but not within the area; it is possible that these dolerites may be present, but are covered by the Cainozoic regolith. As the dolerites are intrusive igneous rocks they have no palaeontological potential. A brief description of the Adelaide Subgroup and the Cainozoic regolith and their potential palaeontological contents is provided below.

6.1 Cainozoic regolith

6.1.1 Geology

Figure 3 indicates that there is an aerially extensive cover of Cainozoic age regolith of unknown thickness over the entire project area. The legend of Geological Survey of South Africa 1: 250 000 geological maps series 2826 Winburg and 2726 Kroonstad indicates that these sands were deposited by aeolian processes.

6.1.2 Palaeontological potential

Cainozoic age palaeontological sites are occasionally identified in alluvial terraces and dongas throughout South Africa. It may be expected that large mammal bones, dentition, horn cores, micromammal bones and fresh water molluscs may be identified within strata of this age.

6.2 Adelaide Subgroup

6.2.1 Geology

The project area is completely underlain by Late Permian sedimentary rocks of the Adelaide Subgroup, Beaufort Group (Figure 2). In the south and central portions of the Main Karoo Basin 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. In the north-eastern region of the basin only a single formation (the Normandien Formation) is present (Groenewald, 1984, 1990; Figure 4).

In general the Adelaide Subgroup consists of alternating bluish-grey, greenish-grey or greyish-red mudrocks and grey, very fine- to medium-grained lithofeldspathic sandstones (South African Committee for Stratigraphy, 1980). Sandstones generally constitute 20-30% of the total thickness of the sequence, but maybe as high as 60% and as low as 10%. Deposition within the northern part of the basin varies from that in

the remainder of the basin in that coarse to very coarse sandstones or even granulestones are common within the Normandien Formation and the mudstones of the Adelaide Subgroup are generally massive and blocky weathering except in parts of the Normandien Formation and Daggaboersnek Member where horizontal lamination is common and rhythmites are common (Johnson *et al*., 2006). The sediments of the Normandien Formation are further differentiated from the remainder of the Adelaide Subgroup in that thin coal beds are occasionally present in the lower part (Botha and Linstrőm, 1984; Groenewald, 1984).

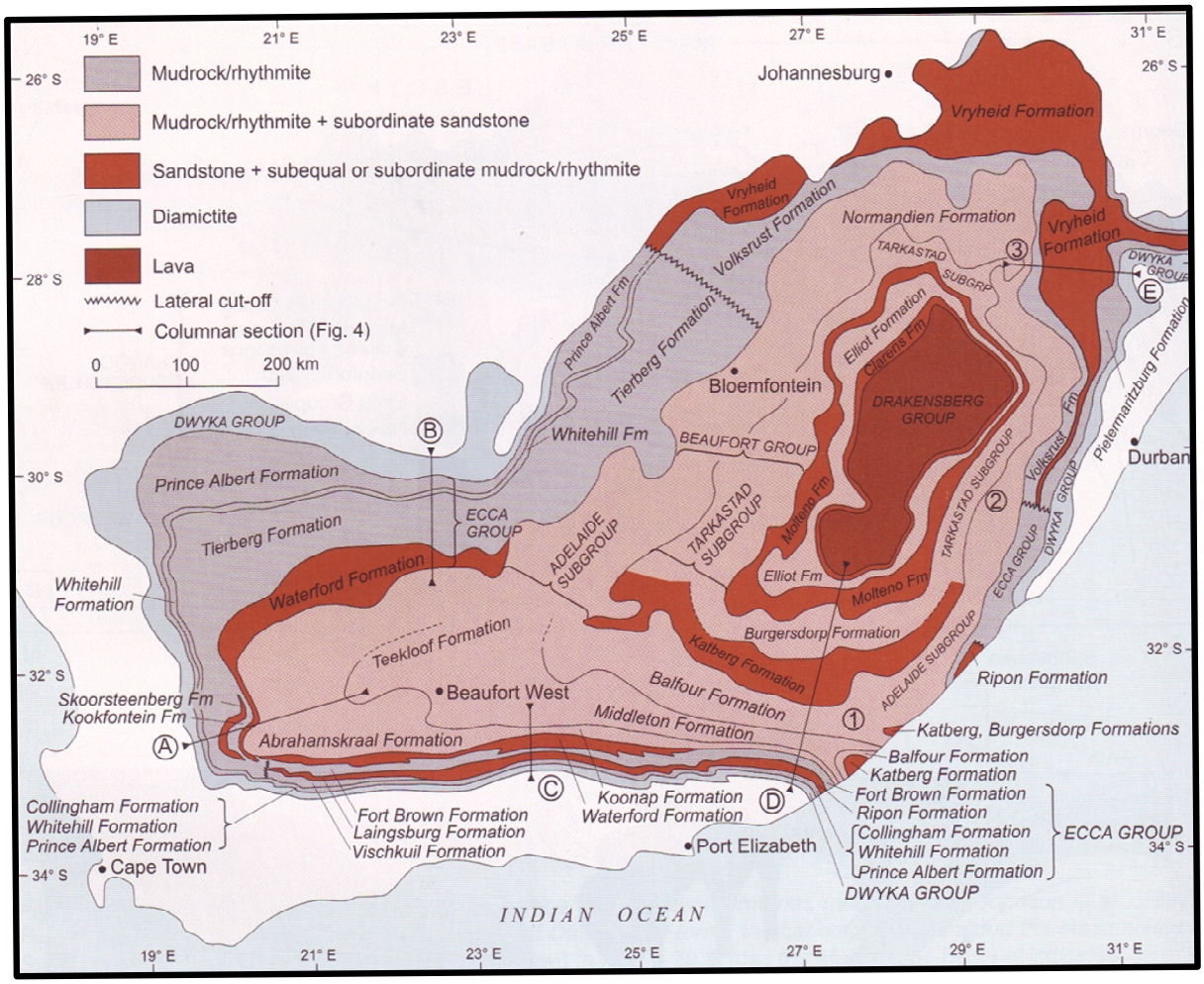

Figure 4: Schematic geological map of the Main Karoo Basin showing the location of the various stratigraphic subdivisions of the Adelaide Subgroup as well as the major lithological characteristics of each major stratigraphic unit (Johnson *et al*., 2006).

Genetically the Normandien Formation differs from the strata coeval in the southern and central portions of the Karoo Basin in that deposition took place within a west-northwesterly fluvial transport system (Cole and Wipplinger, 2001). The depositional

system was initially lacustrine and deltaic with progradation to the east and changed upwards into fluvial meandering under drier conditions (Cole and Wipplinger, 2001).

6.2.2 Palaeontological potential

The project area falls within the distribution of the *Dicynodon* Assemblage Zone (Kitching, 1995; Figure 5). The fossil record of this biostratigraphic zone is diverse and includes 62 species of synapsid reptiles, six species of captorhinid reptiles, two species of eosuchian reptiles, two fish genera (*Namaicthys* and *Athersonia)*, two amphibians (*Laccocephalus* and *Rhinesuchus*) and the mollusc *Palaeomutela* (Kitching, 1995). A total of 34 genera of insects have been described from western Natal Province (Riek, 1973, 1976a, 1976b). Trace fossils including arthropod trails and worm burrows have also been recorded from this biostratigraphic unit (Kitching, 1995).

It may be expected that this sequence may also contain plant fossils (including silicified wood) belonging to the *Glossopteris* flora (Johnson *et al*., 2006). Bamford (2004) indicates that this sequence contains the fossil wood genera *Agathoxylon* and *Australoxylon*.

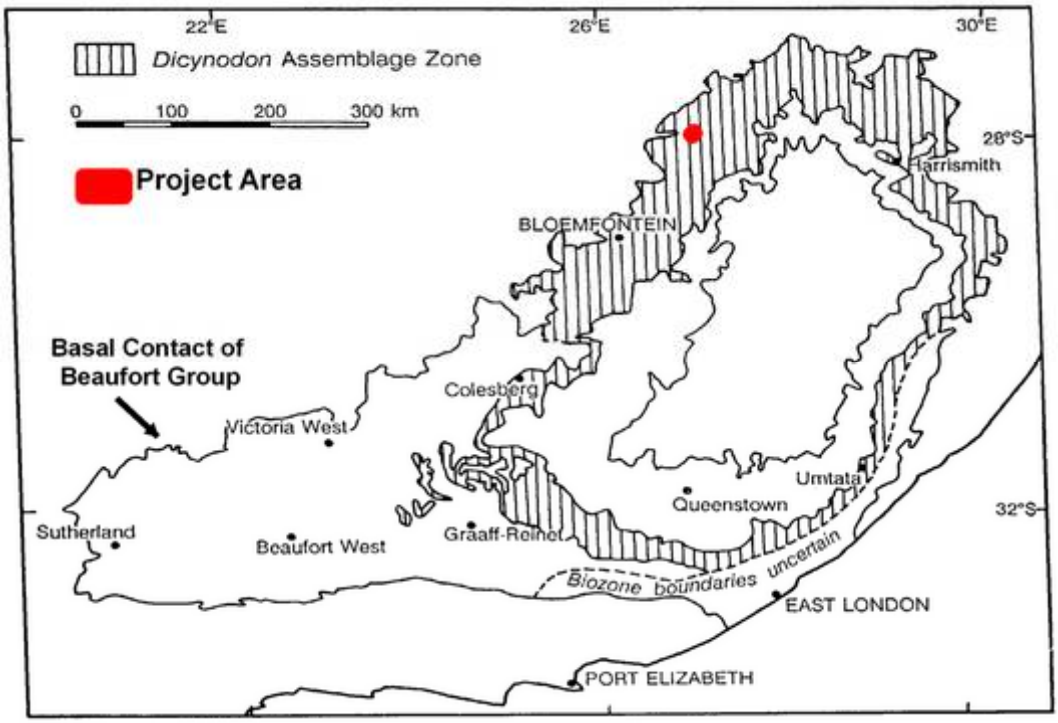

Figure 5: Map of the Main Karoo Basin showing the distribution pattern of the *Dicynodon* Assemblage Zone showing the location of the project area. Indicated is the outcrop distribution of the basal contact of the Beaufort Group (modified from Kitching, 1995).

7. ENVIRONMENT OF THE PROPOSED PROJECT SITE

The project area is approximately 393 Ha in extent. Examination of Google Earth imagery of the project area suggests that the land surface is essentially flat, featureless and appears to be used for agriculture and has been extensively cultivated in the eastern- and western-most portions (Figure 6).

Figure 6: Google Earth image of the project area (the red polygon) and its environs. It is evident from the image that the eastern and western extents of the area has been extensively cultivated (ploughed) for agricultural use. The dark coloured central region of the project area coincides with the area of outcrop of Adelaide Subgroup strata.

8. OVERVIEW OF SCOPE OF THE PROJECT

The proposed facility will have a generating capacity of approximately 80 MW. The main infrastructure includes the following technology and infrastructural elements:

» Mounting structures for the solar panels to be either rammed steel piles or piles with pre-manufactured concrete footings to support the PV panels.
» Cabling between project components, to be lain underground where practical.
» A new on-site substation to evacuate the power from the facility into the Eskom grid.
» A loop in loop out power line connection to the 132kV power line on the farm, which connects to the Theseus 132/44/11 kV substation.
» Internal access roads and fencing.
» Workshop area for maintenance, storage, and offices.

The extent of the vertical disturbance of the regolith and/or bedrock profile that can be anticipated by this project has not been specified. However, comparison to other similar solar power generation facilities suggests that the disruption would be shallow (i.e., restricted to approximately the top 1-2 meters of the land surface). The following impact assessment is made in the light of this assumption.

9. IMPACT ASSESSMENT

The potential impact of FRV Energy South Africa (Pty) Ltd's solar power generation facility is categorised below according to the following criteria:-

9.1 Nature of Impact

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

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

- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

9.2 Extent of impact

The possible extent of the impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **long term**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below the structures and infrastructural elements that will constitute the power generation facility will be unavailable for scientific study for the life of the existence of those features.

9.4 Probability of impact

It is pertinent to realise that fossils are generally scarce and sporadic in their occurrence and as such the probability of any development affecting a fossil at any particular point on the land surface in relatively low. However, both the Adelaide Subgroup and Cainozoic regolith are potentially fossiliferous and as the area under consideration is large (approximately 393 Ha) there is a reasonable chance of fossil materials occurring within the rocks underlying the project area.

Should any excavation or development occur along the central portion of the project area, where the Adelaide Subgroup strata crop out (Figure 3), the probability of any fossils contained within those strata being negatively affected is assessed as **low**.

The eastern and western portions of the project area appear to be extensively covered with Cainozoic regolith. It was indicated in Section 7 above and illustrated in Figure 6 that much of this regolith cover appears to have been extensively cultivated (ploughed). The implication of the heavily cultivated nature of the regolith is that any fossils that may have existed within the surface of the regolith will have been destroyed damaged as

a result of the historical farming operations. The likelihood of a direct negative impact on the palaeontological heritage on the immediate land surface of these ploughed areas can be described extremely **low to negligible**.

Comparison to other similar solar power projects being planned within South Africa suggests that the disruptions and excavations associated with the construction of the project will be restricted to the upper 1-2 meters of the land surface. Accordingly, if the regolith layer is thicker than this there will be no permanent damage to the fossil content of the underlying Adelaide Subgroup. If the thickness of the regolith layer is determined and the maximum depth of disturbance of the land surface to be expected due to the project is determined these possibilities can be better quantified.

In accordance with the above discussion points **the probability of any negative impact on the palaeontological heritage of the area is categorised as low**.

9.5 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 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.

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 underscored by the fact that the rocks of the Karoo Supergroup (of which the Adelaide Subgroup are part) are known as one of the most complete and important rock sequence in the world in terms of its fossil record 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. 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. This situation would also be true of any fossil materials that occur within the regolith horizon below the depth of disturbance due to historical ploughing. Thus, **although the likely hood of any disturbance of palaeontological materials is low, the severity of any impact is potentially high**.

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project would certainly expose deeper portions of the regolith horizon that are unaffected by the historical cultivation practises and possibly even the rocks of

the Adelaide Subgroup. 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 to be able to study and excavate fossil materials that would otherwise be hidden to scientific study.

9.6 Significance

Should the project progress without due care to the possibility of fossils being present within either the bedrock or regolith the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. This is significant as fossil materials occurring within the project area are potentially scientifically significant. However, if adequate mitigation processes are put into place then the potential for damage to any fossil material can be minimised. Accordingly, **the significance of the proposed project on the palaeontological heritage is categorised as low if appropriate mitigation procedures are put into place**.

9.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced prior to commencement of the construction phase little to no negative effect on the palaeontological heritage of the area is anticipated. As the proposed project would supply electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

10. DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

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

10.1 Mitigation

A thorough field investigation by a palaeontologist prior to the commencement of construction, of the site identified for final development of the solar power generation facility, would allow a meaningful evaluation of the extent of the affects of any cultivation practices upon the fossil-bearing potential of the regolith. Such an investigation would allow the location of all areas of outcrop of Adelaide Subgroup as well as areas of regolith that are undisturbed by historic cultivation to determine their

fossiliferous potential. If any of the area proves fossiliferous, the process would allow the identification of any fossil materials that should either be protected completely or could have damage mitigation procedures emplaced to minimise negative impacts.

It is also recommended that a close examination of all excavations be made while they are occurring. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery. A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

10.2 Reversal of damage

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

10.3 Degree of irreversible loss

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

By their nature fossils are usually scarse 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 within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

11. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

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

Cainozoic age palaeontological sites are occasionally identified in alluvial terraces and dongas throughout South Africa. It may be expected that large mammal bones, dentition, horn cores, micromammal bones and fresh water molluscs may be identified within Cainozoic strata. Examination of the available data for project site indicates that there are no significant fluvial features present near the project area, but the presence of fluvial terraces in the area is not unknown. There are, however, significant exposures of potentially fossiliferous Cainozoic strata evident across the area on the geological maps of the area (Geological Survey of South Africa 1: 250 000 geological map series 2826 Winburg and 2726 Kroonstaad). It is uncertain if there would be any regolith that would be unaffected by the historical faming activities. Similarly, there may be locations within the project area where the Adelaide Subgroup crops out at surface that are not indicated on the available geological maps.

Many details concerning the aerial extent and location of the infrastructural elements that will comprise this development will only be finalised after the completion of the Scoping and Environmental Impact Assessment phase. The assumption made in this study is that the final project area will occupy a much reduced surface area than that reported on herein. This assumption is based on comparison to the size of other similar projects being proposed within South Africa.

12. ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of the proposed construction of an 75 MW solar power generation facility. This desktop study forms part of a Heritage Impact Assessment Report that is a component of a larger Scoping and Environmental Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified, and propose appropriate mitigation measures in an Environmental Management Programme.

The project site discussed, herein, is relatively large (393 Ha) in size. It is probable that the area that will be affected by the proposed project is considerably smaller, but this is yet to be finalised. Any negative effects emanating from the project will be restricted to the local environment of the final development area. It is anticipated, herein, that most infrastructural elements will only directly affect the surface of the site to a relatively shallow depth, although the maximum depth of the constructions is unknown at the time of compilation of this report.

This study has identified that there are two geological units that underlie the project area. These geological units, in order of decreasing stratigraphic age, are 1) a regolith layer composed of Cainozoic aeolian sands and 2) the underlying sedimentary rocks of the Adelaide Subgroup; both of which are potentially fossiliferous. The rocks of the Adelaide Subgroup crop out through the central portion of the project area and, as such, there is a potential for negative impact on the palaeontological heritage of the formation there; the potential risk is categorised as low. It appears that much of the eastern and western portions of the project area are covered by the regolith layer and that the regolith has been extensively disturbed by ploughing. Thus, any fossil materials that may have been present at/or near the surface will have been destroyed. The likelihood of a direct negative impact on the palaeontological heritage on the immediate land surface of these ploughed areas can be described extremely low to negligible. If areas of unploughed regolith exist, or if portions of the regolith exist that that are deeper than the zone affected by cultivation the risk of any negative impact is assessed as low.

The probability of a negative impact of the project on the fossil heritage of the area has been assessed as low for the exposures of Adelaide Subgroup and areas of regolith unaffected by cultivation (due to the normal rarity of fossils). 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, while the risk of a negative impact is low, the significance of any negative impact could potentially be high. Any damage to fossil material that occurs during the excavation and construction phase of the project would be permanent and irreversible.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. A thorough site investigation of the outcrops of the area prior to commencement of the project by a palaeontologist would make it possible that scientifically and/or culturally significant fossils, present within the Adelaide Subgroup exposures and in any uncultivated areas of regolith, may be discovered that would be otherwise damaged, destroyed or inadvertently moved. Any fossil materials 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. Similarly, a thorough and ongoing examination should be made of all excavations as they are

being performed. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery.

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

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